Efficiency Market Share Needs Assessment and Feasibility Scoping Study

Volume 1

Prepared by
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Table of Contents

Volume 1

Volume 2

List of Figures

Volume 1

List of Tables

Volume 1

Volume 2

Project Summary

Regional Economic Research, Inc. (RER) conducted the Efficiency Market Share Needs Assessment and Feasibility Scoping Study for the California Board for Energy Efficiency (CBEE) under management of Pacific Gas and Electric Company (PG&E). The objective of this study is to formulate recommendations for tracking the market shares of key energy efficiency measures in the California market. Data required for tracking efficiency market shares as defined in this study must meet the following requirements:

- Data represent unit sales, <u>and</u>
- Data are/can be segmented by efficiency level, <u>and</u>
- Data are/can be segmented by geographic region, at least at the state level, <u>and</u>
- Decision type (new construction and replace-on-burnout/retrofit/net acquisition) must be identifiable, when applicable.[1]

This scoping study is comprised of three major phases, summarized briefly below.

Needs Assessment. The objective of the Needs Assessment was to identify the specific energy efficiency measures for which a tracking system should be developed. The process of identifying energy-efficient measures and services as priorities for tracking was based upon four primary criteria: 1) the cost-effective savings potential, 2) the extent of marketing effort that will be expended to promote certain high efficiency measures through the transition period, 3) the severity of market barriers associated with individual measures, and 4) the extent to which program intervention can reduce or mitigate key market barriers. RER identified 10 priority residential measures and 10 priority nonresidential measures after reviewing existing information sources, such as market potential studies and utility program plans, and after an extensive two-stage interviewing process with industry experts and participants. Table 1 includes the priority measures for tracking that served as the basis for the remaining stages of this scoping study.

Methods Assessment. The primary objective of the Methods Assessment was to identify and investigate alternatives for tracking market shares for the 20 priority residential and nonresidential measures included in Table 1. The results of the Methods Assessment include 1) a set of possible points in the distribution channel for collecting the data required for efficiency market share tracking, for each measure and applicable decision type, and 2) a set of viable tracking methods for each priority measure and applicable decision type.

[1] Because energy efficiency programs in the state are categorized and developed according to *market events*, including new construction, retrofit, replace-on-burnout/net acquisition, it is also necessary to collect data that can distinguish these decision types.

Table 1: Priority Measures for Tracking Initiatives

Residential Sector Measures	Nonresidential Sector Measures
Duct Sealing	High Efficiency Windows
High Efficiency Central Air Conditioning	High Efficiency Packaged Air Conditioning
Compact Fluorescent Fixtures	High Efficiency Chillers
Horizontal Axis Washers	High Efficiency Motors
High Efficiency Windows	Adjustable Speed Drive Fans
Compact Fluorescent Lamps	32 Watt/T8 Lamps with Electronic Ballasts
High Efficiency Gas Furnaces	Energy Management Systems
High Efficiency Refrigerators	High Eff. Packaged Refrigeration Equip.
High Efficiency Dishwashers	Adjustable Speed Drive Pumps
High Efficiency Gas Water Heaters	Compressed Air System Optimization

Feasibility Assessment. The objective of the Feasibility Assessment, the third and final phase of this study, was to evaluate alternative tracking methods for each priority measure in a systematic, consistent manner and devise final tracking recommendations. The results of the feasibility evaluation include the four residential and three nonresidential recommended tracking initiatives summarized below.

Initiative I (Residential): Integrating On-Site Surveys and Building Department Data. This initiative integrates building department data and installation data collected with on-site surveys in the residential new construction sector. This initiative is the recommended primary data source for new construction installations of the following priority measures: duct sealing (practices), central air conditioning equipment, compact fluorescent fixtures, windows, gas furnaces, gas water heating equipment, and dishwashers. This initiative would also be a secondary data source for new construction installations of the clothes washers, compact fluorescent lamps, and refrigerators. RER estimates the costs of this initiative to be roughly $442,000 to $560,000 in the first year and $420,000 to $512,000 in subsequent years.

Initiative II (Residential): On-Site Surveys of Prescreened Residential Sites. This initiative recommends that on-site surveys be conducted for a prescreened sample of residential sites that have replaced windows or that have retrofitted air distribution ducts. This recommended initiative would be the primary data source for retrofits of the following priority measures: duct sealing (practices), and windows. This initiative can also be used as a primary data source for replace-on-burnout, or net acquisition installations of air conditioning and water heating priority measures, including central air conditioning equipment, gas water heating equipment, and gas furnaces. RER estimates the costs of this initiative to be roughly $356,000 to $445,000in the first year and $332,000 to $410,000 in subsequent years.

Initiative III (Residential). Collecting Distributor Sales Data. This initiative recommends that quarterly sales data be collected from HVAC and water heating distributors. These data will not provide tracking data by decision type.[2] However, if Initiative I is also adopted, this initiative can be the primary data source for replace-on-burnout, or net acquisition installations of the following HVAC and water heating priority measures: central air conditioning equipment, gas furnaces, gas water heating equipment, and packaged air conditioning equipment. RER estimates the costs of this initiative to be roughly $96,000 to $170,000in the first year and $68,000 to $140,000 in subsequent years.

Initiative IV (Residential): Energy Starâ /EGIA Retail Tracking. This recommended initiative is an integrated approach involving current ENERGY STAR® data collection efforts and the Electric and Gas Industries Association for tracking of replace-on-burnout and net acquisition purchases. This initiative would be the primary data source for replace-on-burnout and net acquisition purchases of the following priority measures: compact fluorescent fixtures and lamps, clothes washers, refrigerators, and dishwashers. This tracking method would be a secondary data source for replace-on-burnout and net acquisition purchases of central air conditioning equipment, residential windows, and gas furnaces. RER estimates the costs of this initiative to be roughly $160,000 to $230,000in the first year and $100,000 to $140,000 in subsequent years.

Initiative V (Nonresidential): Integrating CEC On-Site Commercial Surveys and Building Department Data. This initiative integrates data collected via the CEC commercial on-site surveys and compliance data from participating building departments throughout the state. This initiative is the recommended primary data source for new construction installations of the following priority measures: nonresidential windows, packaged air conditioning, adjustable speed drive pumps and fans (HVAC and water heating applications), 32 watt T8s with electronic ballasts, and energy management systems. RER estimates the costs of this initiative to be roughly $172,000 to $233,000in the first year and $136,000 to $180,000 in subsequent years.

Initiative Va (Nonresidential): Integrating On-Site Commercial Surveys and Building Department Data. Because of the current uncertainties regarding the CEC data collection efforts, RER offers this initiative as an alternative to Initiative V. This initiative integrates data collected via on-site surveys in the commercial sector and compliance data from participating building departments throughout the state. The measures covered by this initiative are the same as those covered by Initiative V. RER estimates the costs of this initiative to be roughly $868,000 to $1,345,000in the first year and $832,000 to $1,280,000 in subsequent years.

Initiative VI (Nonresidential): Integrating CEC On-Site Commercial Surveys and a Commercial & Industrial Sector Telephone Surveys. This initiative integrates the planned CEC commercial on-sites surveys and a telephone survey of commercial and industrial customers to collect data on retrofits of several priority measures. This initiative is the recommended primary data source for retrofits of the following priority measures: adjustable speed drive pumps and fans (HVAC

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[2] Tracking by decision type has been a primary objective of the tracking system. In particular, methods that are unable to provide tracking data by decision type were assumed not to be viable options for tracking. However, data collection from distributors for some measures was retained as a viable option for reasons explained in Section 8.

applications), 32 watt T8s with electronic ballasts, energy management systems, and compressed air optimization. RER estimates the costs of this initiative to be roughly $499,000 to $695,000in the first year and $452,000 to $616,000 in subsequent years.

Initiative VIa (Nonresidential): Integrating On-Site Commercial Surveys and Commercial & Industrial Sector Telephone Surveys. Because of the current uncertainties regarding the CEC data collection efforts, RER offers this initiative as an alternative to Initiative VI. This initiative collects tracking data through on-site surveys of commercial sites and through telephone surveys of commercial and industrial customers. The measures covered by this initiative are the same as those covered by Initiative VI. RER estimates the costs of this initiative to be roughly $810,000 to $1,196,000in the first year and $780,000 to $1,140,000 in subsequent years.

Initiative VII (Nonresidential): Chiller Manufacturer Data Collection. This initiative entails the collection of chiller sales for new construction and replace-on-burnout installations from major chiller manufacturers. RER estimates the costs of this initiative to be roughly $90,000 to $150,000 in the first year and $60,000 to $100,000 in subsequent years.

Summary of Estimated Budgets. The estimated annual budgets to develop and implement the four recommended initiatives for tracking residential measures is $1,054,000 to $1,405,000 for the first year. Development costs are not incurred in subsequent years, which reduces the annual costs to roughly $920,000 to $1,202,000. The estimated annual budget to develop and implement the three recommended tracking initiatives covering nonresidential measures is in the range of $761,000 to $1,078,000 for the first year. Development costs are not incurred in subsequent years, which reduces the annual costs to roughly $648,000 to $896,000.[3] RER understands that the CBEE may consider these costs quite high.[4] The CBEE has a variety of options to reconcile differences between estimated costs and current tracking budgets, including 1) increasing budgets for tracking, 2) track fewer measures, and 3) find less expensive means of tracking. RER provides some recommendations, which could reduce the estimated budgets 746,000 and $571,000, for tracking residential and nonresidential measures, respectively.

[3] Estimated costs increase significantly if tracking needs are not incorporated in the CEC's data collection efforts.

[4] Indeed, the CBEE's Technical Services Consultants have recommended initial budgets for tracking initiatives be $375,000 each for the residential and nonresidential sectors.

Executive Summary

This Executive Summary presents results of the Efficiency Market Share Needs Assessment and Feasibility Scoping Study conducted by Regional Economic Research, Inc. (RER) for the California Board for Energy Efficiency (CBEE) under management of Pacific Gas and Electric Company (PG&E). This study's primary purpose is to develop and recommend strategies for tracking the market shares of energy efficient products and services in the California market.

As an advisory board to the California Public Utilities Commission (CPUC), the CBEE is spearheading a major effort to transform markets for energy efficiency in California. This effort focuses on the mitigation of a variety of market barriers through a series of program interventions funded through a Public Goods Charge (PGC) and natural gas DSM funds. Assessing the effects of programs covered by this statewide effort will be critical from the perspective of both public policy and program planning. While success will be gauged by a variety of indicators of market effects, it seems clear that tracking efficiency market shares of products and services will be an absolutely essential element of the market assessment and evaluation (MA&E) process.[1] Market shares of cost-effective high-efficiency products and services reflect the economic efficiency with which markets are actually operating, and act as the ultimate indicators of the effectiveness of both specific programs and the overall market transformation process.

ES.1 Project Objectives and Overview

The objective of this study was to formulate recommendations for tracking the market shares of key energy efficiency measures in the California market. Market share tracking will ultimately be used to assess the extent of market transformation efforts in the state. Because energy efficiency programs in the state are categorized and developed according to *market events*, including new construction, retrofit, replace-on-burnout/net acquisition, it is also necessary to collect data that can distinguish these decision types. Thus, data used for tracking efficiency market shares were required to meet the following requirements:

- Data represent unit sales, <u>and</u>
- Data are/can be segmented by efficiency level, <u>and</u>
- Data are/can be segmented by geographic region, at least at the state level, <u>and</u>

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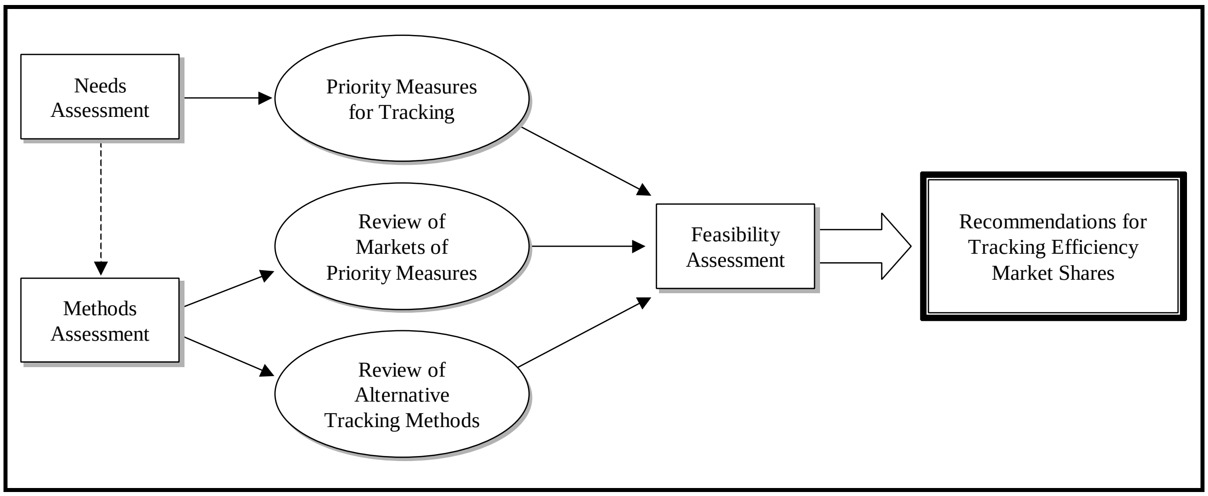
[1] In this context, we use the term market share to refer to the proportion of products/services that are "energy efficient," or to efficiency distributions, or to overall average efficiency levels of end uses.

- Decision type (new construction and replace-on-burnout/retrofit/net acquisition) must be identifiable, when applicable.

As shown in Figure ES-1, this scoping study is comprised of three major phases:

1. A Needs Assessment to identify priority measures for which tracking systems should be developed,
2. A Methods Assessment to characterize the markets of priority measures and identify alternative methods that could be used to implement tracking, and
3. A Feasibility Assessment to compare and evaluate the feasibility of each viable method for tracking the priority measures. RER's approaches to these elements of the study are summarized below.

Figure ES-1: Project Overview



The final result of this scoping study is a set of recommended initiatives for tracking the market shares of the priority efficiency measures. The methodology and results of these three phases and an overview of RER's recommendations are summarized in the following sections.

ES.2 Needs Assessment

As noted above, the objective of the Needs Assessment was to identify the specific energy efficiency measures for which a tracking system should be developed. The primary product of the Needs Assessment was a list of 20 measures identified as priorities for tracking. The methodology for selecting the measures as priorities and the results of this assessment are summarized below.

Methodology

The process of identifying energy-efficient measures and services as priorities for tracking, and market transformation evaluation in general, was based upon four primary criteria:

- ***Cost-Effective Savings Potential.*** The first criterion refers to the overall potential for cost-effective savings associated with various energy efficiency technologies. In general, it will be prudent to design a tracking system that focuses on the measures with greatest potential for cost-effective energy and demand savings in the absence of any market barriers.
- ***Marketing Efforts.*** This second criterion refers to the extent of marketing effort that will be expended to promote certain high efficiency measures through the transition period. All else equal, it will be most important to track the shares of the measures that are being more heavily marketed than to track other measures receiving little attention.
- ***Severity of Market Barriers.*** From a public perspective, the severity of market barriers associated with individual measures should be included as a criterion for the design of the tracking system. Given other factors, it may be judicious to focus programs on measures with the highest barriers.
- ***Susceptibility of Barriers to Market Intervention.*** The efficacy of targeting publicly funded programs at specific energy efficiency measures also partly depends on the extent to which program intervention can reduce or mitigate key market barriers.

Figure ES-2 illustrates the conceptual framework and information sources that were utilized for the Needs Assessment. As shown, this research involved three primary initiatives:

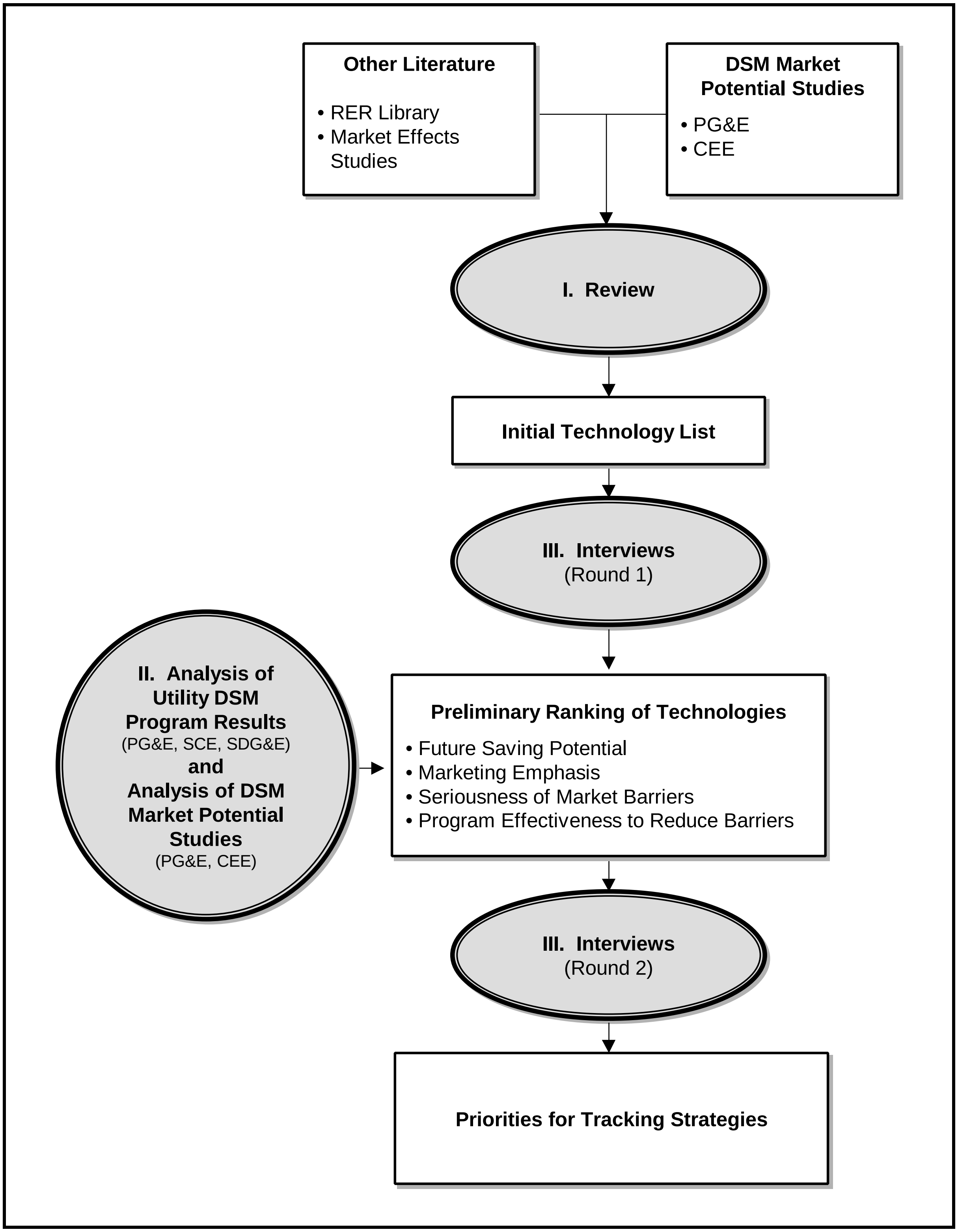
I The derivation of an initial list of energy efficiency measures through a review of existing information sources, including market potential studies, utility program plans, and other literature,

II. Analysis of market potential studies and utility DSM program results, and

III. Two rounds of in-depth interviews with industry experts and participants.

Derivation of an Initial List of Energy Efficiency Measures. To initiate the Needs Assessment phase of this study, it was first necessary to compile a comprehensive list of high efficiency measures available to both the residential and nonresidential sectors for a variety of end uses. Several information sources were utilized for this task, including 1998 utility DSM program plans, utility program results, DSM market potential studies, and other resources, including market effects studies, and RER staff engineers.

Figure ES-2: Conceptual Framework for Needs Assessment



The initial list of residential measures included 36 unique measures covering five end uses, and the initial list of nonresidential measures included 68 unique measures covering 10 end uses. Nearly all measures appeared twice on the list, as it was necessary to distinguish between decision types (e.g., installations in new construction or as retrofits/replace-on-burnouts).[2] These initial lists essentially formed the "measure rating sheets" distributed to Round 1 interview participants.

The in-depth interviews also provided insights into potential sources of tracking data, specific needs for and interest in tracking market shares of energy-efficient technologies, and the need for and interest in tracking other market-effects indicators and market characteristics, such as knowledge and awareness, stocking patterns, organizational practices, and/or other information that might indicate the success of market transformation initiatives.

As illustrated in Figure ES-2, the information obtained from the stakeholder interviews was utilized to derive the final list of priorities for tracking. As shown, a two-step interview process was undertaken to derive the final list of priority measures. The primary objective of the Round 1 interviews was to derive a preliminary short list of measures from the larger initial list of energy efficiency measures. A variety of energy efficiency industry experts and participants were recruited to rate energy efficiency measures according to the four criteria we used as a basis for this assessment. Interview participants rated each measure according to its potential for cost-effective savings, expected marketing emphasis to promote the measure, seriousness of market barriers impeding the measure adoption, and the extent to which program intervention can reduce or mitigate such barriers.

The result of RER's analysis of DSM potential studies and utility program results and the in-depth interviews is a preliminary short list of priority measures. A second round of in-depth interviews was then used to obtain information and feedback from industry experts and participants to compile a final list of priority measures for which tracking systems should be developed.

Needs Assessment Results: Priority measures for which tracking initiatives should be developed

Table ES-1 includes the measures selected as priorities for tracking using the methodology described up to this point. It should be noted here that there is no distinction between decision types (new construction, retrofit, and replace-on-burnout) in Table ES-1. The distinction was considered for nearly all measures throughout the study thus far, but made

[2] There are two primary reasons for distinguishing between measures installed in new construction and those as retrofit or replace-on-burnout. First, for some measures the savings potential is likely to be different between these decision types. Second, tracking strategies might be different to the extent that delivery mechanisms differ between decision types for the same measures.

almost no difference in how any particular measure fared in the derivation of this priority list. In other words, all applicable decision types for nearly every measure included in Table ES-1 survived the final elimination round. The distinction between decision types for each measure was further considered during the Methods and Feasibility Assessment phases of this study.

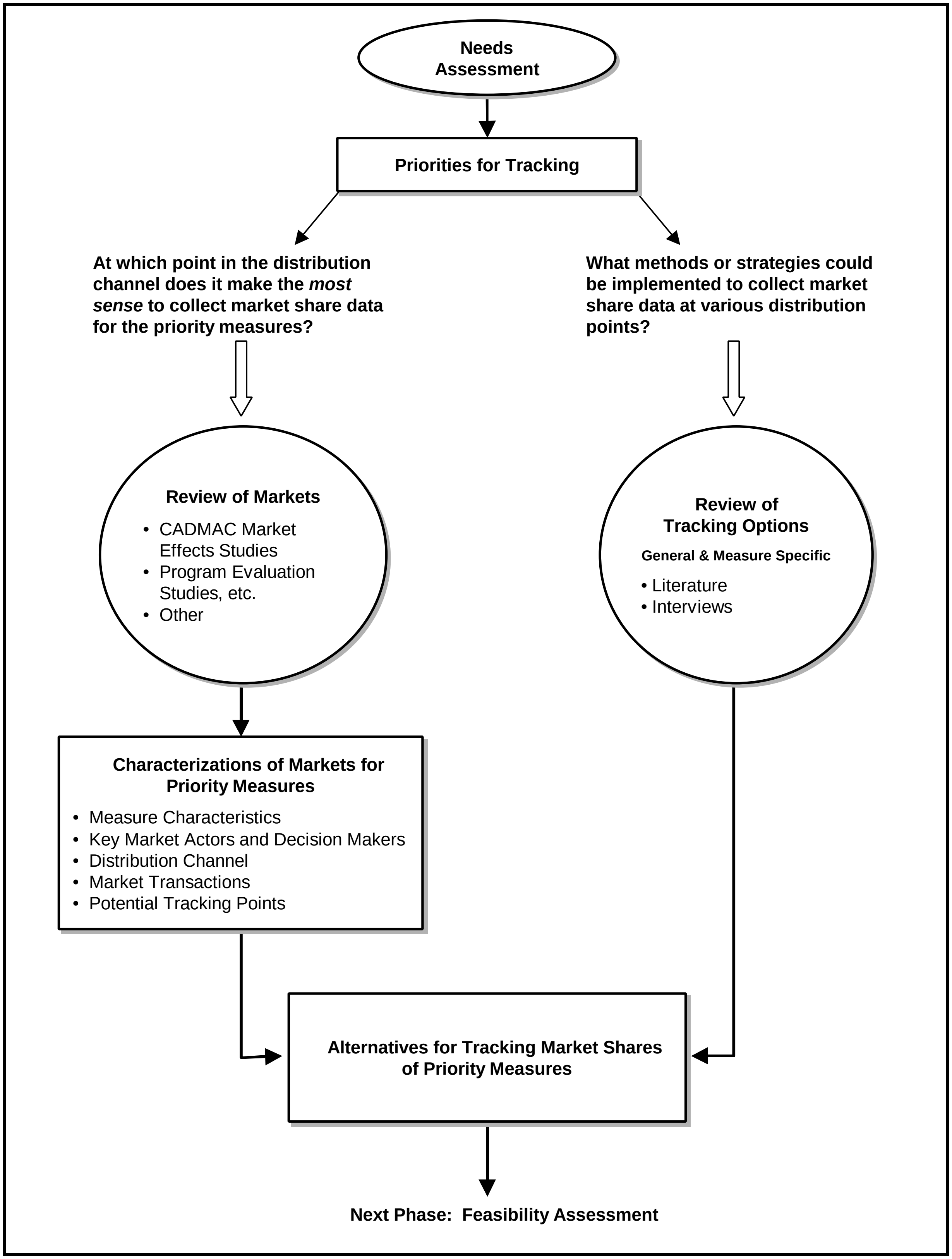
Table ES-1: Priority Measures for Tracking Initiatives for Market Transformation Assessment

Residential Sector Measures	Nonresidential Sector Measures
Duct Sealing	High Efficiency Windows
High Efficiency Central Air Conditioning	High Efficiency Packaged Air Conditioning
Compact Fluorescent Fixtures	High Efficiency Chillers
Horizontal Axis Washers	High Efficiency Motors
High Efficiency Windows	Adjustable Speed Drive Fans
Compact Fluorescent Lamps	32 Watt/T8 Lamps with Electronic Ballasts
High Efficiency Gas Furnaces	Energy Management Systems
High Efficiency Refrigerators	High Eff. Packaged Refrigeration Equip.
High Efficiency Dishwashers	Adjustable Speed Drive Pumps
High Efficiency Gas Water Heaters	Compressed Air System Optimization

ES.3 Methods Assessment

The primary objective of the Methods Assessment is to identify and investigate alternatives for tracking market shares for the 20 priority residential and nonresidential measures included in Table ES-1. The methodology and results of this second phase of the study are summarized below.

Figure ES-3: Conceptual Framework for Methods Assessment



Methodology

As shown in Figure ES-3, the overall approach to this Methods Assessment was to answer two key questions:

1. At which point in the distribution channel does it make the *most sense* to collect market share data for the priority measures?
2. What methods or strategies could be implemented to collect market share data at various distribution points?

Thus, the two primary elements of this project phase include a review of the markets for the priority measures, and a review of market share tracking alternatives, respectively. RER's approaches to these elements of the Methods Assessment are summarized below.

In general, the market reviews followed a three-step approach.

- Group priority measures into markets according to similarities in measure characteristics and distribution channels,
- Characterize the market for each priority measure and identify potential points in the distribution channel for data collection, and
- Determine implications for tracking.

The review of market share tracking alternatives involved a straightforward approach. First, an initial list of market share tracking alternatives was compiled from numerous sources, including EPRI's recent study on market tracking sources, Internet searches, and RER records. Second, a template was developed for the information to be collected about each method. This was done because the final phase of this study required the evaluation of each tracking alternative according to the same criteria, it was necessary to obtain the same information for each method, if possible. Third, market share tracking alternatives were assessed using several types of data sources, including in-person and telephone interviews and discussions with a variety of potential data suppliers, interviews with individuals involved in the market share tracking initiative in Wisconsin, and internet resources.

Results

The results of the second phase of this study include 1) a set of possible points in the distribution channel for collecting the data required for efficiency market share tracking, for each measure and applicable decision type, and 2) a set of viable tracking methods for each priority measure and applicable decision type.

Table ES-2 and Table ES-3 summarize the available tracking alternatives by market/measure for residential and nonresidential measures, respectively. In these tables, an "**X**" indicates a *viable* method – one that provides data that meet the four requirements for market share tracking in California:

- Data represent unit sales, and
- Data are/can be segmented by efficiency level, and
- Data are/can be segmented by geographic region, at least at the state level, and
- Decision type (new construction and replace-on-burnout/retrofit) must be identifiable, when applicable.[3]

As shown in Table ES-2 and Table ES-3, several of the options are viable for efficiency market share tracking in California. Surveys of downstream market actors can be developed to collect the required data for all priority measures. For example, on-site surveys can be developed to collect data on all priority measures. Data can also be obtained from upstream and midstream market actors for many of the residential and nonresidential measures. The viability of these methods essentially depends upon each measure's market structure and ability of various market actors to supply the needed data.

3 Note that it is not necessary for the method to produce data by all decision types for all measures.

Table ES-1: Review of Alternative Tracking Options for Residential Measures, by Measure and Method

Priority Measure/Market and Decision Type		Existing Data Sources[4]	In-Store Survey	Building Dept. Data[5]	Warranty Card Data	Interview Market Actor	Downstream Surveys[6]			Upstream/Midstream Market Actor Data Collection					
							Phone	Mail	On-Site	Manufacturer	Distributor	Retailer	Builder	Contractor	Site Engineer
Residential Duct Sealing	NC			X					X				X	X	
	Retro								X					X	
Residential HVAC[1]	NC			X	X				X		X		X	X	
	ROB				X				X		X			X	
Residential Lighting[2]	NC						X	X	X				X	X	
	Retro						X	X	X			X		X	
Residential Appliances[3]	(n/a)				X		X	X	X			X			
Dishwashers	NC				X		X	X	X				X		
Residential Gas Water Heating	NC			X	X				X		X		X	X	
	ROB				X				X		X	X		X	
Residential Windows	NC			X					X				X	X	
	Retro								X			X		X	

1 Includes residential gas furnaces and central air conditioning.
2 Includes compact fluorescent fixtures and lamps.
3 Includes refrigerators, dishwashers, and clothes washers.
4 Includes consumer panels, scanner data, and shipments data.
5 Building department data sources include compliance forms, verification forms, and field inspector on-site inspections.
6 Included in this category are developing consumer panels and collecting scanner data that specifically meets the CBEE's market share tracking needs.

Table ES-2: Review of Alternative Tracking Options for Nonresidential Measures, by Measure and Method

Priority Measure/Market and Decision Type		Existing Data Sources[2]	In-Store Survey	Building Dept. Data[3]	Warranty Card Data	Interview Market Actor	Downstream Surveys			Upstream/Midstream Market Actor Data Collection					
							Phone	Mail	On-Site	Manufacturer	Distributor	Retailer	Builder	Contractor	Engineer / Designer
Nonresidential Windows	NC			X					X				X	X	
	Retro								X					X	
Packaged Air Conditioning	NC			X	X				X		X		X	X	
	ROB				X				X		X			X	
Nonresidential HVAC: Chillers	NC			X			X	X	X	X				X	X
	ROB						X	X	X	X				X	X
Nonresidential HVAC: EMS	NC			X			X	X	X					X	
	Retro						X	X	X					X	
Nonresidential Motor System: Motors & ASDs	NC			X			X	X	X		X				X
	Retro						X	X	X		X				X
Nonresidential Ancillary Equip: Compress Air Opt.	(n/a)						X	X	X						
Nonresidential Lighting: T8s w/Electronic Ballasts	NC			X					X				X	X	
	Retro								X					X	
Nonresidential Packaged Refrig. [1]	(n/a)								X						

1 Includes display cases, walk-in/reach-in coolers, icemakers, and vending machines.
2 Includes consumer panels, scanner data, and shipments data.
3 Building department data sources include compliance forms and field inspections.

ES.4 Feasibility Assessment

The objective of the Feasibility Assessment, the third and final phase of this study, was to evaluate alternative tracking methods for each priority measure in a systematic, consistent manner and to devise final tracking recommendations. This Assessment essentially integrates the first two phases of the study: the Needs Assessment, which prioritized efficiency measures, and the Methods Assessment, which identified and reviewed alternative methods for efficiency market share tracking.

Figure ES-4 depicts the conceptual framework for the Feasibility Assessment of market share tracking for high efficiency measures in California. As shown, the data and information utilized for this analysis include the following:

- A review of existing tracking initiatives and interviews with tracking system developers, and
- Interviews with key market actors, industry participants, and potential tracking data suppliers.

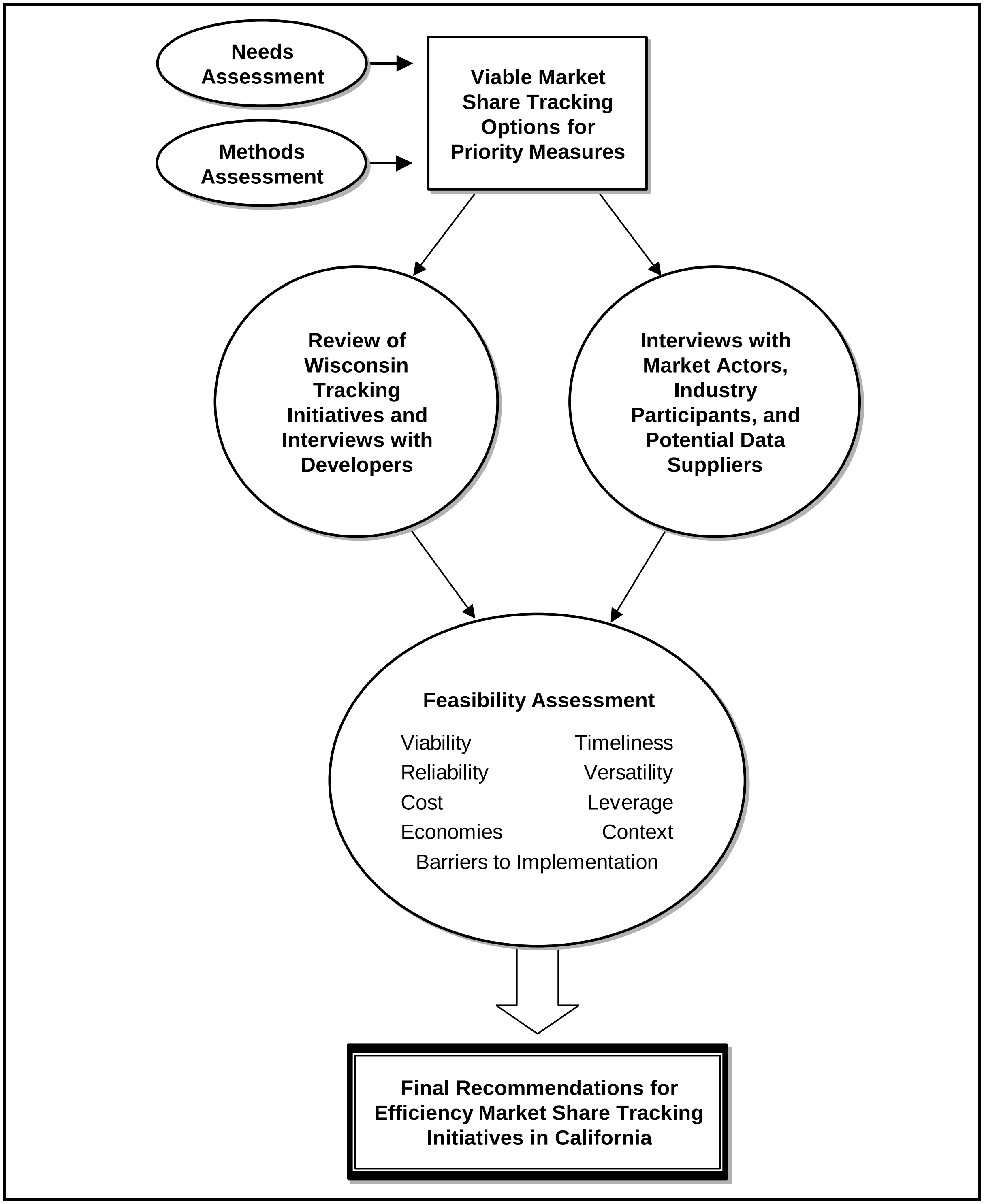
The information and data collected during the Methods Assessment were used to evaluate the feasibility of each tracking alternative for each measure according to the nine criteria defined below.

Viability. Viability refers to the capability of the method to yield data required for efficiency market share tracking in California. In particular, a method is considered "viable" if it can produce data that meet the data requirements enumerated above.

Reliability. In the context of this study, reliability connotes both the accuracy and consistent availability of the data. Tracking systems should produce reasonably accurate data, in the sense of having relatively low biases and fairly small standard errors on estimated shares. Sampling issues, data collection methods (e.g., telephone, mail, or on-site survey), whether the data represent actual or planned purchases/installations, market coverage, and the market node or market actors from which data are collected are examples of factors considered under this criterion.

Cost. The cost of developing and operating a tracking system will also be important. In general, the cost should be justified based on the importance of the covered measure(s), as well as the level of accuracy yielded by the tracking method in question. Both development and operation costs are estimated for each method (and, therefore, first-year and subsequent-year costs are estimated as well), to the extent possible.

Figure ES-4: Conceptual Framework for Feasibility Assessment



Economies. The economies criterion refers to the extent to which economies can be realized by tracking numerous measures with the same tracking initiative. This criterion accounts for two types of economies: 1) tracking multiple priority measures with the same initiative, and 2) tracking other non-priority measures with the same initiative. The former directly influences the estimated per-measure costs. As the number of measures covered by the method increases, the per-measure tracking costs decrease. Because of this correlation, and to avoid double-counting, this first type of economy is not accounted for in the method scoring. Non-priority measures refer to both competing and substitute measures.

Timeliness. Timeliness refers to the time lapse between the onset of development and the time at which the first tracking data point will be available. Throughout the course of this study, RER recognized that the development time would be a critical factor, as the results of the tracking efforts are to be utilized by several statewide MA&E priority projects, as well as by utility-specific evaluation efforts.

Barriers to Implementation. The barriers to implementation criterion is intended to represent how likely the method can be implemented as designed. Cooperation by potential data suppliers and the endurance of their participation are examples of factors considered under this criterion.

Leverage. Leverage refers to the extent to which existing CBEE relationships with other market actors, such as private service providers, program administrators, manufacturers, distributors, trade associations, and government agencies, can be used to facilitate the collection of data useful for market share tracking. Leverage can arise from program participation, financial relationships, or commonality of purposes.

Versatility. Versatility refers to the ability of the tracking system to generate information on other market effects, such as awareness or key perceptions, stocking practices, and product availability. Such data could be extremely useful to the CBEE for monitoring market effects and the assessment of overall program effectiveness in achieving market transformation objectives. Changes in market shares—by themselves—do not necessarily signal true market transformation unless these changes are attributable to interventions that are to some extent permanent. Being able to assess program impacts on market barriers could help to ascertain the likely permanence of changes in market shares stemming from programs.

Context. Context refers to the ability of the system to yield comparable data from a control area or multiple areas. Context could be important for two reasons. First, discerning program impacts might entail comparing changes in market shares in California to those occurring in other parts of the country. To this extent, it will be necessary to have access to information on efficiency market shares elsewhere. Second, if a source could yield information on market shares in the rest of the country, it might eventually be possible to form a multi-state collaborative to support the development of one or more tracking systems. Pooling resources like this could yield major economies.

The review of analysis results and the development of recommendations was a complex, often iterative process, required the consideration of not only the scoring of specific methods for each individual method, but factors that were common across measures. Throughout the evaluation process, RER recognized the importance of several issues, including the following:

- To develop a set of market tracking initiatives that provide the broadest market coverage yet maintain an acceptable level of data accuracy,
- To avoid recommending a single method for each measure based solely on the final evaluation scores without analyzing the impact of economies across priority measures,
- That a single method for collecting data from any one market actor might not provide the optimal solution to tracking efficiency market shares in California, and
- There are advantages to collecting data at multiple market nodes, particularly if different methods have different strengths and weaknesses. The result would be an integrated method that provides more reliable results than any one single method.

The remaining sections summarize RER recommendations for tracking the efficiency market shares of the residential and nonresidential priority measures.

ES.5 Recommendations for Tracking Priority Residential Measures

Table ES-4 summarizes RER's recommendations for tracking the priority residential measures.[4] As indicated, RER recommends that the market shares of the residential measures be tracked with four initiatives:

- Integrating on-site surveys and data obtained from building department records for new construction installations,
- Conduct on-site surveys of a sample of prescreened residential sites to track retrofit measures,
- Collect distributor sales data for tracking replace-on-burnout purchases of HVAC and water heating equipment, and

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[4] Note that the recommendations appearing in Table ES-4 represent the primary tracking initiative for each measure. In some cases, RER recommends that the primary data be supported or augmented with secondary data to cross-check data obtained from other sources. Secondary methods are discussed when appropriate.

- Obtain tracking data collected under the ENERGY STAR® program in addition to data from smaller, independent retailers in California.

When combined, these four initiatives encompass tracking systems for all of the priority residential measures for all decision types. These initiatives entail collecting data at the end-user level using on-site surveys, from building departments for new construction, from retailer records, and from distributors. Where possible, these initiatives utilize the significant economies from collecting information about numerous priority measures at one market node using a single customized approach. Alternative approaches that require data collection from market nodes other than from consumers generally require either a multi-node tracking initiative or the omission of a significant portion of the market.

Table ES-4: Summary of Recommended Tracking Initiatives for Priority Residential Measures

Priority Measure	Recommended Tracking Initiative
Duct Sealing [NC]	I Bldg. Dept./On-site Survey Data
Duct Sealing [Retro.]	II On-Site Survey of Prescreen Sample
Central Air Conditioners [NC]	I Bldg. Dept./On-Site Survey Data
Central Air Conditioners [Net Acquis./ROB]	III Distributor Sales Data
Compact Fluorescent Fixtures [NC]	I Bldg. Dept./On-Site Survey Data
Compact Fluorescent Fixtures [ROB]	IV ENERGY STAR®/EGIA Retail Initiative
Horizontal Axis Clothes Washers [Net Acquis/ROB.]	IV ENERGY STAR®/EGIA Retail Initiative
Windows [NC]	I Bldg. Dept./On-Site Survey Data
Windows [Retro]	II On-Site Survey of Prescreen Sample
Compact Fluorescent Lamps [NC]	I Bldg. Dept./On-Site Survey Data
Compact Fluorescent Lamps [ROB]	IV ENERGY STAR®/EGIA Alliance Retail Initiative
Gas Furnaces [NC]	I Bldg. Dept./On-site Survey Data
Gas Furnaces [ROB]	III Distributor Sales Data
Refrigerators [Net Acquis./ROB]	IV ENERGY STAR®/EGIA Retail Initiative
Dishwashers [NC]	I Bldg. Dept./On-Site Survey Data
Dishwashers [ROB]	IV ENERGY STAR®/EGIA Alliance Retail Initiative
Gas Water Heaters [NC]	I Bldg. Dept./On-Site Survey Data
Gas Water Heaters [ROB]	III Distributor Sales Data *(See table footnote)*

[NC] [Retro.] [ROB] and [Net Acquis.] denote new construction, retrofit, replace-on-burnout, and net acquisition decision types, respectively.
Note that distributor sales data of sales of water heater replacements excludes roughly 50% of the water heaters sold through retailers who purchase directly from the manufacturer. This issue is discussed in Section 9.5.

Initiative I: Integrating On-Site Surveys and Building Department Data

As indicated in Table ES-4, RER recommends tracking new construction installations of several residential measures at the end user level—through data collected via on-site surveys and through building department compliance forms, in particular. The initiative proposed here integrates data from quarterly on-site surveys in the residential new construction sector with data from building department verification records. This tracking initiative would be the primary source of market tracking for seven priority measures in the residential new construction sector including:

- Duct sealing (practices),
- Central air conditioning equipment,
- Compact fluorescent fixtures,
- Windows,
- Gas furnaces,
- Gas water heating equipment, and
- Dishwashers.

This initiative would also be a secondary data source for new construction installations of clothes washers, compact fluorescent lamps, and refrigerators.

This initiative entails data collection from three samples of newly constructed residential sites. A quarterly sample of 400 on-site surveys will be conducted using a stratified sample of newly constructed homes. This data will be augmented with the collection of data from at least 1,100 Installation Certificates (CF-6R Form) from a sample of building departments throughout California. In addition, for 50 of the 400 on-site surveys, both building department data and on-site survey data will be collected each quarter. Data from these three samples will verify the accuracy of the building department data, calibrate the timing of the installation of energy using equipment in newly purchased homes, generate useful tracking parameters, collect data on other market effects indicators, and ultimately populate a measure efficiency tracking database.

RER estimates that this initiative could be developed and operational within six months of its inception. Development and first year estimated costs are $442,000 to $560,000.

Initiative II: On-Site Surveys of Prescreened Residential Sites

As indicated in Table ES-4, RER recommends tracking the retrofits of two residential measures – windows and duct sealing - at the customer level.[5] RER recommends that on-site surveys be conducted for sample of residential sites that have replaced windows or that have retrofitted air distribution ducts. This recommended initiative would be the primary data source for retrofits of the following priority measures:

- Duct sealing (practices), and
- Windows.

This initiative can also be used as a primary data source for replace-on-burnout, or net acquisition installations of air conditioning and water heating priority measures, including central air conditioning equipment, gas water heating equipment, and gas furnaces.

RER estimates that this method could be developed and operational within six months of the onset of development. Estimated first year costs range from $356,000 to $445,000

Initiative III. Collecting Distributor Sales Data

As indicated in Table ES-4, RER recommends tracking the replace-on-burnout and net acquisition purchases of residential HVAC and water heating measures at the distributor level. The measures covered by this initiative include:

- Central air conditioning equipment,
- Gas furnaces,
- Gas water heating equipment, and
- Packaged air conditioning equipment.

As discovered in the Methods Assessment, collecting data at the distributor level does not allow for the tracking measures at the decision type level. However, if Initiative I is implemented, detailed data on HVAC and water heating equipment will be known for new construction installations. Because distributor data would represent both new construction and replace-on-burnout/net acquisition purchases, replace-on-burnout and net acquisition shares can be inferred by subtracting new construction shares from the distributor sales data.[6]

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[5] This could also be a primary source for gas water heaters, central air conditioners, and gas furnaces. Insofar as these are replace-on-burnout or *net-acquisitions*, a purely random sample of homes is unlikely to yield a sufficient number of transactions for the covered measures. Consequently, this approach recommends on-site surveys of a prescreened sample of residential sites that have only recently purchased or replaced windows or upgraded their air distribution system.

[6] As explained in Section 8, at least some distributors can identify sales by decision type according to the customer, even though this information is not typically recorded at the point-of-sale. Should this tracking initiative be adopted, there is potential to encourage distributors to record this information in the future.

The major benefit of using the distributor survey as opposed to a pre-screened on-site survey is cost. The development and operation of data collection from distributors is considerably cheaper than conducting quarterly on-site surveys. Furthermore, collecting data at the distributor level will provide an accurate representation of the size and efficiency mixes of the California HVAC and water heating markets overall.

RER estimates that this initiative can be developed within six to nine months and will cost roughly $96,000 to $170,000 during the first year of implementation.

Initiative IV: Energy Star® /EGIA Retail Tracking

As indicated in Table ES-4, RER recommends tracking the replace-on-burnout and net acquisition purchases of several residential measures at the retail level. This recommended initiative is an integrated approach involving current ENERGY STAR® data collection efforts and the Electric and Gas Industries Association for tracking of replace-on-burnout and net acquisition purchases. This initiative would be the primary data source for replace-on-burnout and net acquisition purchases of the following priority measures:

- Compact fluorescent fixtures and lamps,
- Clothes washers,
- Refrigerators, and
- Dishwashers.

This tracking method would be a secondary data source for replace-on-burnout and net acquisition purchases of central air conditioning equipment, residential windows, and gas furnaces.

RER recommends that a tracking initiative be developed and operated through a cooperative effort between ENERGY STAR® and the Electric and Gas Industries Association (EGIA). Both organizations offer tremendous opportunities for successful market share tracking. First, market shares of several priority residential measures are already being tracking through the ENERGY STAR® program. Second, the EGIA, a California-based trade organization with a membership comprised of manufacturers, distributors, and contractors, is an ideal candidate for recruiting and maintaining relationships with non-ENERGY STAR® retailers as data suppliers.

RER estimates that this initiative can be developed within six to nine months and will cost roughly $160,000 to $230,000 during the first year of implementation.

Summary of Estimated Costs of Residential Recommendations

Table ES-5 presents a summary of the costs by initiative for the first and subsequent years. The estimated annual budget to develop and implement the four recommended tracking initiatives is in the range of $1,054,000 to $1,405,000 for the first year. Development costs are not incurred in subsequent years, which reduces the annual costs to roughly $920,000 to $1,202,000.

Table ES-5: Summary of the Annual Costs for First and Subsequent Years for Planning and Implementing the Recommended Residential Tracking Initiatives

Initiative	First Year	Second Year
I Integrating On-Site Survey and Building Department Data	$442,000 - $560,000	$420,000 - $512,000
II On-Site Surveys of Prescreened Residential Sites	$356,000 - $445,000	$332,000 - $410,000
III Collect Distributor Sales Data	$96,000 - $170,000	$68,000 - $140,000
IV ENERGY STAR®/EGIA Retail Tracking	$160,000 - $230,000	$100,000 - $140,000
Total Estimated Cost	$1,054,000 - $1,405,000	$920,000 - $1,202,000

ES.6 Recommendations for Tracking Priority Nonresidential Measures

Table ES-6 summarizes RER's recommendations for tracking the priority nonresidential measures.[7] As indicated, RER recommends that the market shares of the nonresidential measures be tracked with the following three initiatives:

- Integrate data collected with CEC on-site surveys with data obtained from building department records to track nonresidential new construction measures,
- Integrate CEC on-site surveys of a prescreened sample of commercial sites and a telephone survey of commercial and industrial sites to collect data on retrofit and replace-on-burnout installations, and
- Obtain sales data from major chiller manufacturers to track new construction and replace-on-burnout chiller installations.

[7] Note that the recommendations appearing in Table ES-6 represent the primary tracking initiative for each measure. In some cases, RER recommends that the primary data be supported or augmented with secondary data to cross-check data obtained from other sources. Secondary methods are discussed when appropriate.

These recommendations offer tracking approaches for most of the priority nonresidential measures, with the exception of packaged refrigeration equipment and non-HVAC motors.[8] Initiatives V and VI recommend collecting data at the end-user level using on-site surveys and data obtained from building department records for new construction, and on-site surveys augmented with a telephone survey for retrofit/replace-on-burnout installations. Because of the rather unique structure of the chiller market, data useful for efficiency market share tracking can be obtained from major chiller manufacturers.

Note that two of the recommended initiatives involve incorporating market share tracking needs into commercial on-site surveys that might be conducted by the California Energy Commission (CEC). The CBEE has unanimously agreed to fund CEC data collection efforts in 1999. However, the transfer of funds is dependent upon approval by the California Public Utility Commission (CPUC). Pending the CPUC's approval, $1.7 million of the $2.1 million could fund data collection in the commercial sector. However, because of the current uncertainties of CEC data collection efforts and the allocation of funds pending CPUC approval, RER offers alternatives to Initiatives V and VI (Va and VIa, respectively). These initiatives are very similar to V and VI, with the exception that their development and implementation are completely independent of the CEC and that the costs of these alternative initiatives would not be subsidized with funds already earmarked for data collection activities.

Initiative V: Integrating CEC On-Site Commercial Surveys and Building Department Data

RER recommends tracking new construction installations of several nonresidential measures at the end-user level—through data collected via the CEC's planned commercial on-site survey effort and from building department compliance forms. This initiative is the recommended primary data source for new construction installations of the following priority measures:

- Nonresidential windows,
- Packaged air conditioning,
- Adjustable speed drive pumps and fans (HVAC and water heating applications),
- 32 watt T8s with electronic ballasts, and
- Energy management systems.

This initiative can also provide secondary data for motors installed in the commercial sector and chillers.

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8 Measures for which tracking recommendations are not provided are discussed in Subsection 10.7.

Table ES-6: Summary of Recommended Tracking Initiatives for Priority Nonresidential Measures

Priority Measure	Recommended Primary Tracking Initiative
Nonresidential Windows [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Nonresidential Windows [Retro.]	*None recommended (see below).*
Packaged Air Conditioning [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Packaged Air Conditioning [ROB]	III. Distributor Data Collection *(see Section 9)*
Chillers [NC]	VII. Chiller Manufacturer Data Collection
Chillers [ROB]	VII. Chiller Manufacturer Data Collection
Non-HVAC Motors	*None recommended (see below).*
Adjustable Speed Drive Fans [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Adjustable Speed Drive Fans [Retro.]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
32W T8s w/Electronic Ballasts [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
32W T8s w/Electronic Ballasts [Retro.]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
Energy Management Systems [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Energy Management Systems [Retro]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
Packaged Refrigeration Equipment	*None recommended (see below).*
Adjustable Speed Drive Pumps [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Adjustable Speed Drive Pumps [Retro.]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
Compressed Air System Optimization	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys

[NC] [Retro.] [ROB] and [Net Acquis.] denote new construction, retrofit, replace-on-burnout, and net acquisition decision types, respectively.

Briefly, Initiative V entails quarterly data collection from three samples of newly constructed nonresidential sites. A quarterly sample of 350 on-site surveys will be conducted using a stratified sample of newly constructed homes. This data will be augmented with the collection of data from at least 1,100 Compliance Certificates (ENV-1, MECH-1, and LTG-1 Forms, at a minimum) from a sample of building departments throughout California. In addition, for 100 of the 350 on-site surveys, both building department data and on-site survey data will be collected each quarter. Data from these three samples will verify the accuracy of the building department data, calibrate the timing of the installation of energy using equipment in newly constructed buildings, generate useful tracking parameters, and ultimately populate a measure efficiency tracking database.

RER anticipates that this initiative can be developed an operational six months. The estimated costs for the development and first year of implementation are $172,000 to $233,000.

Initiative Va: Integrating On-Site Commercial Surveys and Building Department Data.

Because of the current uncertainties regarding the CEC data collection efforts, RER offers this initiative as an alternative to Initiative V. This initiative integrates data collected via on-site surveys in the commercial sector and compliance data from participating building departments throughout the state. Essentially, this recommendation is identical to Initiative V summarized above, except it would be developed and implemented without CEC involvement. Conducting unsubsidized on-site surveys on a quarterly basis will be expensive. RER estimates the budget of this alternative initiative to be $868,000 to $1,345,000 during the first year of implementation.

Initiative VI: Integrating CEC On-Site Commercial Surveys and Commercial and Industrial Sector Telephone Surveys.

This initiative integrates the planned CEC commercial on-sites surveys and a telephone survey of commercial and industrial customers to collect data on retrofits of several priority measures. This initiative is the recommended primary data source for retrofits of the following priority measures:

- Adjustable speed drive pumps and fans (HVAC applications),
- 32 watt T8s with electronic ballasts,
- Energy management systems, and
- Compressed air optimization.

This tracking initiative uses the CEC on-site commercial survey to collect tracking data wherever possible. However, the CEC survey does not cover the industrial sector and the proposed sample sizes will not be sufficient to support a statistical analysis of market shares.[9]

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[9] Assuming the CEC is amenable to conducting the survey quarterly, and that the existing proposed sample size would be spread evenly across quarters, this would result in a sample of 1,000 on-sites per quarter. Further, if the nonresidential Initiative I is adopted and 350 new construction sites are sampled, the sample size for existing buildings would be 650.

To mitigate these shortcomings, RER recommends a telephone survey of at least 2,000 commercial and 2,000 industrial sites to 1) augment data collected from commercial on-site survey, and 2) collect data on measures installed in the industrial sector.

RER anticipates that this initiative can be developed an operational six months. The estimated costs for the development and first year of implementation are $499,000 to $695,000.

Initiative VIa: Integrating On-Site Commercial Surveys and Commercial & Industrial Sector Telephone Surveys.

Because of the current uncertainties regarding the CEC data collection efforts, RER offers this initiative as an alternative to Initiative VI. This initiative collects tracking data through on-site surveys of commercial sites and through telephone surveys of commercial and industrial customers. The measures covered by this initiative are the same as those covered by Initiative VI. RER estimates the budget for the development and first year of implementation of this alternative initiative to be $810,000 to $1,196,000.

Initiative VII: Chiller Manufacturer Data Collection

As indicated in Table ES-6, RER recommends tracking efficiency market shares of chiller installations in new construction, as well as chiller replacements, with data collected from chiller manufacturers. Tracking efficiency market shares of chillers in California at the manufacturer level, rather than through midstream market actors or at the site level, is favored for several reasons, most of which relate to the structure of the chiller market and relative costs of implementing tracking alternatives.

RER expects this initiative to be developed and operational within three to six months. RER estimates development and first year implementation costs to be $90,000 to $150,000.

Cost Summary of Nonresidential Recommendations

Table ES-5 presents a summary of the costs by initiative for the first and subsequent years. As shown, the estimated annual budget to develop and implement the three recommended tracking initiatives is $761,000 to $1,078,000 for the first year. Development costs are not incurred in subsequent years, which reduces the annual costs to roughly $648,000 to $896,000.

As indicated above, the costs of implementing Initiatives Va and VIa are considerably higher than if tracking needs were incorporated into the planned CEC data collection efforts. Without CEC involvement, the annual budget to develop and implement the recommended initiatives increases considerably to roughly $1,768,000 to $2,691,000.

Table ES-7: Summary of the Costs for First and Subsequent Years for Planning and Implementing the Recommended Nonresidential Tracking Initiatives

Initiative	First Year	Second Year
V. CEC On-Site Survey/Bldg. Dept. Data	$172,000 to $233,000	$136,000 to $180,000
Va. On-Site Survey/Bldg. Dept. Data	*$868,000 to $1,345,000*	*$832,000 to $1,280,000*
VI. CEC On-Site Survey/C&I Telephone Survey	$499,000 to $695,000	$452,000 to $616,000
VIa. On-Site Survey/C&I Telephone Survey	*$810,000 to $1,196,000*	*$780,000 to $1,140,000*
VII. Chiller Manufacturer Data Collection	$90,000 to $150,000	$60,000 to $100,000
Total Cost with CEC Involvement	$761,000 to $1,078,000	$648,000 to $896,000
Total Cost w/out CEC Involvement	$1,768,000 to $2,691,000	$1,672,000 to $2,520,000

ES.7 Reflections on the Cost of Tracking

Clearly, tracking market shares is an essential ingredient in the overall assessment of the market transformation effort. This is true in two respects. First, access to market share data will be critical for the support of decisions relating to the continuation of public funding for energy efficiency programs as the close of the transition period draws closer. Second, the availability of comprehensive market share tracking systems will greatly facilitate the assessment of the effectiveness of individual programs, program elements, and intervention strategies. Program administrators will have to have access to tracking data to assess the effectiveness of these activities. If they are not available from a set of statewide initiatives such as those recommended here, they will have to be developed in the course of individual MA&E projects. Arguably, the available of a single set of consistent tracking systems would be preferable to piecemeal tracking as part of periodic program assessments. The availability of uniform tracking data would also foster more effective use of other MA&E funds allocated in 1999 and beyond.

Depending upon the specific options chosen by the CBEE, the development of a comprehensive tracking system covering the priority measures could cost around $2 million in the first year and between $1 and 2 million per year thereafter. The recommended initiatives would cost between $1.0 and $1.4 million for the residential sector and between $0.7 and $1.0 million and for the commercial/industrial sector. RER understands that the CBEE may consider these costs quite high. Indeed, the CBEE’s Technical Services

Consultants have recommended initial budgets for tracking initiatives be $375,000 each for the residential and commercial/industrial sectors. In light of the obvious discrepancy between our recommended budgets and the budgets currently being anticipated by the CBEE for market share tracking, some means of reconciling this difference is necessary.

The CBEE has a variety of options for reconciling the differences between our recommendations and current tracking budgets, including the following:

- Increase budgets for tracking,
- Track fewer measures, or
- Find less expensive means of tracking.

These options re considered briefly below:

Increase CBEE Budgets for Market Share Tracking. In light of the results of this scoping study, this would be the most reasonable option. The costs of the recommended tracking initiatives should be evaluated in the context of the size of California's market transformation efforts. Roughly $300 million per year will be spent to promote market transformation in California over the next three years. The first year cost of the recommended initiatives would amount to less than 0.8% of the total annual energy efficiency budget. The annual cost of maintaining the tracking system would be less than 0.6% of the annual energy efficiency budget.

The CBEE might also consider the budget in the context of historical utility expenditures on the collection of market data. For instance, California utilities have traditionally spent several hundred thousand dollars per year on the collection of commercial on-site data for forecasting and DSM planning. Utilities have also spent (and will continue to spend) far larger amounts of money for the evaluation of energy efficiency programs.

Track Fewer Measures. Some preliminary comments on our recommendations suggest that the CBEE may choose to prioritize the recommended initiatives rather than funding them all. While RER understands the desire to be parsimonious in the expenditure of funds for market share tracking, we are hard-pressed to recommend a prioritization scheme for three reasons:

- First, the research conducted for the Needs Assessment phase of this study implicitly prioritized the focus of market share tracking efforts. Each of these measures is considered important by the energy efficiency community.
- Second, prioritizing recommended initiatives really requires an implicit tradeoff between the costs and benefits of information, and this is essentially a policy

decision. These options should be evaluated on the basis of a wider range of judgments than ours.

- Third, several of the recommendations are interrelated, so adopting one without the other may result in major economies being lost.

Nonetheless, if we were *forced* to exclude one of the residential initiatives ourselves, we would probably drop Initiative II, which deals with residential duct sealing and windows retrofits. While these are important measures, they entail fairly high tracking costs. This would save between $332,000 and $410,000, thus reducing the cost of the residential tracking system to between $698,000 and $960,000. If we were *compelled* to drop a measure from the commercial/industrial sector, we would probably sacrifice the portion of Initiative VI dealing with compressed air optimization. We would do so partly on the basis of the difficulty of determining system efficiencies and partly because tracking this measure requires industrial surveys that contribute relatively little to the development of information on other measures. This would produce savings of $240,000 to $320,000, leaving the overall commercial/industrial budget between $491,000 and $778,000. Of course, others could justifiably disagree with the value judgments underlying these choices.

Find Less Expensive Means of Tracking. In our judgment, the tracking initiatives recommended in this report are well-designed and cost-effective. The recommended initiatives take advantage of a variety of economies that lower overall data collection costs substantially. For instance, they make extensive use of CEC survey efforts, data collected by Building Departments, and the tracking procedures of the ENERGY STAR® Program. (Had we ignored these efforts and designed independent approaches, the overall cost would have been at least twice as high.) Nonetheless, cheaper options may be available if certain conditions are relaxed. For instance, lowering precision levels and reducing sample sizes could yield some minor economies. We have offered suggestions for cutting costs throughout Sections 9 and 10. Overall, we suspect something on the order of 10% of the budget could reasonably be trimmed through the use of some of these suggestions.

If we were to take advantage of all of the above suggestions for reducing overall tracking costs—dropping duct sealing and window retrofits as well as industrial air compressor optimization, as well as tightening sample sizes—the total cost of tracking would be $628,000 to $864,000 for residential measures and $442,000 to $700,000 for commercial measures. Using the midpoints of these ranges, the CBEE could set budgets of $746,000 and $571,000, respectively.[10]

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[10] The total budget would therefore be $1.317 million, which is very close to the $1.2 million rough estimate provided a few months ago in the interim report.

ES.8 Additional Observations

In addition to the recommendations summarized above, RER offers some additional thoughts. These observations cover a wide range of caveats, exhortations and ruminations, and are presented below in fairly arbitrary order.

Difficulties of Tracking

While some tracking systems have been put in place in parts of the country, prior attempts to track market shares of high efficiency measures have had generally discouraging results. Previous scoping studies have generally painted a fairly pessimistic picture of the prospects for traditional tracking systems. Nonetheless, the specific tracking initiatives we have proposed should provide the kind of information on market shares that will be needed for the assessment of California's market transformation efforts.

Importance of Tracking

Depending upon the specific options chosen by the CBEE, the development of a comprehensive tracking system covering the priority measures could cost around $2 million in the first year and between $1 and 2 million per year thereafter. We understand that the CBEE may consider these costs quite high. However, we would suggest that the CBEE evaluate these costs in the context of the size of California's market transformation efforts. Roughly $300 million will be spent to promote market transformation in California over the next year. The cost of the recommended initiatives would amount to less than 1% of the total energy efficiency budget. Of course, the CBEE could choose to limit the expenditures on tracking to a lower proportion of the overall budget. However, devoting this level of PGC and gas DSM funds to implement market transformation programs without the ability to track efficiency market shares of key measures would appear to be unwise.

Prioritization of Recommendations

Some preliminary comments on our recommendations suggest that the CBEE may choose to prioritize the recommended initiatives rather than funding them all. While RER understands the desire to be parsimonious in the expenditure of funds for market share tracking, we are hard-pressed to recommend a prioritization scheme. First, the research conducted for the Needs Assessment phase of this study implicitly prioritized the focus of market share tracking efforts. Prioritizing recommended initiatives really requires an implicit tradeoff between the costs and benefits of information; this is essentially a policy decision. RER would, however, remind the CBEE that several of the recommendations are interrelated, so adopting one without the other may result in major economies being lost.

Timing Issues

As explained in Section 9 and summarized above, developing the recommended market share tracking initiatives will take time. Depending upon lags in procurement and difficulties in implementing our recommendations or some other initiatives, it is likely that tracking results will not be available until the end of 1999. If we focus only on the need for tracking data over the transition period (up to 2002), this lag could appear ominous. However, as we have argued elsewhere in this report, tracking should continue to be a priority beyond the transition period. It will be important to know, for instance, if the reduction in PGC-funded program interventions at the end of the transition leads to the degeneration of energy efficiency in the State. This may mean that tracking systems need to be put in place with PGC funds, but that another method of financing and overseeing these systems will be necessary.

Collecting Comparable Data from Other Regions (Context)

One of the criteria used to select tracking options was the ability to yield information on other (non-California) areas. Such information could clearly be useful in assessing market effects, insofar as it would provide cross-sectional comparisons of market shares. One of the disappointments of the study was that very few options provide context in this sense at a reasonable cost. Of course, it is always possible to duplicate an initiative in another area (e.g., we could always conduct on-sites in other states to obtain comparison data); however, such data collection efforts would be likely to quite expensive.

Tracking by Decision Type

The tracking methods we have recommended are capable of tracking market shares by decision type when decisions differ substantially by these market events. RER imposed this capability as a data requirement for tracking because programs relating to these measures are categorized and designed by market event. If new construction programs and retrofit programs are to implemented to promote transformation, for instance, it seems logical to track new construction and retrofit shares separately. RER understands that the requirement of this capability results in tracking budgets that are sometimes higher than they would otherwise be. Nonetheless, we would argue that the additional costs are warranted.

Collecting Data from Multiple Market Nodes

Section 4 reviewed the markets for the priority measures and identified market nodes where data for market share tracking could be obtained. For most, if not all, measures, more than one node was cited. While this issue is not explicitly addressed in Section 4, it is important to recognize that there could be benefits in collecting data from multiple points in the distribution channel. Two primary benefits result from tracking at multiple nodes. First, doing so provides a “sanity check,” or helps to cross-reference results of tracking efforts.

Second, tracking from multiple nodes can provide indicators of the extent of market transformation on national as well as regional perspectives. For example, as discussed above, collecting data at the manufacturer level would not provide data specific enough to meet market share tracking needs in California. Most manufacturers use well established distribution channels and do not have the mechanism for knowing where the measures are ultimately purchased. Most manufacturers track sales only at the first point-of-invoice, which is typically a regional distribution center. Nonetheless, it still may be useful to pursue tracking at the manufacturer level. Market transformation is a primary objective of energy efficiency programs in California and other states. There has been some evidence that manufactures continue to produce the same mix of efficiencies, but that a greater percentage of high efficiency units are shipped to areas with higher demand for these products, such as California. This practice would work against market transformation efforts from a national perspective. Tracking efficiency mixes of manufacturer shipments on a national level can provide insights into this issue.

Data Collection 1 Market Share Tracking

While this phase of the study has identified logical points in the distribution channel for collecting data and the alternative methods for doing so, the *actual* data that should be collected for market share tracking has not specifically been addressed. One of the four data requirements for market share tracking in California is that data must be segmented by efficiency level. One cannot assume, however, that market actors keep sales or inventory records by efficiency level. Most often, sales and inventory records are maintained by product codes, model or part numbers, and possibly other parameters that would uniquely define a product, such as size or manufacturer. The point here is that the data collected will need to be converted or coded to be useful for market share tracking. Some resources for coding data in this manner are already available. For example, some organizations are creating or maintaining databases comprised of key characteristics for available products. For example, the Washington State Energy Office maintains the Motor Master database, which catalogs most induction motors in the 1 to 500 HP range that are available in the United States. Another example is the Ballast Master database, also maintained by the Washington State Energy Office. The EPRI market tracking study is an excellent resource for identifying such resources. Moreover, the EPRI study discusses coding options for market tracking.[11]

[11] The EPRI study focuses on market tracking for compact fluorescent lighting, horizontal axis clothes washers, commercial HVAC equipment, commercial and industrial lighting equipment, and motors.

Availability of Baseline Data

We have not explicitly addressed the means of collecting baseline data to provide an historical perspective on market shares in California. Another study being conducted by Xenergy is addressing this issue. We should note, however, that some of the methods discussed and recommended here (data collection from upstream market actors, in particular) might be able to yield historical data on market shares.

Tracking Should Be Long Term

It is tempting to think of the need for tracking as a short-run requirement for monitoring market transformation during the "transitional period." However, this would be a myopic view. While the transition period is an important interval, tracking initiatives need to be implemented on a longer-term basis, even if PGC funds are no longer used to support energy efficiency.

1

Introduction

This report presents results of the Efficiency Market Share Needs Assessment and Feasibility Scoping Study conducted by Regional Economic Research, Inc. (RER) for the California Board for Energy Efficiency (CBEE) under management of Pacific Gas and Electric Company (PG&E). This study's primary purpose is to develop and recommend strategies for tracking the market shares of energy efficient products and services in the California market.

The primary function of the CBEE is to oversee and promote market transformation in the California. As an advisory board to the California Public Utilities Commission (CPUC), the CBEE is spearheading a major effort to transform markets for energy efficiency in California. This effort focuses on the mitigation of a variety of market barriers through a series of program interventions funded through a Public Goods Charge (PGC) and natural gas DSM funds. Assessing the effects of programs covered by this statewide effort will be critical from the perspective of both public policy and program planning. While success will be gauged by a variety of indicators of market effects, it seems clear that tracking efficiency market shares of products and services will be an absolutely essential element of the market assessment and evaluation (MA&E) process.[1] Market shares of cost-effective high-efficiency products and services reflect the economic efficiency with which markets are actually operating, and act as the ultimate indicators of the effectiveness of both specific programs and the overall market transformation process.

1.1 Project Objectives and Overview

The objective of this study is to formulate recommendations for tracking the market shares of key energy efficiency measures in the California market. Market share tracking will ultimately be used to assess the extent of market transformation efforts in the state. Because energy efficiency programs in the state are categorized and developed according to *market events*, including new construction, retrofit, replace-on-burnout/net acquisition, it is also necessary to collect data that can distinguish these decision types. Thus, in the context of this

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1 In this context, we use the term market share to refer to the proportion of products/services that are "energy efficient," or to efficiency distributions, or to overall average efficiency levels of end uses.

2

Needs Assessment

2.1 Overview

This section presents the results of the first of three major phases of the Efficiency Market Share Needs Assessment and Feasibility Scoping Study.

The objective of the Needs Assessment is to identify the specific energy efficiency measures for which a tracking system should be developed. A list of 20 measures considered priorities for tracking was derived based upon four primary criteria: 1) potential for cost-effective savings, 2) the expected level of marketing efforts to promote the measure through the transition period, 3) the seriousness of market barriers associated with the measure, and 4) the extent to which such barriers can be mitigated or reduced with market intervention. This assessment is based upon stakeholder interviews and reviews of the California Demand Management Advisory Committee (CADMAC) market effects studies, utility demand-side management (DSM) potential studies and program results, market transformation plans and initiatives, and other DSM potential studies.

The section is organized as follows:

- Subsection 2.2 provides a brief overview our methodology for prioritizing energy efficiency measures,
- Subsection 2.3 briefly summarizes the initial list of energy efficiency measures from which the final priority list of measures was selected,
- Subsection 2.4 details our analysis of DSM potential studies and utility DSM program results,
- Subsection 2.5 discusses the stakeholder interviewing process and results, and
- Subsection 2.6 presents the results of this Needs Assessment, including the final list of measures for which tracking strategies should be developed.

2.2 Overview of Methodology

In the context of this research, market transformation is evidenced by market effects, or the reduction in market barriers, due to program or market intervention, that extend after the intervention strategy has been removed, reduced, or changed. Market transformation implies a long-lasting, self-sustaining change. The goal of the CBEE is to oversee and promote market transformation initiatives through the transition period, after which energy efficiency services will be completely relegated to the private market. Given these objectives, market transformation assessment and evaluation will be of primary importance over the next few years. The goal of this scoping study is to identify and investigate market share tracking strategies for specific energy efficiency measures as a means for evaluating the success of market transformation initiatives and assessing the extent of market transformation in California.

The process of identifying energy-efficient measures and services as priorities for tracking, and market transformation evaluation in general, was based upon four primary criteria:

- ***Cost-Effective Savings Potential.*** The first criterion refers to the overall potential for cost-effective savings associated with various energy efficiency technologies. In general, it will be prudent to design a tracking system that focuses on the measures with greatest potential for cost-effective energy and demand savings *in the absence of any market barriers*.
- ***Marketing Efforts.*** This second criterion relates to the extensiveness of efforts that will be focused on promoting certain high efficiency measures over the transition period. To a large extent, priorities of energy efficiency service providers will be based upon the savings potential of high efficiency technologies. However, other factors such as marketing costs, measurement, and verification costs, potential for customer contributions, and market barriers will also influence supplier decisions. All else equal, it will be most important to track the shares of the measures that are being more heavily marketed than to track other measures receiving little attention.
- ***Severity of Market Barriers.*** From a public perspective, the severity of market barriers associated with individual measures should be included as a criterion for the design of the tracking system. Given other factors, it may be judicious to focus programs on measures with the highest barriers.
- ***Susceptibility of Barriers to Market Intervention.*** The efficacy of targeting publicly funded programs at specific energy efficiency measures also partly depends on the extent to which program intervention can reduce or mitigate key market barriers. In practice, the susceptibility of barriers to market intervention may be a difficult factor to integrate into the Needs Assessment because of the limited information currently available on the influence of market transformation programs. However, some evidence is beginning to surface on this point as a

result of research sponsored by CADMAC, NEEP, individual utilities, public agencies such as the CEC, and the major research labs.

Figure 2-1 illustrates the conceptual framework and information sources that were utilized for this Needs Assessment. As shown, this research involved three primary initiatives:

I The derivation of an initial list of energy efficiency measures through a review of existing information sources, including market potential studies, utility program plans, and other literature,

II. Analysis of market potential studies and utility DSM program results, and

III. Two rounds of in-depth interviews with industry experts and participants. This *Delphi* interviewing approach was implemented primarily to ensure the consistency of information obtained from the interviews.

Each of these initiatives is discussed in the following subsections.

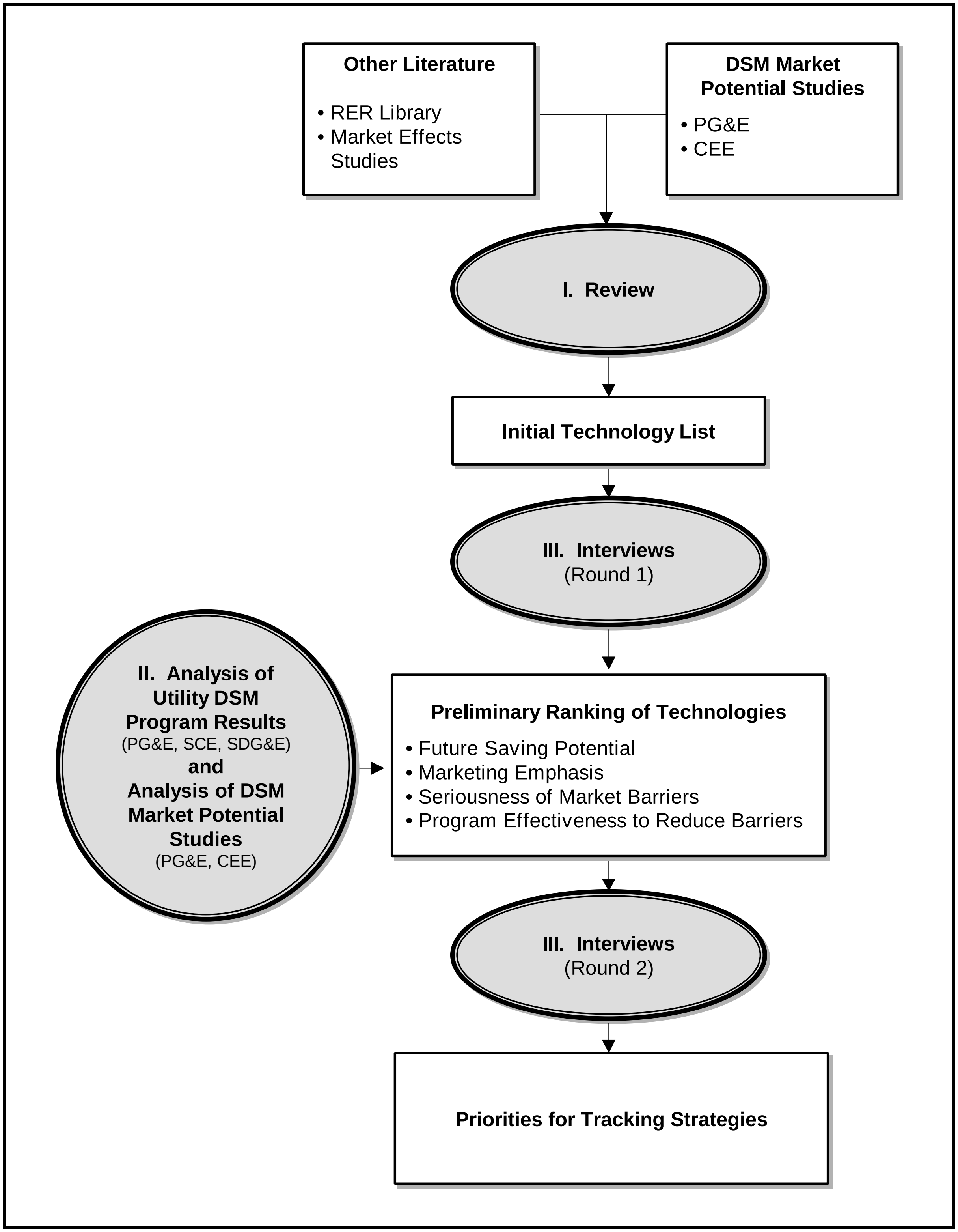
2.3 Derivation of an Initial List of Energy Efficiency Measures

To initiate the Needs Assessment phase of this study, it was necessary to compile a comprehensive list of high efficiency measures that have been installed in both the residential and nonresidential sectors and that cover a variety of end uses. Because the final measures selected for tracking priorities would eventually be selected from this initial list, it was critical to include as many measures in this initial list as possible. As such, several information sources were utilized for this task, including 1998 utility DSM program plans, utility program evaluation results, DSM market potential studies, and other resources such as market effects studies and RER staff engineers.

The initial list of residential measures included 36 unique measures for five end uses and the initial list of nonresidential measures included 68 unique measures covering 10 end uses. Nearly all measures appeared twice on the list, as it was necessary to distinguish measures installed in new construction from those installed as retrofits or replace-on-burnouts.[1] These initial lists essentially formed the "measure rating sheets" distributed to Round 1 interview participants (included in Appendix B).

[1] There are two primary reasons for distinguishing between measures installed in new construction and those as retrofit or replace-on-burnout. First, for some measures the savings potential is likely to be different between these decision types. Second, tracking strategies might be different to the extent that delivery mechanisms differ between decision types for the same measures.

Figure 2-1: Conceptual Framework for Needs Assessment



2.4 Analysis of DSM Potential Studies and Utility Program Results

Studies Used in the Analysis

As shown in Figure 2-1, the priorities for tracking strategies were identified through a two-step interview process and our analysis of DSM potential studies and utility program results. This subsection summarizes the latter; the former is discussed in Subsection 5.

The two sources of information were utilized for this task include the following:

- Market potential studies conducted by California utilities and other organizations, and
- Utility DSM program plans and/or program results relating to market transformation programs.

Incorporating this information in the Needs Assessment phase of this study ensured that no important DSM measures were omitted from the list of measures from which the final priorities for tracking strategies were derived. These sources of information are discussed below.

Market Potential Studies. Our initial work scope called for the consideration of market potential studies conducted recently by California utilities and other organizations on the premise that they would provide a reasonably thorough overview of the potential associated with a comprehensive set of energy efficiency measures and would at least constitute a good starting point for the analysis. We requested DSM studies from each of the four investor-owned utility distribution companies (UDCs), but were able to identify and secure only one study that could be used in the Needs Assessment. San Diego Gas & Electric (SDG&E), Southern California Edison (SCE) and the Southern California Gas Company (SoCalGas) had conducted DSM potential studies several years ago, but these studies were considered too out-of-date to be used for the Needs Assessment (e.g., they were not conducted with the objective of market transformation). Only PG&E could provide a study conducted recently enough to be useful for our analysis. We were also able to access a recent DSM potential study conducted for the Consortium for Energy Efficiency (CEE). The PG&E and CEE market potential studies are described briefly below:

- ***PG&E DSM Potential Study.*** ACEEE, Xenergy, and E-Source conducted research for PG&E study to identify measures that should be targeted by market transformation programs. The study began with an initial list of 64 DSM measures and derived a final list of 20 measures on which market transformation programs should focus. Measures were evaluated on the basis of three criteria: potential energy savings, likelihood of success, and cost of energy saved (ACEEE, Xenergy, and E-Source, 1998).

- ***CEE DSM Potential Study.*** ACEEE conducted a similar study for the CEE except that it took a national perspective. Like the PG&E study, it started with a reasonably comprehensive list of measures (56) and ranked them on the basis of potential energy savings, likely success of market transformation programs, and cost effectiveness. (Suozzo and Nadel, 1998).

Utility Program Plans. Acting as Interim Administrators, the California electric UDCs designed 1998 programs at least partly to achieve some of the objectives of market transformation. To this extent, the coverage of these programs should reflect utility assessments of the relative importance of different measures and barriers, as well as the effectiveness of program interventions. We requested the expected 1998 program results for each measure from each of the three electric utilities. The types of data provided by the utilities varied considerably. In particular, SCE provided a fairly specific listing of measures incorporated in their 1998 programs, coupled with expected electricity savings for each. In contrast, SDG&E provided a fairly generic listing of measures and expected savings, thus, it was necessary to disaggregate these listings into specific measures judgmentally based on our experience with recent SDG&E programs. PG&E was unable to offer measure-level estimates of savings from 1998 programs, but did provide extensive data on measure-specific savings from 1997 programs.

Development of a List of Key Measures

Using the studies cited above, overall rankings were derived for each measure by customer class (residential and nonresidential) using the following approach:

- First, measure rankings were obtained directly from the PG&E and CEE studies. In the case of the PG&E study, it was necessary to choose between two rankings, one of which took into account "other factors" (primarily the role of these measures in PG&E's own strategic business plan), and one that did not. Insofar as PG&E's strategic plans may be driven by a number of issues specific to that utility, the ranking that ignored "other factors" was used.[2] For the CEE study, the baseline ranking was used.[3]
- Second, measure rankings were compiled from utility data on program plans/results. These three rankings were based solely on estimated or projected energy savings. Again, it should be noted here that the application of considerable judgment was necessary to translate available information into terms required to support a ranking of specific measures.
- Third, each set of rankings from these sources was integrated with our overall list of measures. Measures in our initial list that were not ranked by these studies were assigned a default ranking of 100, a value considerably larger that the worst

[2] See Table 3 of the report.

[3] See Table 3, p. 11.

ranking from any of the lists. The results of this exercise are depicted in Appendix E. Separate tables are provided for residential and nonresidential measures.

- Fourth, an overall score was derived for each measure in the residential and nonresidential lists based upon the ranking from Step Three. In particular, the score was computed as the weighted average of the rankings from the five lists. The PG&E and CEE DSM potential studies were assigned weights of 3.0, while the rankings from the utility DSM studies were weighted as follows: PG&E and SDG&E results were assigned a weight of 1.0, and SCE results a weight of 2.0. In general, the rankings based on utility program plans/results were assigned lower weights than the DSM potential rankings because the latter formally took into account two of the major factors underlying our needs assessment (energy savings and likelihood of success) while the former did not necessarily do so. The rankings based on PG&E program results received a fairly low weight (1.0) because 1) PG&E was already represented in the form of its DSM potential study, and 2) because PG&E program data related to 1997 program results rather than market transformation potential. SDG&E rankings were assigned a low weight (1.0) because the service area is relatively small and because the data were actually available only in aggregated form and required the most subjective judgment to be applied to the ranking of specific measures. Because of the similarity in rankings across sources, final scores were very insensitive to the choices of weights.
- Fifth and finally, the weighted scores were used to derive two rankings – one for residential measures and one for nonresidential measures. The top 20 measures based upon these final rankings are included in Table 2-1.

Table 2-1: Rankings of Energy Efficiency Measures Based on Analysis of DSM Potential Studies and Utility Program Results

Ranking	Residential Measures	Nonresidential Measures
1	High efficiency central AC	LED Exit signs
2	Compact fluorescent lamps	High efficiency packaged AC
3	Duct sealing	T8s/electronic ballasts
4	Horizontal axis washers	High efficiency non-HVAC motors
5	Integrated Space/Water Heating Heat Pumps	High efficiency refrigeration conversions
6	High efficiency windows	High performance windows
7	Weatherstripping	Daylighting
8	Heat pump water heaters	Occupancy sensors
9	High efficiency refrigerators	Light colored roofing
10	Compact fluorescent fixtures	Heat pump water heating
11	Low energy dishwashers	High efficiency industrial air compressors
12	Light colored roofing	High efficiency chillers
13	Coin-operated clothes washers	Delamping
14	High efficiency gas water heaters	HID lighting
15	High efficiency ground / dual source heat pumps	Compact fluorescents
16	A-line halogen IR lamps	Adjustable speed drive HVAC fans
17	Pilotless gas instantaneous water heaters	ASDs on non-HVAC motors
18	Integrated gas space/water heating	Gas absorption chillers
19	Evaporative pre-coolers	Window treatments (film, screens)
20	High efficiency electric water heaters	High efficiency gas boilers and furnaces

2.5 Stakeholder Interviews

The primary objective of the stakeholder interviews was to collect information from a variety of energy efficiency industry experts and participants to assist in the derivation of a priority list of measures for which tracking systems should be developed. In particular, the goal was to obtain measure-specific information pertaining to the following:

1) Each measure's potential for cost-effective savings,
2) The marketing emphasis that will be expended to promote each measure,
3) The seriousness of market barriers impeding the success of each measure, and
4) The extent to which program intervention can reduce or mitigate such market barriers.

The in-depth interviews also provided insights into potential sources of tracking data, specific needs for and interest in tracking market shares of energy-efficient technologies, and the need for and interest in tracking other market-effects indicators and market characteristics, such as perceptions, knowledge, awareness, stocking patterns, organizational practices, and/or other information that might indicate the success of market transformation initiatives.

Summary of Interview Process

Figure 2-1 above illustrates how the information obtained from the stakeholder interviews was utilized to derive the final list of priorities for tracking. There were three steps to this process:

1. Conduct Round 1 interviews,
2. Derive preliminary ranking and integrate results with analysis of DSM potential studies and utility DSM program results, and
3. Conduct Round 2 interviews.

During the Round 1 interviews, respondents were asked to rate energy efficiency measures installed in both residential and nonresidential sectors according to the four criteria enumerated above. An overall ranking of measures was derived based upon the respondents' ratings of these measures. The ranking of measures from the Round 1 interview results was then integrated with our analysis of the PG&E and CEE market transformation studies and measure specific information on energy savings from recent utility DSM program results. The result of this process was a preliminary short list of measures from which the final list of priorities would eventually be selected. Round 2 interview respondents then helped to prioritize the measures on this preliminary short list.

The results of the Round 1 and Round 2 interviews are discussed below in more detail.

Round 1 Interviews

The primary objective of the Round 1 interviews was to derive a preliminary short list of measures from the extensive list of energy efficiency measures described in Subsection 3. A variety of energy efficiency industry experts and participants were recruited to rate energy efficiency measures according to the four criteria we used as a basis for this assessment.[4] All interview respondents were provided with the comprehensive lists of energy efficiency measures and an introductory letter that explained the objectives of this study and provided instructions for completing the rating sheets. Appendix A includes the efficiency measure rating sheets and Appendix B includes the introductory letter sent to each respondent as well as the Round 1 interview guide.

A few points about the rating sheets are worth noting here. First, under each end use for each sector, blank spaces were provided to give the respondent the opportunity to add measures to the list if he/she felt measures were excluded that should be considered as candidates for tracking. Second, because most respondents were assumed to not be knowledgeable about every measure, they were encouraged to seek input from others in their organization as an attempt to ensure that all measures were rated by as many qualified individuals as possible. Respondents were also reminded to skip over any unfamiliar measures.

The ratings completed by all respondents were used, along with the results of the review of utility programs and market potential studies, to derive a preliminary short list of energy efficiency technologies for which market share tracking system(s) might be developed. The results of the Round 1 interviews and the derivation of the preliminary short list is explained below.

Computing an Overall Ranking for Each Measure. The primary result of the Round 1 interviews was an overall ranking of all energy efficiency measures included on the rating sheets. The overall measure rankings were computed from the respondents' ratings of the potential for cost-effective savings, anticipated market effort, severity of market barriers, and likelihood of barriers being reduced with market intervention associated with each measure.

Before computing an overall rating for measure, each respondent's ratings for each question were normalized. In particular, each response was adjusted so the mean of the responses for each question for each respondent was equal. This normalization procedure was implemented to account for the relative differences in the tendencies of respondents to rate the measure criteria. For example, respondent "A" might have the tendency to rate the seriousness of market barriers of <u>all</u> measures lower than respondent "B." The objective of

[4] Appendix E includes the Round 1 interview participants.

the normalization procedure is to center all responses around the same value, while maintaining their relative integrity.

First, we normalized each respondent's ratings for every criteria for each measure by dividing it by their mean rating for that criteria. Second, we computed an overall rating using the normalized responses for all four criteria as computed above. Essentially, this overall rating is computed by multiplying the means of all normalized responses for all four criteria.[5] The equation below depicts how the overall ratings for each measure, *m*, were computed.

$$RATE\_W_m = \left(\overline{SAV\_N_m}\right)^{a_1}\left(\overline{MKTG\_N_m}\right)^{a_2}\left(\overline{BARR\_N_m}\right)^{a_3}\left(\overline{PGMI\_N_m}\right)^{a_4}$$

where

$RATE\_W_m$ = the weighted overall rating for each measure,

$\overline{SAV\_N_m}$ = the normalized mean rating for cost-effective savings potential for measure *m*,

$\overline{MKTG\_N_m}$ = the normalized mean rating for marketing effort expended to promote measure *m*,

$\overline{BARR\_N_m}$ = the normalized mean rating for the seriousness of market barriers associated with measure *m*,

$\overline{PGMI\_N_m}$ = the normalized mean rating for effectiveness of program intervention to reduce barriers associated with measure *m*, and

$a_1, a_2, a_3,$ and a_4 = are weights for normalized mean cost-effective savings potential, marketing effort, seriousness of market barriers, and effectiveness of program intervention criteria, respectively.

To test the sensitivity of the overall ratings results to the weighting of cost-effective savings relative to the other three criteria, overall ratings were computed using different weights for the cost-effective savings ratings. In particular, overall measure ratings were computed with values of a_1 ranging from 0.8 to 1.2. While changing the weighting of cost-effective saving potential in the overall rating changed the ordinal ranking of some measures, the top 25 measures remained the same, irrespective of the weighting scheme.[6] Thus, here we present

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5 Because some respondents did not provide ratings for all four criteria for each measure, it was first necessary to compute the mean rating of each criterion over all respondents first. Without first taking the mean over all respondents, a considerable number of responses would be excluded from the overall rating.

6 Note that the objective of this exercise is to develop a shorter preliminary list of measures, not to derive a final priority ranking. Thus, the explicit ranking of measures is not as relevant in this context.

the top 20 ranked energy efficiency measures based upon the unweighted overall rankings (a_1, a_2, a_3, and $a_4 = 1$).

The Top 20 Energy Efficiency Measures by Sector Based Upon Round 1 Interview Results. Table 2-2 and Table 2-3 present the top 20 measures for the residential and nonresidential sectors, respectively, in order of their overall rating. The complete list of measures and their computed overall rankings is included in Appendix D.[7]

Table 2-2: Top 20 Nonresidential Measures from Round 1 Interview Results

	New Construction	Retrofit or Replace-On-Burnout
1	Computer Optimizer Control	Leak Maintenance and Mgmt. (Compress Air)
2	Daylighting	Adjustable Speed Drive Fans
3	High-Performance Windows	Energy Management System
4	Leak Maintenance and Mgmt.	Refrigeration Computer Optimizer Control
5	Adjustable Speed Drive Fans	High-Eff. Packaged AC Equipment
6	Energy Management System	Adjustable Speed Drive Pumps
7	Adjustable Speed Drive Pumps	Refrigeration High-Eff. Conversions
8	High-Eff. Packaged AC Equipment	High-Eff. Chillers
9	Wastewater Facility Optimization	Wastewater Facility Optimization
10	High-Eff. Packaged Refrigeration Equip.	Compact Fluorescents
11	High-Eff. Chillers	Adjustable Speed Drive Chillers
12	Adjustable Speed Drive Chillers	High-Eff. Conversions (screw)
13	Light Colored Roofing	32 W/T8s with Electronic Ballasts
14	ASDs on Non-HVAC Motors	Controls Optimization (Compressed Air)
15	Compact Fluorescents	ASDs on Non-HVAC Motors
16	High-Eff. Motors (Non-HVAC)	High-Eff. Motors (Non-HVAC)
17	Skylights and Controls	High-Eff. Gas Boilers & Furnaces
18	High-Eff. Low NOx Burners	Refrigeration High-Eff. Case Fans
19	32 W/T8s with Electronic Ballasts	Refrig. Anti-Condensate Heater Controls
20	Controls Optimization (Compressed Air)	High-Eff. Industrial Air Compressors

7 Note that each table distinguishes between measures installed for new construction from those installed as retrofits or replaced on burnout.

Table 2-3: Top 20 Residential Measures from Round 1 Interview Results

	New Construction	Retrofit or Replace-On-Burnout
1	Compact Fluorescent Fixtures	Compact Fluorescent Lamps
2	Horizontal Axis Washers	Compact Fluorescent Fixtures
3	Duct Sealing	Horizontal Axis Washers
4	Compact Fluorescent Lamps	Duct Sealing
5	High-Eff. Refrigerators	High-Eff. Refrigerators
6	High-Eff. Central AC	High-Eff. Central AC
7	High-Eff. Windows for Cooling Climate	High-Eff. Gas Furnaces
8	Integrated Gas Space/ H_20 Heat Sys.	High-Eff. Gas H_20 Heaters
9	High-Eff. Gas H_20 Heaters	Increased Ceiling Insulation
10	Duct Sealing	Low Energy Dishwashers
11	Indirect/Direct Evaporative Cooling	Weatherstripping/Infiltration Reduction
12	High-Eff. Ground & Dual Source Heat Pumps	High-Eff. Windows for Cooling Climate
13	Low Energy Dishwashers	Duct Insulation
14	High-Eff. Gas Furnaces	High-Eff. Freezers
15	High-Eff. Air Source Heat Pumps	Indirect/Direct Evaporative Cooling
16	High-Eff. Windows for Heating Climate	Integrated Gas Space/ H_20 Heat Sys.
17	High-Eff. Freezers	High-Eff. Air Source Heat Pumps
18	Evaporative Pre-Coolers	High-Eff. Gas Cooking Equipment
19	A-Line Halogen IR Lamps	High-Eff. Room AC
20	Light Colored Roofing	High-Eff. Windows for Heating Climate

Write-In Candidates. As explained above, respondents were given the opportunity to add measures to the rating sheets – the majority did, in fact, exercise this right. To give all interview participants the opportunity to consider these measures as candidates for tracking, the "write-in candidates" were included in the preliminary list of measures that was distributed for the Round 2 interviews, as explained below.

Derivation of the Preliminary Short List of Measures

The second step of the interviewing process was to compile a preliminary short list of measures which would then be distributed to Round 2 participants. This *Delphi* interviewing approach not only helped RER derive the final list of priorities for tracking and market transformation analysis, but also ensured the consistency of our results thus far. A preliminary short list was compiled from the following:

- The ranking of residential and nonresidential energy-efficient measures resulting from Round 1 of the stakeholder interviews, and

- The ranking of residential and nonresidential energy-efficient measures resulting from analysis of DSM market potential studies (conducted by PG&E and CEE) and utility DSM program results that were presented in Subsection 4.

The integration of these rankings to derive the preliminary short list of measures is detailed below. This procedure was followed to derive both residential and nonresidential preliminary short lists.

Comparison of Top 20 Measures of Each Ranking. First, the top 20 measures from each source were compared to determine the extent to which the measures appeared in the top 20 ranking of both sources. There was nearly a perfect correspondence between the residential sector lists, but a lesser degree of correspondence between the nonresidential sector lists.

It was determined that all of the top 20 ranked measures from the Round 1 interviews would be included in the preliminary short list of measures.

Add Measures from Analysis of DSM Market Potential Studies and Utility Program Results. Second, we identified the top 20 measures from our analysis of DSM market potential studies and utility program results that did not make the top 20 list from the Round 1 interview results. Whether or not these measures were added to the preliminary short list was based upon the following:

- The ranking of the measure based upon the Round 1 interview results, and
- The ranking of the measure based upon the DSM market potential studies.

Some subjective judgement was used here – essentially, a measure was added to the preliminary short list if it was ranked highly on at least one of the above sources.

Include Measures Added by Interview Participants in Round 1. As mentioned above, all Round 1 interview participants were given the opportunity to add candidates for tracking if such measures were excluded from the initial measure lists. All of these measures were added to the preliminary short list to give all Round 2 participants the opportunity to consider the measure as a priority for tracking.

Compile Preliminary Short List of Measures. Table 2-4 and Table 2-5 include the measures selected for the residential and nonresidential preliminary short lists, respectively. As shown, the measures on each list cover a variety of end uses and all decision types (new construction and retrofit or replace-on-burnout). As explained below, these lists of measures were then distributed to Round 2 interview participants (the actual documents given to Round 2 participants are included in Appendix G).

Table 2-4: Preliminary Short List of Nonresidential Measures

Top 20 Round 1 Interview Results	
End Use	**Measure [Decision Type]**
Compressed Air	Leak Maintenance & Mgmt. [R]
Refrigeration	Computer Optimizer Control [NC]
Indoor Lighting	Daylighting [NC]
HVAC & H_2O Heat	Adjustable Speed Drive Fans [R]
HVAC & H_2O Heat	Energy Mgmt. System [NC]
Shell	High Performance Windows [NC]
Refrigeration	Computer Optimizer Control [R]
Compressed Air	Leak Maintenance & Mgmt. [NC]
HVAC & H_2O Heat	Adjustable Speed Drive Fans [NC]
HVAC & H_2O Heat	Energy Mgmt. System [NC]
HVAC & H_2O Heat	Adjustable Speed Drive Pumps [NC]
HVAC & H_2O Heat	High Eff. Packaged AC Equip. [NC]
HVAC & H_2O Heat	High Eff. Packaged AC Equip. [R]
Other	Wastewater Facility Optimization [NC]
HVAC & H_2O Heat	Adjustable Speed Drive Pumps [R]
Refrigeration	High Eff. Conversions [R]
HVAC & H_2O Heat	High Eff. Chillers [R]
Refrigeration	High Eff. Packaged Refrigeration Equip. [NC]
HVAC & H_2O Heat	High Eff. Chillers [NC]
Other	Wastewater Facility Optimization [R]
Additional Measures from DSM Potential Studies & Utility DSM Program Results	
End Use	**Measure [Decision Type]**
Other	LED Traffic Lights
Indoor Lighting	LED Exit Signs
Indoor Lighting	32 W/T8s
Motors	High Eff. Non-HVAC Motors
Shell	Light Colored Roofing
Compressed Air	High Eff. Industrial Air Compressors
Indoor Lighting	Compact Fluorescents
Other Measures Added by Stakeholders	
End Use	**Measure [Decision Type]**
HVAC & H_2O Heat	Passive Heating/Cooling Design
Refrigeration	Electronic Evaporative Pressure Regulating Valves
Lighting	T-5 Lamps
Shell	Air Distribution System Sealing

Table 2-5: Preliminary Short List of Residential Measures

Round 1 Interview Results	
End Use	**Measure [Decision Type]**
Lighting	Compact Fluorescent Lamps [R]
Lighting	Compact Fluorescent Fixtures [R]
Other	Horizontal Axis Washers [R]
Lighting	Compact Fluorescent Fixtures [NC]
Shell	Duct Sealing [R]
Other	High Eff. Refrigerators [R]
Other	Horizontal Axis Washers [NC]
Space Cooling	High Eff. Central AC [R]
Shell	Duct Sealing [NC]
Lighting	Compact Fluorescent Lamps [NC]
Space & H_2O Heat	High Eff. Gas Furnaces [R]
Other	High Eff. Refrigerators [NC]
Space & H_2O Heat	High Eff. Gas H_2O Heaters [R]
Space Cooling	High Eff. Central AC [NC]
Shell	High Eff. Windows for Cooling Climate [NC]
Space & H_2O Heat	Integrated Gas Space/H_2O Heat System [NC]
Shell	Increased Ceiling Insulation [R]
Space & H_2O Heat	High Eff. Gas H_2O Heaters [NC]
Other	Low Energy Dishwashers [R]
Shell	Weatherstripping/Infiltration Reduction [R]
Additional Measures from DSM Potential Studies & Utility DSM Program Results	
End Use	**Measure [Decision Type]**
Space & H_2O Heat	Heat Pump Water Heaters
Shell	Light Colored Roofing
Space & H_2O Heat	High Eff. Ground & Dual Source Heat Pumps
Lighting	A-Line Halogen IR Lamps
Other Measures Added by Stakeholders	
End Use	**Measure [Decision Type]**
Space & H_2O Heat	Passive Cooling Design
Lighting	Occupancy Sensor Power Strips
Lighting	T-5 Lamps
Space & H_2O Heat	Evaporative Condensers
Other	Faucet Aerators
Other	Energy-Efficient Showerheads
Space & H_2O Heat	Solar Water Heating
Space & H_2O Heat	Pipe Wrap
Shell	Attic Radiant Barrier

Round 2 Interviews

The ultimate objectives of the Round 2 interviews were to solicit information to help finalize a priority list of measures and to obtain information that will contribute to the Methods and Feasibility Assessment phases of this study. In contrast to the Round 1 interviews, Round 2 interviews were in-depth discussions focusing on the preliminary short list of measures developed in Round 1. In particular, prior to the in-depth interview, all Round 2 interview participants were provided with the preliminary lists of priority measures included in Table 2-4 and Table 2-5 (the actual documents provided to participants are included in Appendix F). Prior to the actual interview, each participant was asked to select the measures that they felt would be most important or relevant for tracking and market transformation assessment (e.g., interview participants were asked to choose their "top 10 measures" for tracking, or to rate the measures as "high," "medium," or "low" priorities). When possible, the interview participant returned their written comments about the measures on these lists to the researcher prior to the interview time to facilitate the discussion.

The objectives for the Round 2 in-depth interview were as follows:

- To discuss the respondents' rationale for prioritizing the measures,
- To discuss the notion of tracking "whole-system" or "whole-building" efficiency as a method for measuring or evaluating the extent of market transformation (and solicit suggestions for doing so),[8]
- To obtain information about other market-effects indicators or market features associated with any of the technologies on the lists that should be tracked,
- To discuss the need and interest for tracking specific high efficiency measures and data sources that could contribute to such tracking systems, and
- To determine which emerging technologies should be considered for tracking.

As explained below, the results of the Round 2 interview helped to finalize the priority high efficiency measures for which tracking strategies should be developed. The interview guide for Round 2 interviews is included in Appendix C.

[8] Tracking whole-system or whole-building efficiency as method for evaluating market transformation was a concept mentioned by many Round 1 interview participants. As such, the concept was included as a topic of discussion for the Round 2 interview.

2.6 Needs Assessment Results

This subsection discusses the results of this Needs Assessment and presents the final priority lists of high efficiency measures for which tracking systems should be developed.

Methodology to Select Measures

A much more subjective approach was taken to compile the final list of priority measures than the methodology for deriving the preliminary short list detailed above in Subsection 5. In particular, inclusion of the measures in the final list was based upon the following criterion:

- Consensus of Round 2 interview responses regarding priorities for tracking, and
- Consideration of other market characteristics.

Consensus of Round 2 Interview Responses

As explained above, Round 2 interview participants prioritized measures on the preliminary list with “high,” “medium,” or “low” or “yes”/”no” responses. Thus, the first step to finalizing the lists of measures for tracking was to look at the consensus of responses among interviewees. Essentially, we looked at the number of interviewees that considered each measure a priority for tracking and market transformation assessment. While this approach seems somewhat simplistic, it enabled us at least to identify the measures that all or most participants identified as priorities, as well as the measures that did not receive any “votes.” Measures that were considered as high priorities by all or most of the Round 2 interviewees, such as *duct sealing* in the residential sector and *high efficiency windows* in the nonresidential sector, were considered obvious candidates for tracking. Recall from Table 2-1, Table 2-2, and Table 2-3 that *duct sealing* and *high efficiency windows* were ranked very highly in the DSM potential studies as well as by Round 1 interview participants.

In most cases, the measures that did not receive any “votes” were those that were added as “write-in candidates” by Round 1 interview participants. The residential measures that none of the Round 2 interviewees considered to be priorities include *A-line halogen IR lamps*, *faucet aerators*, *increased ceiling insulation*, and *pipe wrap*. The “rejected” nonresidential measures include *electronic evaporative pressure regulating valves* and *wastewater facility optimization*. Although none of the interview participants considered these measures to be priorities for tracking, they were not eliminated from the final list without further consideration, as discussed below.

<u>*Consideration of Other Market Characteristics*</u>

While examining the consensus of Round 2 interview responses helped RER to flag some measures whose market shares should definitely or definitely *not* be tracked, it was necessary to consider other market issues relating to each measure as well, not only to justify eliminating or including the obvious ones, but to help us deal with those that were rated as high priorities by some respondents and as low priorities as others (e.g., the measures on the "margin"). The primary sources of information for this process were 1) discussions during the Round 2 interviews regarding the rationale for measure prioritization, and 2) market potential studies. The factors considered at this point are discussed below.

Market Nearing Full Potential. The stage of market maturation is a critical factor when considering measures for market transformation evaluation initiatives. In particular, it would not be prudent to track high efficiency measures if the market for such measures has already reached its full potential (e.g., the market has already or is close to being transformed). *Energy-efficient showerheads*, *faucet aerators*, *ceiling insulation*, and *pipe wrap* were eliminated from the priority list based upon these criteria.

Market Not Yet Fully Developed (Emerging Technology Criteria). Measures were not only excluded because their market has already reached its full potential but also because its market has not yet been fully developed or the specific measure has not yet been widely commercialized. The CBEE considers "the process of removing market barriers to the commercialization of new energy-efficient products and services" as a component or indicator of market transformation (CBEE, 1998). However, the commercialization of "new" or "near-term" energy efficiency products and services will be the focus of an add-on to this study. Thus, such measures were excluded from further consideration in this study to avoid duplication of efforts.

Light emitting diode (LED) traffic signals, for example, were considered as a high priority for tracking by nearly all Round 2 interview participants. LED traffic lights can be considered as one, three-color measure (includes red, amber, and green LEDs) or as three individual measures. Even though the market for LED traffic signals has been ramping up in recent years, the majority of retrofits have been for red LEDs. In fact, several pilot projects completed in California spurred the adoption of red LEDs in many areas throughout the state. However, because of several technological and market characteristics, sales of amber and green retrofit kits have been much lower and a three-color traffic signal is still being developed (Suozzo, 1998; Suozzo and Nadel, 1998; Mowris & Assoc., 1998). Therefore, it might be more appropriate to include the three-color LED traffic signal or retrofit kit under the emerging technology add-on study instead of this analysis. Other measures on the preliminary short list that might be considered under the emerging technology add-on study that did not make the final cut for this study include *daylighting*, *passive heating/cooling design*, and *T-5 fluorescent lamps*.

Other Measure-Specific Issues. Finally, other measure-specific issues such as Title 24 revisions (changes in Title 24 standards could indicate the market for a given measure has been transformed) and practicality for tracking, were considered to compile the final list of priorities for tracking. For example, *daylighting* is an energy efficiency practice that some Round 2 participants felt should be a high priority for tracking. However, *daylighting* was also viewed by most participants as a difficult measure to define (for example, in the extreme case, all architects or building engineers could claim they use "daylighting" if their designs include windows). In the case of air compressor measures in the nonresidential sector, *leak maintenance and management* and *high efficiency industrial air compressors* were combined into one measure labeled *compressed air system optimization*.

In summary, the measures included in the preliminary short list were examined almost on a case-by-case basis to derive the final list of priorities for which tracking strategies should be developed. Some of the factors considered include stage of market maturity and practicality issues for tracking, particularly for considering the measures on the "margin."

Final Priority Measures

Table 2-6 includes the measures selected as priorities for tracking using the methodology described up to this point. It should be noted here that there is no distinction between decision types (new construction, retrofit, and replace-on-burnout) in Table 2-6. The distinction was considered for nearly all measures throughout the study thus far – and made almost no difference in how any particular measure faired in the derivation of this priority list. In other words, both decision types (e.g., new construction and retrofit or new construction and replace-on-burnout) for nearly every measure included in Table 2-6 survived the final elimination round.

Table 2-6: Final Priority Measures for Tracking Initiatives

Residential Sector Measures	Nonresidential Sector Measures
Duct Sealing	High Efficiency Windows
High Efficiency Central Air Conditioning	High Efficiency Packaged Air Conditioning
Compact Fluorescent Fixtures	High Efficiency Chillers
Horizontal Axis Clothes Washers	High Efficiency Motors
High Efficiency Windows	Adjustable Speed Drive Fans
Compact Fluorescent Lamps	32 Watt/T8 Lamps with Electronic Ballasts
High Efficiency Gas Furnaces	Energy Management Systems
High Efficiency Refrigerators	High Efficiency Packaged Refrigeration Equip.
High Efficiency Dishwashers	Adjustable Speed Drive Pumps
High Efficiency Gas Water Heaters	Compressed Air System Optimization

2.7 Additional Priorities for Tracking

The remainder of this memorandum discusses additional priorities for tracking strategies and related issues to augment the CBEE's market transformation evaluation plan, including tracking other market-effects indicators, tracking competing products, tracking additional measures and/or services that are not included in Table 2-6 if the marginal cost of doing so is low, and monitoring changes in whole-building or whole-system efficiency levels.

Tracking Other Market-Effects Indicators

In order to meet the CBEE's market transformation evaluation objectives, it is necessary to track not only sales of specific high efficiency measures and services, but other market-effects indicators as well.[9] Here, market transformation denotes a long-lasting change in the marketplace, or at least one that lasts beyond the life of market transformation initiatives that will be implemented through the transition period over the next few years. Market transformation is typically characterized as the removal of market barriers that prevent the achievement of socially optimal levels of energy efficiency activity.[10] Thus, the first step in identifying the appropriate market effects to monitor is to identify the market barriers impeding the optimal level of adoption associated with each measure.

General categories market barriers identified in the literature include: [11]

- Product unavailability,
- Organizational practices,
- Performance uncertainties and perceived risks,
- Information costs,
- Hassle costs,
- Asymmetric information,
- Externalities,
- Hidden costs,
- Access to financing,
- Inseparability of product features,

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9 In fact, during the two rounds of interviews, many respondents commented that tracking market characteristics and other market-effects indicators is more informative than tracking sales of specific measures

10 A taxonomy of these barriers has been developed in a recent report by Eto, Prahl, and Schlegel (1996).

11 The reduction of market barriers does not necessarily yield market transformation in the sense in which that term is used in policy discussions surrounding energy efficiency markets. In this context, market transformation implies the use of policies and programs to secure long lasting reductions in these barriers. While some kinds of program features might diminish barriers for the duration of these programs, true market transformation requires that such features actually cause more or less permanent improvements in market performance.

- Irreversibility,
- Bounded rationality, and
- Split incentives.

These market barriers are clearly interdependent and to some extent overlapping. In a few cases, they might not even be distinguishable from each other. For instance, split incentives are clearly exacerbated by customers' lack of awareness of the energy savings associated with efficiency measures, and this lack of awareness is strongly related to both performance uncertainties and bounded rationality. In addition, most of the barriers can be characterized as costs (information costs, decision costs, etc.) or risk perceptions. The mere existence of costs or risks in a marketplace does not necessarily signal market failure or indicate the need for policy. If these costs or risks are misperceived or unnecessary, however, appropriate policies might help to improve market performance.

Table 2-7 and Table 2-8 provide a summary of the market barriers associated with the residential and nonresidential measures identified as priorities in Table 2-6, respectively. Each table includes the primary barriers to market penetration and the general market barrier categories.[12]

Now that the market barriers associated with the measures identified as priorities for tracking have been identified, the next step is to investigate the best way to approach the task and the alternatives for tracking changes in these market barriers (e.g., market effects) over the next few years. These, and other issues, will be examined and addressed during the Methods and Feasibility Assessment phases of this study.

[12] Measure specific barriers to market penetration were primarily derived from Suozzo and Nadel,1998. Note that this study had a national focus.

Table 2-7: Summary of Market Barriers: Residential Measures

Measure	Measure Specific Market Barrier(s)	General Market Barrier Categories
Duct Sealing	• Lack of awareness of homeowners and contractors about impact of duct sealing on energy use, home comfort, indoor air quality • Lack of contractor knowledge of duct sealing technologies, methods and practices • No contractor certification of good duct sealing practices.	• Performance uncertainties and perceived risks • Information costs • Hassle costs • Split incentives
High Efficiency Central Air Conditioning	• Lack of consumer awareness/knowledge of technology and energy savings • Lack of contractor knowledge of proper installation of high efficiency models • Many units are bought by landlords and builders who seek to minimize first cost	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Split incentives
Compact Fluorescent Fixtures	• Poor quality of residential grade fixtures • Limited product selection • Consumers aversion to appearance characteristics • Poor reliability	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Split incentives
Horizontal Axis Washers	• Lack of consumer awareness/knowledge of technology and energy savings • Consumer acceptance of front-loading configuration • Limited number of manufacturers and distributors	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Information costs
High Efficiency Windows	• Lack of consumer awareness/knowledge of technology and energy savings • Limited product availability • Many units are bought builders who seek to minimize first cost	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Information costs • Hassle costs • Split incentives
Compact Fluorescent Lamps	• Poor lamp quality • Lack of product specification labels • Inability to fit existing fixtures (lamp size) • Retailer stocking practices	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks
High Efficiency Gas Furnaces	• Lack of consumer awareness/knowledge of technology and energy savings • Lack of contractor knowledge of proper installation of high efficiency models • Many units are bought by landlords and builders who seek to minimize first cost	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Split incentives
High Efficiency Refrigerators	• Limited number of manufacturers and distributors • Stocking practices • Lack of consumer awareness/knowledge of improved efficiency and energy savings • Many units are bought by landlords and builders who seek to minimize first cost	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Split incentives
High Efficiency Dishwashers	• Lack of consumer awareness/knowledge of technology and energy savings • Many units are bought by landlords and builders who seek to minimize first cost	• Performance uncertainties and perceived risks • Information costs • Split incentives
High Efficiency Gas Water Heaters	• Lack of consumer awareness/knowledge of technology and energy savings • Stocking practices • Many units are bought by landlords and builders who seek to minimize first cost	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Split incentives

Table 2-8: Summary of Market Barriers: Nonresidential Measures

Measure	Measure Specific Market Barrier(s)	General Market Barrier Categories
High Efficiency Windows	• Lack of awareness/knowledge of technology and energy savings • Poor stocking practices • Majority of units are bought by builders who seek to minimize first cost	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Hassle costs • Information costs • Split incentives
High Efficiency Packaged Air Conditioning	• Poor stocking practices • Limited availability • Many units are bought by building managers and builders who seek to minimize first cost	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Split incentives
High Efficiency Chillers	• Lack of awareness/knowledge of technology, design requirements and energy savings • Lack of willingness to complete needed system design requirements • Many units are bought by building managers and builders who seek to minimize first cost	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Hassle costs • Information costs • Split incentives
High Efficiency Motors	• Lack of awareness/knowledge of technology performance and energy savings • Lack of good planning practices for motor replacements • Majority of units are bought by end-users who seek to minimize first cost • Emphasis on reliability and performance	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Hassle costs • Information costs • Split incentives
Adjustable Speed Drive Fans	• Lack of awareness/knowledge of technology, *system* design approach and requirements and energy savings • Lack of end user's willingness to complete needed complex system design requirements • Many units are bought by end-users who seek to minimize first cost • Need for standardized performance measurement and certification • Emphasis on reliability and performance	• Organizational practices • Performance uncertainties and perceived risks • Hassle costs • Information costs • Split incentives
32 Watt/T8 Lamps with Electronic Ballasts	• Lack of awareness/knowledge of technology and energy savings • Need for specialized skill for certain applications • Many units are bought by building managers and builders who seek to minimize first cost • Incompatibility of technology with certain types of existing systems	• Product unavailability • Organizational practices • Performance uncertainties and perceived risks • Hassle costs • Information costs • Split incentives
Energy Management Systems	• Lack of awareness/knowledge of technology, design requirements and energy savings • Lack of end user's willingness to complete needed complex system design requirements • Many units are bought by end-users who seek to minimize first cost	• Organizational practices • Performance uncertainties and perceived risks • Hassle costs • Information costs • Split incentives

Table 2-8 (cont'd): Summary of Market Barriers: Nonresidential Measures

Measure	Measure Specific Market Barrier(s)	General Market Barrier Categories
High Eff. Packaged Refrigeration Equip.	• Lack of awareness/knowledge of technology and energy savings by end user • Some vending units supplied by distributors free of charge to establishments that agree to buy vendors products. • Need for standardized performance measurement and certification	• Performance uncertainties and perceived risks • Hassle costs • Information costs • Split incentives
Adjustable Speed Drive Pumps	• Lack of awareness/knowledge of technology, design requirements and energy savings • Lack of end user's willingness to complete needed complex system design requirements • Many units are bought by end-users who seek to minimize first cost	• Organizational practices • Performance uncertainties and perceived risks • Hassle costs • Information costs • Split incentives
Compressed Air System Optimization	• Lack of awareness/knowledge of technology and energy savings by end user • Lack of availability of specialized skill to design and implement systems • Need for standardized performance measurement and certification	• Performance uncertainties and perceived risks • Hassle costs • Information costs

Taking Advantage of Tracking Economies

While the energy-efficiency measures identified as priorities in Table 2-6 should be the focus of tracking strategies, we recognize that it could be possible to monitor sales of other competing and non-competing high efficiency measures not included as a priority if the marginal cost of doing so is very low. For example, high efficiency gas furnaces are included in the priority list for measures in the residential sector. The additional cost for tracking high efficiency electric furnaces (not a priority measure, but a competing measure) might be very low. Further, market shares for high efficiency central air conditioning (a non-competing high efficiency measure) might be available from the same data source (e.g., HVAC distributors). The key is to collect the relevant data at a point in the market where such economies could be realized (i.e., at the distributor level instead of the manufacturer level).

Tracking Whole-Building/Whole-System Efficiency Levels

The original objective of this study was to identify specific energy efficiency measures or services for which market-share tracking strategies should be developed. Market share trends will then be used to assess market the extent of market transformation at least through the transition period. However, discussions with industry experts and participants during this Needs Assessment phase of the study reveal that a considerable amount of information would be excluded if whole-building or whole-system efficiency levels are not included in this framework. While most, if not all, of the industry experts and participants interviewed for this study see the value of doing so, they also recognized the difficulties associated with such an effort. The possible methods for and feasibility of tracking overall efficiency levels as one indicator of market transformation will be investigated during the Methods and Feasibility phases of this study.

There are many issues that need to be addressed for progress to be made in this area. First, attribution of changes in efficiency levels to specific market transformation initiatives might be difficult, if not impossible. Program attribution would only be important, however, if increasing whole-building efficiency levels will be the objective of specific intervention strategies in the state. Second, efficiency-level data might not be cost-effectively available and secondary indicators might need to be used as proxies for changes in overall energy efficiency. Third, the issue becomes more complex, yet more important, for nonresidential buildings, and there are many services (e.g., building commissioning) and “subsystems” (e.g., HVAC system optimization, compressed air system optimization) that could be tracked to determine changes in efficiency levels. While such services and practices will be more difficult to track than equipment sales, omitting from an analysis plan could be detrimental to the CBEE’s market transformation evaluation efforts.[13]

Despite the difficulties associated with tracking overall efficiency levels, we recognize the fact that the energy efficiency market in California, in general, is evolving away from focusing on specific energy efficiency measures and associated energy or demand savings to a market approach for achieving higher levels of energy efficiency, as evidenced by market intervention strategies and overall policy objectives for the transition period in the state of California. Particular programs will still incentivize or promote the adoption of specific measures, but program planning and policy making decisions are considering the integration of programs (the “balanced portfolio criteria”) that target a variety of market actors to achieve market transformation (CBEE, 1998). Given this perspective, monitoring whole-building efficiency through the transition period will not only provide a measure of market transformation, but will provide feedback to the CBEE as to the success of these program planning efforts.

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[13] Recall from above that compressed air system optimization was included as a priority for tracking in this assessment. Building commissioning is a practice that is beginning to be more widely used and will likely be included in the emerging technologies add-on.

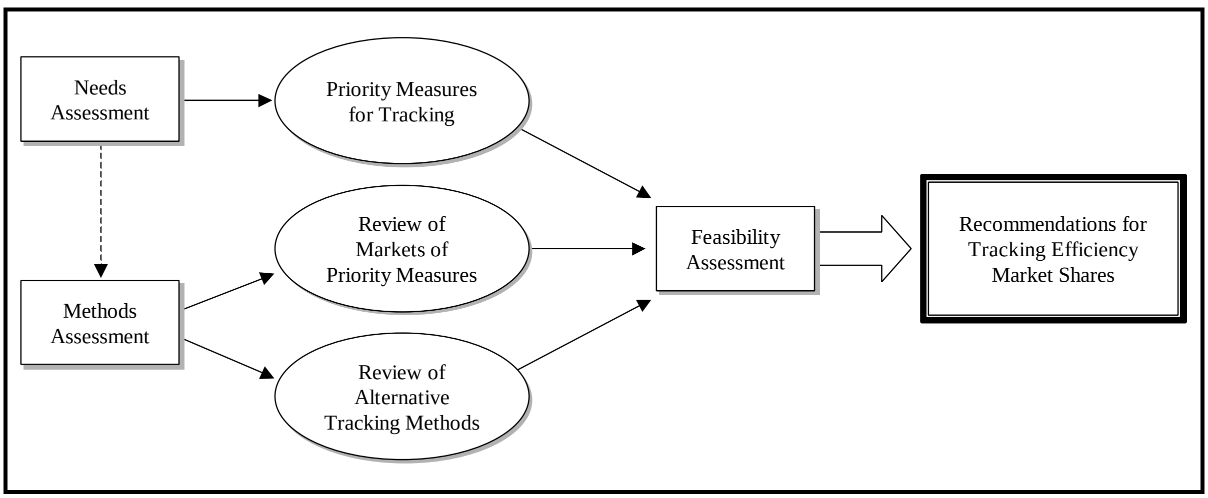
scoping study, data required for tracking efficiency market shares must meet the following requirements:

- Data represent unit sales, <u>and</u>
- Data are/can be segmented by efficiency level, <u>and</u>
- Data are/can be segmented by geographic region, at least at the state level, <u>and</u>
- Decision type (new construction and replace-on-burnout/retrofit/net acquisition) must be identifiable, when applicable.

As shown in Figure 1-1, this scoping study is comprised of three major phases:

1. A Needs Assessment to identify priority measures for which tracking systems should be developed,
2. A Methods Assessment to characterize the markets of priority measures and identify alternative methods that could be used to implement tracking, and
3. A Feasibility Assessment to compare and evaluate the feasibility of each viable method for tracking the priority measures. RER's approaches to these elements of the study are summarized below.

Figure 1-1: Project Overview



The final result of this research is a set of recommended initiatives for tracking the market shares of the priority efficiency measures. RER's approaches to these elements of the study are summarized below.

Needs Assessment

The objective of the Needs Assessment was to identify specific energy efficiency measures for which tracking systems should be developed. A list of 20 residential and nonresidential measures considered to be priorities for tracking was derived based upon several criteria, including potential cost-effective savings, the expected level of marketing efforts to promote the measures, the seriousness of market barriers associated with the measures, and the susceptibility of such measures to market intervention. This assessment was based upon information obtained from two rounds of in-depth interviews with industry experts and participants, and reviews of a variety of previous studies, such as the California Demand Management Advisory Committee (CADMAC) market effects studies, utility demand-side management (DSM) potential studies, market transformation plans and initiatives, and utility program impact analysis results.

Methods Assessment

The objective of the second phase of this study was to identify and investigate alternative methods for tracking the market shares of the measures identified as priorities in the Needs Assessment. The overall approach to this Methods Assessment was to answer two key questions:

1. At which point in the distribution channel does it make the *most sense* to collect market share data for the priority measures?
2. What methods or strategies could be implemented to collect market share data at various distribution points?

To address these key research questions, RER characterized the markets for the identified priority measures and determined the point(s) in the distribution channels where it makes the most sense to collect data required for tracking. The Methods Assessment also entailed the identification and review of a wide range of alternative data sources and data collection methods. These sources include existing data sources, such as shipments data consumer panel data, and scanner data, as well as undeveloped data sources, including downstream market actor surveys and data collection from upstream and midstream market actors. The Methods Assessment resulted in a set of viable tracking methods for each measure and applicable decision type.

Feasibility Assessment

In this third and final phase of this scoping study, RER evaluated each alternative tracking method for each measure and decision type according to nine criteria. This final research phase utilized reviews of past efforts to develop tracking systems and interviews with those involved in their development, interviews with key market actors or potential data suppliers, and information gathered throughout the course of this research.

The result of the Feasibility Assessment is a set of recommendations and associated cost estimates for tracking efficiency market shares of the priority measures in the California market.

1.2 Preview of Results

Recommendations for Tracking Residential Priority Measures

Table 1-1 summarizes RER's recommendations for tracking the priority residential measures.[2] As indicated, RER recommends that the market shares of the residential measures be tracked with four initiatives:

- Integrating on-site surveys and data obtained from building department records for new construction installations,
- Conduct on-site surveys of a sample of prescreened residential sites to track retrofit measures,
- Collect distributor sales data for tracking replace-on-burnout purchases of HVAC and water heating equipment, and
- Obtain tracking data collected under the ENERGY STAR® program in addition to data from smaller, independent retailers in California.

When combined, these four initiatives recommend approaches for tracking all of the priority residential measures for all decision types. These initiatives recommend collecting data at the end-user level using on-site surveys, from building departments for new construction, from retailer records, and from distributors. Where possible, these initiatives utilize the significant economies from collecting information about numerous priority measures at one market node using a single customized approach. Alternative approaches that require data collection from market nodes other than from consumers require either a multi-node tracking initiative or the omission of a significant portion of the market.

[2] Note that the recommendations appearing in Table 1-1 represent the primary tracking initiative for each measure. In some cases, RER recommends that the primary data be supported or augmented with secondary data to cross-check data obtained from other sources. Secondary methods are discussed when appropriate.

Table 1-1: Summary of Recommended Tracking Initiatives for Priority Residential Measures

Priority Measure	Recommended Tracking Initiative
Duct Sealing [NC]	I Bldg. Dept./On-site Survey Data
Duct Sealing [Retro.]	II On-Site Survey of Prescreen Sample
Central Air Conditioners [NC]	I Bldg. Dept./On-Site Survey Data
Central Air Conditioners [Net Acquis./ROB]	III Distributor Sales Data
Compact Fluorescent Fixtures [NC]	I Bldg. Dept./On-Site Survey Data
Compact Fluorescent Fixtures [ROB]	IV ENERGY STAR®/EGIA Retail Initiative
Horizontal Axis Clothes Washers [Net Acquis/ROB.]	IV ENERGY STAR®/EGIA Retail Initiative
Windows [NC]	I Bldg. Dept./On-Site Survey Data
Windows [Retro]	II On-Site Survey of Prescreen Sample
Compact Fluorescent Lamps [NC]	I Bldg. Dept./On-Site Survey Data
Compact Fluorescent Lamps [ROB]	IV ENERGY STAR®/EGIA Alliance Retail Initiative
Gas Furnaces [NC]	I Bldg. Dept./On-site Survey Data
Gas Furnaces [ROB]	III Distributor Sales Data
Refrigerators [Net Acquis./ROB]	IV ENERGY STAR®/EGIA Retail Initiative
Dishwashers [NC]	I Bldg. Dept./On-Site Survey Data
Dishwashers [ROB]	IV ENERGY STAR®/EGIA Alliance Retail Initiative
Gas Water Heaters [NC]	I Bldg. Dept./On-Site Survey Data
Gas Water Heaters [ROB]	III Distributor Sales Data *(See table footnote)*

[NC] [Retro.] [ROB] and [Net Acquis.] denote new construction, *retrofit*, *replace-on-burnout,* and *net acquisition* decision types, respectively.

Note that distributor sales data of sales of water heater replacements excludes roughly 50% of the water heaters sold through retailers who purchase directly from the manufacturer. This issue is discussed in Section 9.5.

Table 1-2 presents a summary of the costs of the residential tracking initiatives for the first and subsequent years. The estimated annual budget to develop and implement the four recommended tracking initiatives is in the range of $1,054,000 to $1,405,000 for the first year. Development costs are not incurred in subsequent years, which reduces the annual costs to roughly $920,000 to $1,202,000.

Table 1-2: Summary of the Annual Costs for First and Subsequent Years for Planning and Implementing the Recommended Residential Tracking Initiatives

Initiative	First Year	Second Year
I Integrating On-Site Survey and Building Department Data	$442,000 - $560,000	$420,000 - $512,000
II On-Site Surveys of Prescreened Residential Sites	$356,000 - $445,000	$332,000 - $410,000
III Collect Distributor Sales Data	$96,000 - $170,000	$68,000 - $140,000
IV ENERGY STAR®/EGIA Retail Tracking	$160,000 - $230,000	$100,000 - $140,000
Total Estimated Cost	$1,054,000 - $1,405,000	$920,000 - $1,202,000

Recommendations for Tracking Nonresidential Recommendations

Table 1-3 summarizes RER's recommendations for tracking the priority nonresidential measures.[3] As indicated, RER recommends that the market shares of the nonresidential measures be tracked with the following three initiatives:

- Integrate data collected with CEC on-site surveys with data obtained from building department records to track nonresidential new construction measures,
- Integrate CEC on-site surveys of a prescreened sample of commercial sites and a telephone survey of commercial and industrial sites to collect data on retrofit and replace-on-burnout installations, and
- Obtain sales data from major chiller manufacturers to track new construction and replace-on-burnout chiller installations.

These recommendations offer tracking approaches for most of the priority nonresidential measures, with the exception of packaged refrigeration equipment and non-HVAC motors.[4] Initiatives V and VI recommend collecting data at the end-user level using on-site surveys and data obtained from building department records for new construction, and on-site surveys augmented with a telephone survey for retrofit/replace-on-burnout installations. Because of the rather unique structure of the chiller market, data useful for efficiency market share tracking can be obtained from major chiller manufacturers.

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[3] Note that the recommendations appearing in Table 1-2 represent the primary tracking initiative for each measure. In some cases, RER recommends that the primary data be supported or augmented with secondary data to cross-check data obtained from other sources. Secondary methods are discussed when appropriate.

[4] Measures for which tracking recommendations are not provided are discussed in Subsection 10.7.

Table 1-3: Summary of Recommended Tracking Initiatives for Priority Nonresidential Measures

Priority Measure	Recommended Primary Tracking Initiative
Nonresidential Windows [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Nonresidential Windows [Retro.]	*None recommended (see below).*
Packaged Air Conditioning [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Packaged Air Conditioning [ROB]	III. Distributor Data Collection *(see Section 9)*
Chillers [NC]	VII. Chiller Manufacturer Data Collection
Chillers [ROB]	VII. Chiller Manufacturer Data Collection
Non-HVAC Motors	*None recommended (see below).*
Adjustable Speed Drive Fans [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Adjustable Speed Drive Fans [Retro.]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
32W T8s w/Electronic Ballasts [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
32W T8s w/Electronic Ballasts [Retro.]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
Energy Management Systems [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Energy Management Systems [Retro]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
Packaged Refrigeration Equipment	*None recommended (see below).*
Adjustable Speed Drive Pumps [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Adjustable Speed Drive Pumps [Retro.]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
Compressed Air System Optimization	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys

[NC] [Retro.] [ROB] and [Net Acquis.] denote new construction, *retrofit*, *replace-on-burnout*, and *net acquisition* decision types, respectively.

Table 1-4 presents a summary of the costs of the recommended nonresidential tracking initiatives for the first and subsequent years. As shown, the estimated annual budget to develop and implement the three recommended tracking initiatives is in the range of $761,000 to $1,078,000 for the first year. Development costs are not incurred in subsequent years, which reduces the annual costs to roughly $648,000 to $896,000. As shown, estimated costs increase significantly to $1,768,000 to $2,691,000 in the first year if tracking needs are not incorporated in the CEC's data collection efforts.

Table 1-4: Summary of the Annual Costs for First and Subsequent Years for Planning and Implementing the Recommended Nonresidential Tracking Initiatives

Initiative	First Year	Second Year
V. CEC On-Site Survey/Bldg. Dept. Data	$172,000 to $233,000	$136,000 to $180,000
Va. On-Site Survey/Bldg. Dept. Data	*$868,000 to $1,345,000*	*$832,000 to $1,280,000*
VI. CEC On-Site Survey/C&I Telephone Survey	$499,000 to $695,000	$452,000 to $616,000
VIa. On-Site Survey/C&I Telephone Survey	*$810,000 to $1,196,000*	*$780,000 to $1,140,000*
VII. Chiller Manufacturer Data Collection	$90,000 to $150,000	$60,000 to $100,000
Total Cost with CEC Involvement	$761,000 to $1,078,000	$648,000 to $896,000
Total Cost w/out CEC Involvement	$1,768,000 to $2,691,000	$1,672,000 to $2,520,000

1.3 Organization of Report

This report is comprised of two volumes. The remainder of Volume 1 is comprised of the following sections:

- Section 2 presents methodology and results of the Needs Assessment,
- Section 3 through Section 6 include an introduction, the review of markets of priority measures, a review of tracking alternatives, and the summary sections of the Methods Assessment,
- Section 7 and 8 include the introduction and analysis of the Feasibility Assessment,
- Section 9 presents RER recommendations for tracking the priority residential measures,

- Section 10 includes RER's recommendations for tracking the priority nonresidential measures, and
- Section 11 summarizes the recommended initiatives and offers some concluding remarks.
- The final section of Volume 1 includes the references.

Volume 2 of this report includes the remaining appendices:

- Appendix A includes a comprehensive bibliography.
- Appendices B through G pertain to the Needs Assessment and include results of stakeholder interviews, interview materials, results of RER analysis of DSM potential studies and utility program impact evaluation results, and the preliminary list of measures from which the final priority measures were derived.
- Appendix H summarizes tracking initiatives in Wisconsin,
- Appendix I includes examples of Title 24 compliance forms, and
- Appendix J includes additional, more detailed information about some of the tracking alternatives reviewed for this study.

3

Methods Assessment Introduction and Overview

3.1 Overview and Objectives

The following sections present RER's research and analysis for the second of three major phases of this scoping study. The primary objective of the Methods Assessment is to identify and investigate alternatives for tracking market shares for the 20 residential and nonresidential measures identified as priorities for tracking in the Needs Assessment. The overall approach to this Methods Assessment was to answer two key questions:

1. At which point in the distribution channel does it make the *most sense* to collect market share data for the priority measures?
2. What methods or strategies could be implemented to collect market share data at various distribution points?

The third and final phase of this study – the Feasibility Assessment – will address the most critical question:

3. At which point in the distribution channel and with what method is it *most feasible* to collect market share data for the priority measures?

The following subsection summarizes RER's approach for addressing the first two key questions.

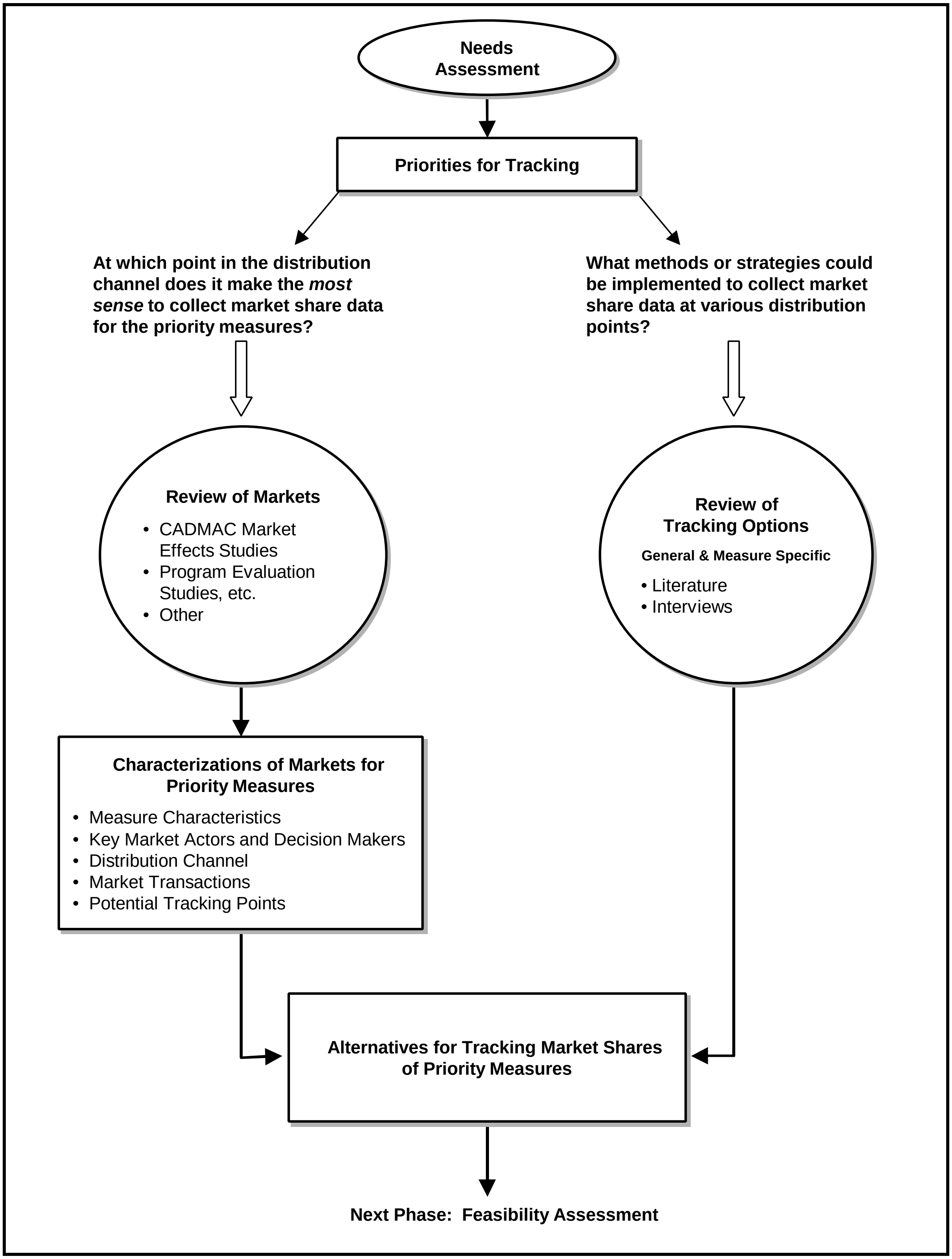
3.2 Methodology

As shown in Figure 3-1, the Methods Assessment includes two primary elements, each of which corresponds to one of the two key questions presented above:

1. A review of markets for high efficiency measures, and
2. A review of market share tracking alternatives.

The methodologies for completing these elements of the Methods Assessment are summarized below.

Figure 3-1: Conceptual Framework for Methods Assessment



Review of Markets for Priority Measures

In general, the market reviews followed a four-step approach. Each step is summarized below.

Step 1. ***Define Markets.*** In the context of this study, a market is comprised of the channels through which products are distributed from the manufacturer to the final end user and key market actors involved in the process and transactions of distribution. Measures with similar or identical distribution channels, therefore, are considered included in the same "market."[1] Even though this study's objective is to develop recommendations for tracking the market shares of specific measures, doing so could not be accomplished without first understanding the markets and transactions through which these measures reach the final end users.

Grouping measures into markets was logically the first step in the review of markets.[2] Here, the 20 residential and nonresidential are grouped into 13 unique markets.

Step 2. ***Define Priority Measures.*** The second step in the review of the market was to define more precisely and comprehensibly the priority measures. In particular, the measures need to be defined with respect to what exactly should be tracked. This is straightforward for some measures, but not for others. In the least, defining and describing the measures "got the ball rolling" in terms of determining the most logical means for tracking each measure.

Step 3. ***Characterize Each Market.*** After grouping the measures into markets and defining and describing each specific measure, each market was investigated to determine key market characteristics, define distribution channels, and identify potential points for collecting useful data for tracking. RER utilized a variety of information sources for this task, including market-effects studies conducted for CADMAC, discussions and interviews with key market actors and other industry participants, market transformation potential studies conducted by ACEEE, the Internet, and RER staff expertise.

The reviews of markets for the measures identified as priorities for tracking include:

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[1] This definition is similar to that used in *Analysis of Available Baseline Data on California Energy Markets*, the other MA&E scoping study currently being conducted by Xenergy. "… [T]he baseline market characteristics (market actors, market barriers, market channels, etc.) are substantially different between individual markets, but consistent within them, and that the market developed are reasonably consistent with the new program categories included in the CBEE's October 15th Advice Filing to the CPUC" (page 2-2 of interim report).

[2] In a few cases, initial groupings of measures into markets were reworked after the markets for some measures were more fully understood.

- A general definition of the measures included in the market,
- A discussion of how efficiency is measured and applicable minimum efficiency standards, and
- A description of the distribution channels and key market actors.

Step 4. Determine Implications for Tracking. By working from more precise measure definitions and having a complete understanding of the markets through which they are distributed enabled RER to arrive at some definitive implications for tracking these market shares. Several factors were considered during this step, including 1) data requirements for tracking, 2) roles of key market actors and their ability to provide such data, 3) the point(s) in the distribution channel where it might be feasible to collect such data, and 4) any key measure characteristics that might influence market share tracking.

Review of Market Share Tracking Alternatives

The review of market share tracking alternatives involved a straightforward approach.

Step 1. Compile List of Tracking Options. First, an initial list of market share tracking alternatives was compiled from numerous sources, including EPRI's recent study on market tracking sources, Internet searches, and RER staff. The options were then categorized as either *existing* or *undeveloped* according to the extent to which the option's infrastructures are developed for collecting useful data for tracking (e.g., data segmented by efficiency level, geographic region, and decision type).

Step 2. Develop Template for Conducting Research. Because the final phase of this study requires the evaluation of each tracking alternative according to the same criterion, it was necessary to obtain the same information for each method, if possible. As such, RER developed a template for the information to be collected about each method.

Step 3. Conduct Research. The review of market share tracking alternatives utilized several types of data sources, including in-person and telephone interviews and discussions with a variety of potential data suppliers, interviews with individuals involved in the market share tracking initiative in Wisconsin, and the internet.

The research into tracking alternatives overlaps to some extent with the Feasibility Assessment phase of this study. In particular, some methods were more aggressively investigated, as they appeared to be viable options.

General descriptions of methods are presented in Section 5 while information about specific methods and potential data suppliers is included in Appendix J.

3.3 Organization of Methods Assessment

The remainder of the Methods Assessment sections of this report includes the following:

- Section 4 includes overviews of the markets for each measure identified as a priority in the Needs Assessment.
- Section 5 presents reviews of a variety of alternatives for market share tracking.
- Section 6 provides a summary of the applicability of each method for tracking the market shares of each measure.
- Appendix J provides additional details about some of the methods reviewed for this study.
- Appendix H summarizes market share tracking in Wisconsin.
- Appendix I includes examples of compliance forms used by building departments throughout the state. These forms are referred to throughout the remainder of this report.

4

Review of Markets for Priority Measures

4.1 Overview

As mentioned in Section 3, one of the two major elements of this Methods Assessment is a review of the markets of the priority measures to identify and better understand the key market actors and primary channels of distribution. The results of these market reviews help identify points in the distribution channels (referred to as "nodes" throughout) where it makes the *most sense* to collect data to support market share tracking efforts in California.

One must consider the data requirements of market share tracking when determining the most sensible tracking possibilities. In the most general terms, the data sought must meet four criteria:

- Data represent unit sales, and
- Data are/can be segmented by efficiency level, and
- Data are/can be segmented by geographic region, at least at the state level, and
- Decision type (new construction and replace-on-burnout/retrofit) must be identifiable, when applicable.[1]

This research reveals that, in most cases, unique measure characteristics as well as key features of their distribution networks help to identify logical market nodes for collecting market share data that meets these criterion.

It is important to note that the market reviews presented here are not intended to be comprehensive market characterizations, as doing so was not the objective of this study.[2] These reviews are intended to provide enough depth for one to understand the basic market structure and distribution mechanisms to make inferences about the most logical means for collecting data for market share tracking.

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1 Note that it is not necessary for the method to produce data by all decision types for all measures. This was discussed in the Needs Assessment.

2 Other studies to characterize energy efficiency markets in California have been conducted and are likely to be conducted again in the near future. RER relied on some of the market effects studies conducted for CADMAC, discussions with a variety of market actors, and the expertise of RER staff to characterize the markets, map the distribution channels, and make inferences about tracking.

Also, these reviews focus on market actors actively involved in product distribution. It is important to recognize that other market actors exist that are not involved in product distribution that could, in fact, participate in market share tracking. Because building departments, for example, collect data on specifications and installations in the residential and nonresidential new construction markets, they could possibly provide useful data for market share tracking. Data collection from building departments is a market share tracking method described in Section 5.

For review, Table 4-1 includes the 20 residential and nonresidential measures identified as priorities for tracking. As indicated by the market or end-use description, some measures were grouped together because their markets (e.g., distribution channel and key market actors) are nearly identical. Doing so was a logical exercise, as market similarities naturally lead to similar implications for tracking.

Table 4-1: Priority Measures for Tracking

Market or End-Use Description	Measure
Residential Duct Sealing	Residential Duct Sealing
Residential and Small Commercial HVAC	Residential High Efficiency Central AC Residential High Efficiency Gas Furnaces Nonresidential High Eff. Packaged AC
Residential Lighting	Compact Fluorescent Lamps Compact Fluorescent Fixtures
Residential Appliances	Horizontal Axis Washers High Efficiency Refrigerators High Efficiency Dishwashers
Residential Water Heating	High Efficiency Gas Water Heaters
Residential Windows	High Efficiency Windows
Nonresidential Windows	High Efficiency Windows & Films
Nonresidential HVAC Equipment	High Efficiency Chillers
Nonresidential HVAC Equipment	Energy Management Systems
Nonresidential Motor Systems	High Efficiency Motors Adjustable Speed Drive Pumps Adjustable Speed Drive Fans
Nonresidential Ancillary Equipment: Compressed Air	Compressed Air System Optimization
Nonresidential Lighting	T-8 Lamps w/ Electronic Ballasts
Nonresidential Refrigeration	High Eff. Packaged Refrigeration Equip.

The following subsections provide a review of each of the above 13 markets. Each subsection includes:

- A brief description of the measure, including how the measure's efficiency is defined and applicable efficiency standards,
- A review of the market, including identification of key market actors and a description of the distribution channel, and
- A discussion of the implications for collecting market share data by efficiency level, given the measure's characteristics and market.

4.2 Residential Duct Sealing

Forced air distribution system leakage in residential buildings has received considerable attention as a major source of energy loss in recent years. Testing for duct leakage and properly sealing leaks, therefore, is viewed as one source of significant achievable energy and demand savings in the residential sector. While duct sealing is commonly viewed as having an important role in residential new construction quality, the Needs Assessment phase of this study revealed that duct sealing of existing buildings should be considered a high priority as well.

Currently, California's Title 24 energy efficiency standards award performance credit for verified tight ducts. The standards, however, do not currently mandate specific sealing methods, nor do they require duct leakage testing. Recent revisions to Title 24 will require that "all pressure sensitive tapes, mastics, aerosol sealants, or other closure systems must meet applicable UL 181 requirements."[3] This requirement pertains to ducts in all building types and will become effective January 1, 1999.

There is no commonly accepted methodology for measuring duct system efficiency. The duct leakage rate, however, is the indicator considered here. The extent of leakage can be measured with either a duct blaster test (which pressurizes the duct system) or a duct blaster test in tandem with a blower door test, which pressurizes the building. These tests measure the leakage from the ducts to the conditioned space within the building envelope, or the leakage between the building envelope and the outside. HVAC contractors conduct these tests at the direction of builders in new construction and homeowners in existing buildings. However, they are not yet commonplace in either the new construction or existing building market in the absence of financial incentives.

Leaking air ducts can be sealed with a variety of methods, including mastics, metal tape (foil back), butyl tape (clear plastic tape), and duct tape, which can be augmented with collars or clamps. A recent development in the duct sealing industry is the advent of a sticky vinyl polymer aerosol sealant, developed at the Lawrence Berkeley National Laboratory (LBNL). In simplest terms, the sealant is injected into the duct system with a machine similar to a duct blaster. The material automatically deposits and dries at leakage points in the duct work, covering large areas and those that are both small and inaccessible with conventional methods. As such, the aerosol technology is ideal for sealing ducts in existing residential and nonresidential buildings, where ducts are often inaccessible.

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[3] California Energy Commission, *Summary of Changes to the Energy Efficiency Standards.* Sacramento, CA. 1997. The revisions also mandate drawband materials and tightening when used with flexible duct work.

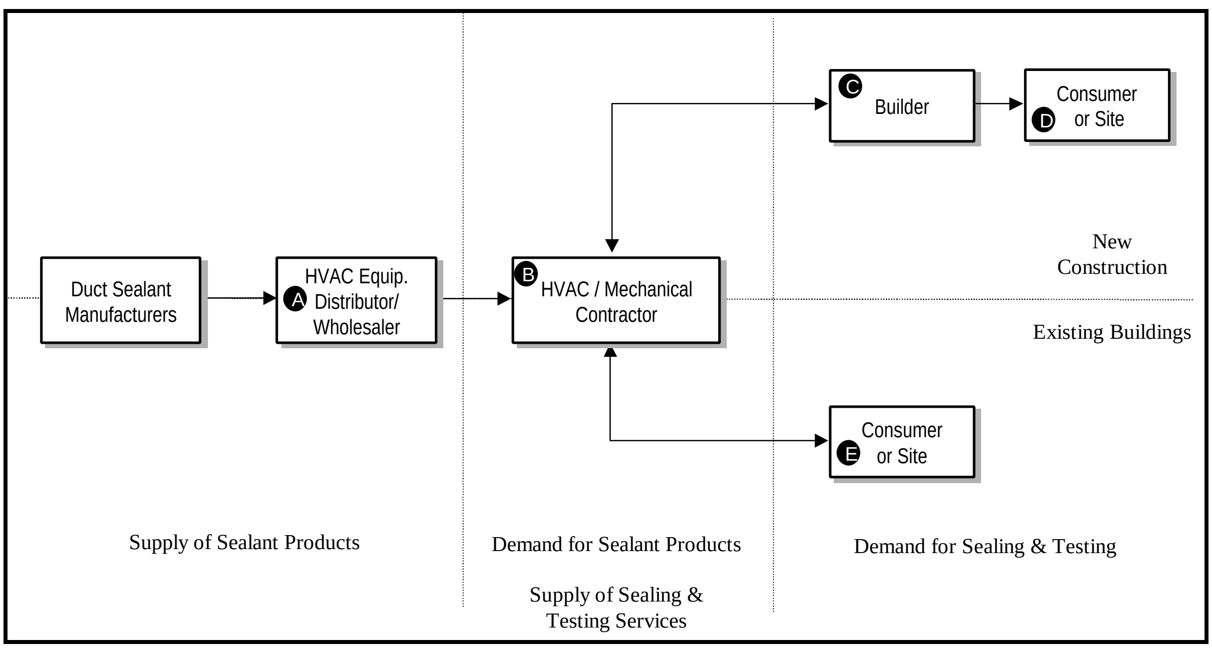
Review of the Market for Residential Duct Sealing

As shown in Figure 4-1, the key actors in this market include sealant product manufacturers, HVAC distributors, HVAC/mechanical contractors, builders, and consumers. The market for duct sealing is comprised of three primary elements: 1) *diagnostic testing* to measure the extent of duct leakage, 2) the actual practice or service of *duct sealing*, and 3) the method of sealing or using duct sealant *products*. Each of these elements should be considered when determining what exactly should be tracked and at which point in the distribution channel tracking data should be collected.

Sealant manufacturers interact with HVAC equipment distributors mainly through product transfer. HVAC equipment distributors often carry the full line of HVAC equipment and related materials, including duct sealant materials. The wholesale HVAC distributor then sells the sealant products to HVAC/mechanical contractors, who design and install the air distribution system and install the HVAC equipment in new construction, or re-seal leaking duct work in existing buildings.

In the new construction market, the HVAC/mechanical contractor and the builder specify the HVAC system and the HVAC contractor primarily designs the duct system, including the methods for sealing the duct work. The builder will generally decide whether to test for duct leakage. In a retrofit situation (e.g., existing buildings), the homeowner interacts directly with the HVAC/mechanical contractor.

Figure 4-1: Market for Residential Duct Sealing



Implications for Tracking Residential Duct Sealing

Tracking the market shares of duct sealing presents a formidable obstacle because it is an energy efficiency *service* or *practice* as opposed to a specific piece of equipment. This issue naturally forces the question: *How do you define its market share?* Provided you can answer this question, one must then ask: *How do you track the market shares of such practices or services?* Despite these obstacles, energy efficiency measures of this nature should not be excluded from tracking initiatives, given the importance of better duct sealing methods and materials and HVAC contractor practices in both achievable energy savings and market transformation.[4]

In the context of this study, *market share* is generically defined as the percentage of all units or installations that exceed a specified threshold of energy efficiency. Several aspects of duct sealing need to be considered with respect to defining exactly what should be tracked to infer with the most accuracy the extent of market transformation. These options are presented below.

- ***Sales of sealant products.*** The sales of sealant products described above can be tracked at one of two points in the distribution channel – from HVAC equipment distributors (node A), or HVAC contractors (node B). However, it is uncertain whether distributors will be able to identify sales of sealant products by decision type. Builders are less likely and consumers are not at all likely to know the sealant products used by duct installers. Note that economies might be gained by tracking both residential and small commercial HVAC equipment and duct sealant products through HVAC equipment distributors. However, distributors may or may not be able to distinguish sealant product sales by decision type.[5]

  Tracking sales of sealant products could serve as a relatively solid indicator of duct efficiency, as sealant products vary in rates of degradation as well as strength. Those that can form tighter seals and/or last longer will contribute to a more energy-efficient duct system. A study conducted by LBNL revealed that some types of duct sealants, namely duct tapes, "failed reliably and catastrophically."[6] Clear tapes, foil-backed tapes, mastics, and aerosol sealants were judged as better sealant products.

- ***Sealing methods and/or other practices employed by HVAC/mechanical contractors.*** Tracking sealing methods overlaps somewhat with tracking sales of sealant products, as the sealing method employed often infers the use of particular sealant product. However, while the measure

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4 Other examples of *services* or *practices* include building commissioning, compressed air system optimization, and right-sizing of equipment.

5 Because of its applicability to re-sealing in existing homes, sales of aerosol products might provide a useful indicator for sealing in the existing home market.

6 The Air Conditioning, Heating, and Refrigeration News. "Duct Tapes Flunk Berkeley Lab Tests." Vol. 204, No. 18. August 31, 1998.

identified as a tracking priority is, technically, duct sealing, a number of factors related to the energy efficiency of an air distribution system are important to total duct leakage.

These factors, which could be termed "HVAC/mechanical contractor practices" or "air distribution system optimization," could serve as useful market-effects indicators. Relevant HVAC contractor practices include 1) duct design, such as location of the duct system (e.g., the proportion of the air distribution system located within unconditioned spaces and consideration of airflow patterns), 2) consideration of airflow factors related to doors, flexible ducts, metal ducts, and duct board, 3) duct insulation R-values, and 4) proper duct installation and sealing practices.[7]

Naturally, data for tracking sealing methods and contractor practices would need to be collected from HVAC/mechanical contractors (node B). Data for practices in both new construction and existing buildings would presumably be available at this market node.

- ***Duct leakage rates.*** Duct leakage rates provide a direct indicator of duct efficiency. Tracking duct leakage rates would require on-site diagnostic tests to be conducted on a representative sample of homes in California (nodes D and E).
- ***Incidence of diagnostic duct testing.*** As mentioned above, diagnostic testing remains an uncommon practice in both new construction and in existing buildings. While changes in the incidence of diagnostic services would not explicitly infer tighter ducts (one cannot assume that testing automatically implies taking action to reduce leakage or the use of better sealant products), such information could serve as an indicator of better duct sealing practices and contractor and consumer awareness, overall. Furthermore, the incidence of duct testing would serve as a useful market-effects indicator of the normal business practices of HVAC/mechanical contractors. Tracking the incidence of duct sealing would necessarily involve collecting data from HVAC/mechanical contractors or builders (nodes B and C). Though builders are the primary decision maker with respect to whether testing will be implemented in new construction, builders would not be able to provide the incidence of testing of existing buildings.[8]

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7 An example of duct sealing practices is the use of collars and clamps with tapes or other products that were designed as such.

8 Davis Energy Group has been retained by the California Energy Commission to conduct the Residential Construction Quality Assessment. The first phase of this study will begin in January of 1999 and entails the identification of HVAC contractors in California currently using diagnostic testing equipment in new homes. This also includes services provided, procedures of diagnostic services, methods for verification, and the identification of barriers to providing diagnostic services for new homes. Furthermore, 30 newly constructed homes will be tested for duct leakage and evaluated according to several factors affecting duct efficiency. This study may also help to assess the incidence of duct testing from data collected from builders.

4.3 Residential and Small Commercial HVAC Equipment

The following are priority measures included in this market:

- Residential central air conditioners,
- Residential gas furnaces, and
- Nonresidential packaged air conditioning equipment.

Residential Central Air Conditioning Equipment. There are two types of residential central air conditioning systems. *Single* or *unitary* systems are units less than 5 tons and are single-zone, constant-volume units. *Split* systems are characterized as having the distribution portion of the system inside the building while the compressors and evaporative elements are located outside the building. *Split* systems are generally more energy-efficient than *single* systems. The efficiency level of a residential central air conditioning system less than 5 tons is expressed as a Seasonal Energy Efficiency Rating (SEER) while those greater than 5 tons are measured as an Energy Efficiency Rating (EER). The minimum energy efficiency standard mandated by the National Appliance Energy Conservation Act (NAECA) is a SEER of 10.0 for *split* systems and a SEER of 9.7 for *single* systems. [9]

Residential Gas Furnaces. The efficiency level of a gas furnace is expressed as an Annual Fuel Utilization Rate (AFUE) – the ratio of heat output to the annual gas input in BTUs. Currently NAECA requires gas furnaces manufactured after January 1, 1992 to have an AFUE of at least 0.78.

Commercial Packaged Air Conditioning Equipment. Commercial packaged air conditioning equipment – units that are typically 5 to 20 tons – accounts for the majority of air conditioning equipment installed in the nonresidential sector. These off-the-shelf units are popular in low-rise buildings (often rooftop units) and are relatively easy to install and maintain. The efficiency levels for HVAC equipment vary by equipment tonnage. Title 24 currently requires a minimum of 8.9 Energy Efficiency Rating (EER) at 95°F for a 10-ton unit.

While the focus of this study is to investigate methods for tracking market shares by EER/SEER, one should recognize that there are additional features or options that influence the efficiency of packaged air conditioning. These include 1) opt for improved controls, 2) install an economizer, 3) choose improved fan controls with adjustable speed drives, and 4)

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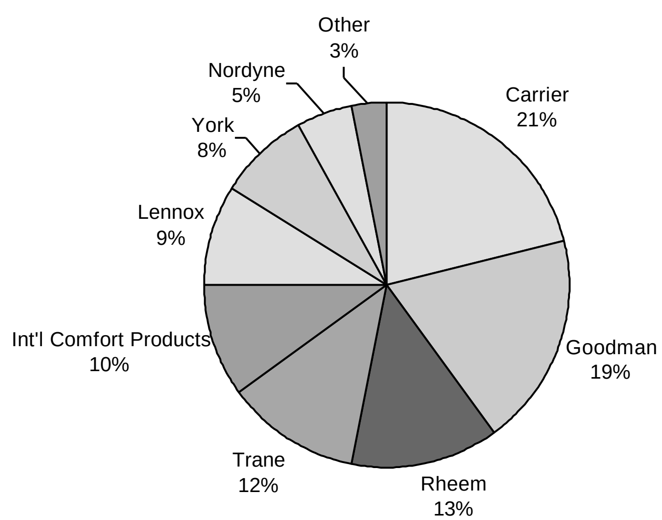
[9] Since 1987, the National Appliance Energy Conservation Act (NAECA) has mandated the national minimum efficiency standards for a variety of residential appliances and energy-using equipment. Those currently covered by NAECA include furnaces, water heaters and plumbing products, refrigerators, freezers, dishwashers, ranges and ovens, air conditioners, fluorescent lamp ballasts, clothes washers and dryers, incandescent reflector lamps, and small electric motors.

install indirect evaporative cooling. While one or all of these options can significantly improve the efficiency of packaged air conditioning units, in some cases it may be uneconomical to do so.

Review of the Residential and Small Commercial HVAC Market

The major manufacturers of residential central air conditioners and gas furnaces and their shares of the national market are presented below in Figure 4-2 and Figure 4-3, respectively. As shown, five manufacturers account for about 75% of the national central air conditioning market and six manufacturers account for over 80% of the national residential gas furnace market.[10]

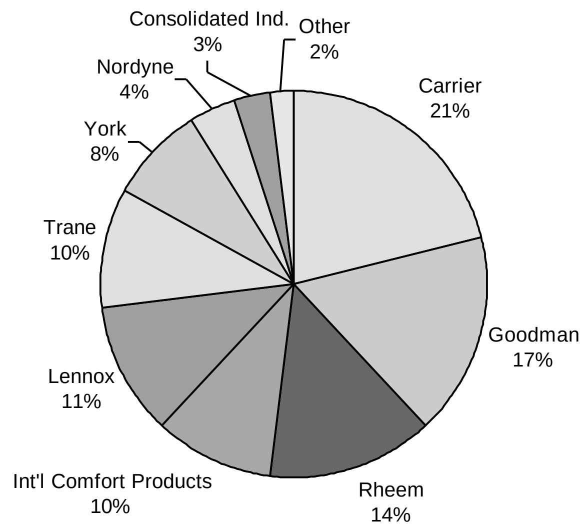
Figure 4-2: Residential Central Air Conditioning Manufacturer Shares of the National Market



Source: Appliance Magazine, September 1998.

[10] Data was not available for manufacturer shares of commercial packaged air conditioning equipment.

Figure 4-3: Residential Gas Furnace Manufacturer Shares of the National Market



Source: Appliance Magazine, September 1998.

Figure 4-4 depicts the distribution channels for new construction and replacement installations of residential and small commercial HVAC equipment. HVAC equipment manufacturers typically produce a variety of heating and cooling equipment for the residential and small commercial market, including central air conditioners, heat pumps, gas furnaces, electric furnaces, and air handling equipment.

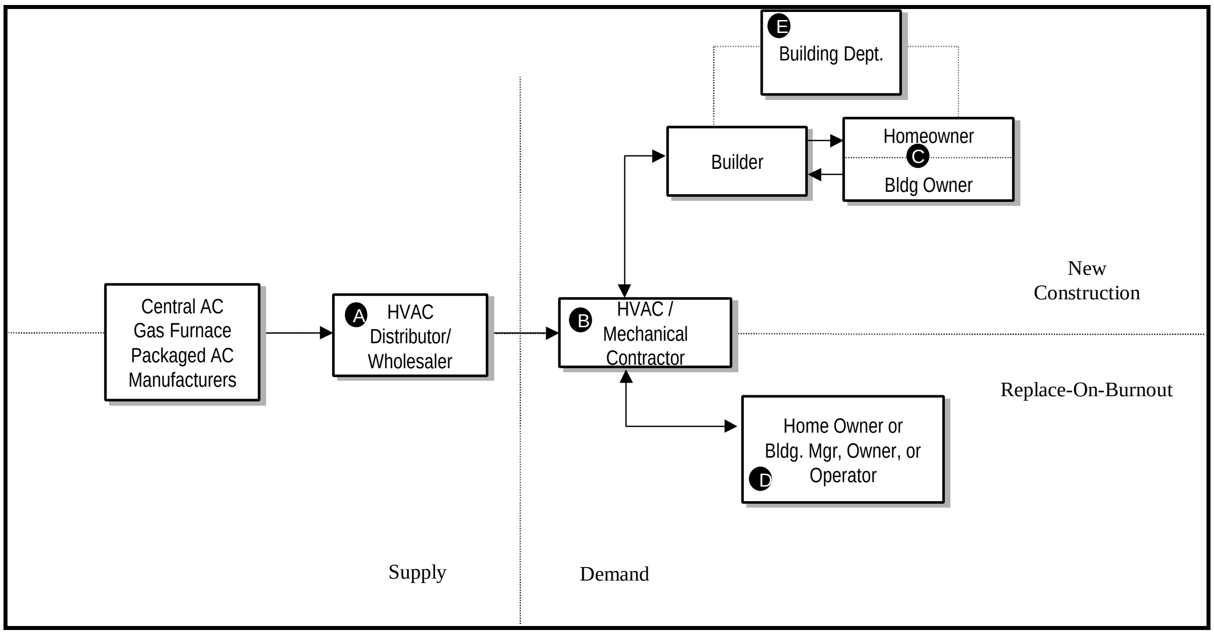
These manufacturers interact with distributors mainly through product transfer. All manufacturers employ a two-step distribution system and sell their products to equipment distributors, who then sell the equipment to an HVAC/mechanical contractor. While some manufacturers own their own distribution networks, others exclusively sell their products to private or independently owned distributors.

While the production of residential and small commercial HVAC equipment is their most critical role, manufacturers provide a significant amount of equipment information to demand-side market actors, primarily to HVAC contractors and builders. Information is disseminated to the marketplace by several means, including in-person contact between a manufacturer (sales) representative and the HVAC contractors, trade literature, and trade association meetings and conventions.

In the residential new construction market, although the final end user is the consumer or homeowner, the primary decision makers with respect to efficiency levels are the HVAC/mechanical contractor and the builder. The homeowner may have some input on the type of system placed in a custom home, but not in a typical tract home. When replacing equipment, the consumer interacts directly with the HVAC contractor and is the primary decision maker.

In the commercial sector, the primary decision makers in the new construction market are the building developers, building owners, and mechanical contractors. Although packaged air conditioners are commonly off-the-shelf units, they can be customized or engineered to better meet the customer's needs. In retrofit/replacement installations, the building or facility manager works with the HVAC/mechanical contractor in specifying retrofits or equipment replacement.

Figure 4-4: Market for Residential and Small Commercial HVAC Equipment



Implications for Tracking Residential and Small Commercial HVAC Equipment

Because the distribution networks are the same for residential central air conditioning equipment, residential gas furnaces, and most commercial packaged air conditioning units, the market shares of these measures can theoretically be tracked with the same system. The tracking initiative in Wisconsin collects sales data from HVAC equipment distributors (node A).[11] However, collecting market shares by decision type becomes an issue for tracking in California, because distributors may or may not be able to identify separately sales for new construction and replacement installations. (Tracking in Wisconsin does not track shares by decision type.)

[11] See Appendix H for an in-depth summary of tracking HVAC equipment in Wisconsin.

The HVAC contracting industry for new construction, at least in Southern California, is fairly concentrated, with only a handful of contractors accounting for a very large percentage of installations the new construction market. Assuming the HVAC equipment distributors can identify sales to those contractors, sales by decision type should be obtainable with a fair level of confidence.

Another option is to collect data from HVAC contractors (node B). This option is less attractive than the distributor option for two reasons. First, collecting data from HVAC contractors would require a much larger sample of “data suppliers” to cover the same portion of the market than if data were collected from distributors. It would also be necessary to ensure the collected data covered new construction and replacement installations in both residential and nonresidential sectors. Second, the Wisconsin experience reveals that HVAC contractors are relatively poor record keepers. If this is the case in California, it may be more difficult to collect data that meets the three key criteria than one would assume.

Another alternative is to collect data at the final end user level (nodes C and D for new construction and replacement installations, respectively) or from building departments (node E). Data can be obtained directly from the homeowner or building manager/owner via a mail or telephone survey, though consumers are not likely to be able to access model numbers or know the efficiency levels and sizes of installed equipment. Obtaining data from building departments or on-site surveys are methods through which more accurate, site-level data can be collected.

4.4 Residential Lighting: Compact Fluorescent Fixtures and Lamps

Compact fluorescent lamps are lighting systems that consist of a lamp, a lamp holder, and a ballast. Compact fluorescent lamp systems are classified as one of three basic types: integrated systems, modular systems, and dedicated systems.

Integrated systems are one-piece units that consist of a lamp, ballast, and socket adapter. These lamps are usually sold with a medium screw base and are designed to replace incandescent lamps in existing luminaires. Modular systems are self-ballasted and are designed for use in an incandescent luminaire. Unlike integrated systems, however, modular systems contain a replaceable lamp socket. Dedicated systems consist of a specially designed luminaire with a ballast and lamp socket that has been directly wired as part of the luminaire.

Residential lighting applications are classified by the type of room and by the type of lighting. Compact fluorescent lamps are suitable for many residential applications including recessed downlighting in kitchens, living rooms, or bathrooms; wall washers in living rooms; and task lighting in any area of the home. Integrated or modular systems are usually best suited to retrofit applications, while dedicated systems are limited to new home construction or to major renovation of a home's lighting. Compact fluorescent luminaires are especially suited to rooms such as kitchens and bathrooms, where high lumen output, good color rendering, and adherence to building codes is required.

The average compact fluorescent lamp consumes only one-quarter to one-third as much energy as the equivalent incandescent lamp and will last up to ten times as long. For example, a 24-watt compact fluorescent lamp (including ballast watts) with a life of 10,000 hours can replace a 75-watt incandescent lamp with a life of less than 1,000 hours.

A limiting factor for compact fluorescent lamps in residential applications is their size. The typical fluorescent lamp/ballast combination is somewhat larger than the incandescent lamp it is meant to a place. Consequently, they may not fit properly in luminaires designed for incandescent light sources. Use of compact fluorescent lamps in the home is often limited to areas where aesthetics are not a primary concern, such as basements, garages, and utility rooms. From a conservation perspective this is unfortunate, as lighting in these areas is generally utilized infrequently and the full energy savings potential of compact fluorescent lamps is not realized in these applications. Availability of high quality, aesthetically pleasing compact fluorescent luminaires is recognized as a prerequisite for widespread in-home use of compact fluorescent lamps.

Review of the Market

There are several key players in the market for residential lighting equipment. Manufacturers, wholesale distributors, contractors, lighting designers, mass-market retailers, specialty retailers, and homeowners all play a significant role in the market. Figure 4-5 presents a simplified view of the distribution channels for residential lighting equipment.

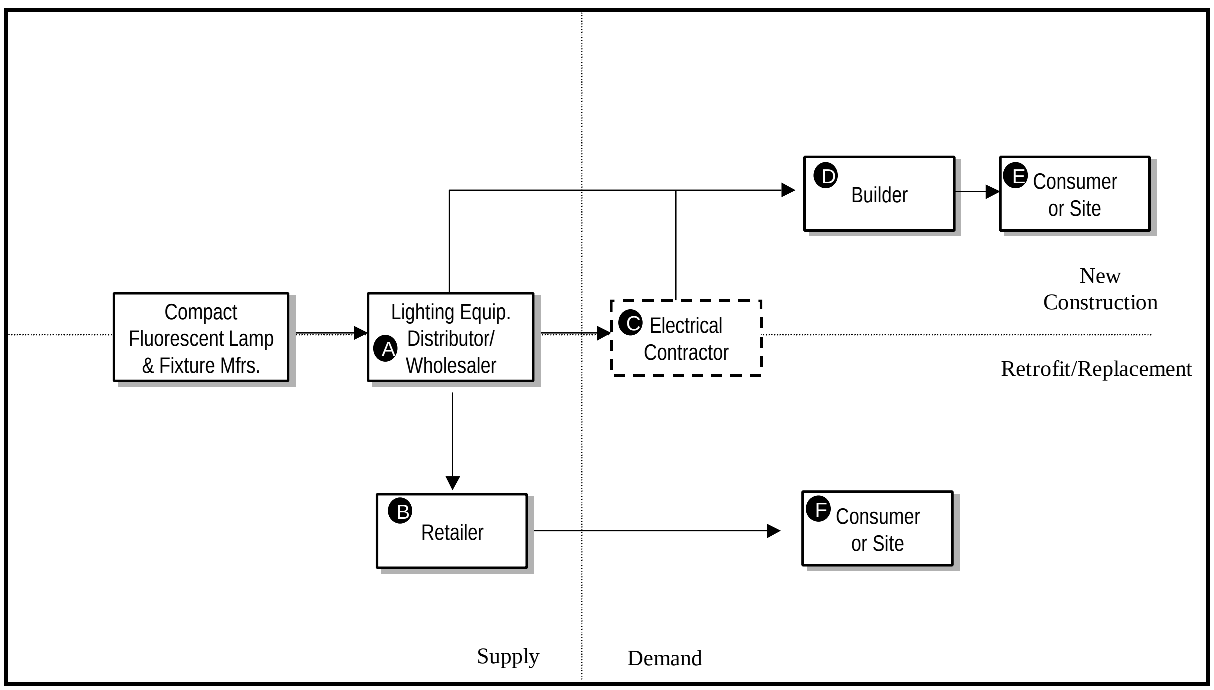
There are numerous manufacturers of residential lighting equipment. In 1996, the Illuminating Engineering Society of North America (IESNA) listed more than 250 manufacturers of luminaires for residential applications and 59 manufacturers of compact fluorescent lamps and/or ballasts. Major compact fluorescent lamp manufacturers include General Electric, Osram Sylvania, Philips Lighting Co., Panasonic Lighting, Enertron, Lumitech, Maxlight, Lights of America, and Feit. Manufacturers of compact fluorescent fixtures include Delray, Edison Price, Halo, Indy, Juno, Lightolier, Omega, Staff, and Wila.

Manufacturers of residential lighting equipment do not sell directly to the end user. When describing the market for compact fluorescent lamps and luminaires, it is useful to separate the market into two segments: fixed lighting and freestanding lighting. Fixed lighting is hard-wired and is installed when a home is constructed or renovated. Freestanding lighting is plugged into an outlet.

Manufacturers of fixed lighting products, including manufacturers of compact fluorescent luminaires such as recessed downlights or wall sconces, interact primarily with independent distributors or manufacturers' representatives through product transfer. Manufacturers also provide product literature to the distributors and lighting consultants. Residential lighting distributors sell directly to contractors, builders, consultants, and retailers. In this market, large home improvement chains, such as Home Depot, often act as wholesalers to small lighting contractors.

In a new construction or renovation, a builder may use a lighting consultant or may specify the lighting himself and purchase directly from a distributor. Retrofit lighting fixtures may be a homeowner's decision or they may hire a lighting consultant that specifies the lighting fixtures. Distributors who deal in dedicated compact fluorescent luminaires can usually supply compatible lamps. Occasionally, "do-it-yourselfers" purchase fixed lighting in a retail setting.

Figure 4-5: Residential Lighting Market



Manufacturers of freestanding luminaires may sell directly to retailers (especially mass-market or national chains) or to a wholesaler that services smaller retailers. Freestanding compact fluorescent luminaires are not widely available and are mainly sold through specialty lighting retailers.

The lamp market differs from the fixture market because most compact fluorescent lamp replacements are sold to consumers through mass-market retailers; fixtures are not typically sold through these outlets. Major retail establishments selling compact fluorescent lamps include Home Depot/Expo, Ace Hardware, Wal-Mart, K-Mart, Target, and Sav-On.

Implications for Tracking

Decision type is a primary consideration when drawing inferences about tracking market shares of compact fluorescent fixtures and lamps. As revealed during the Needs Assessment interviews and this review of the market, fixtures (dedicated systems, in particular) are more dominant in new construction while lamps are primarily a replacement measure. Integrated or modular fixture systems are also appropriate as a retrofit measure.

The most appropriate nodes for collecting data for tracking residential lighting equipment include builders and/or electrical contractors for shares of compact fluorescent fixtures installed in the residential new construction market (nodes C and D) and retail establishments and/or consumers for replacement lamp purchases (nodes B and F). As depicted above in Figure 4-5, lighting equipment distributors (node A) and electrical contractors (node C) are involved in both new construction and retrofit/replacement installations of fixtures. However, distributors may or may not be able to segment fixture sales by decision type, and electrical contractors are not always utilized by consumers unless a remodel involves extensive lighting redesign (electrical contractors do not advise consumers in lamp purchases).

4.5 Residential Appliances

The following measures are included in the residential appliance market:

- Horizontal axis clothes washers
- Refrigerators, and
- Dishwashers.

Horizontal Axis Clothes Washers. Horizontal axis (front loading) clothes washers offer the potential for energy, water and detergent savings, and gentler treatment of clothes when compared to the more familiar vertical-axis models. Horizontal axis washers feature the wash tub turned on its side with the agitator removed; the clothes are gently lifted and plunged into the water approximately 50 times per minute. Electronic controls monitor the tumbling and spin speeds, then automatically adjust the water levels to optimize water use. Three major manufacturers of horizontal axis washers are Maytag, Frigidaire, and General Electric (GE). There are also some foreign manufacturers offering models in the United

States. However, these models tend to be in the high-end price range and have relatively small washing capacity.

Clothes washer standards are primarily designed for residential units. However, there are no upper limits on capacity except for compact models. Clothes washer efficiency is measured by an energy factor (EF) that expresses the number of cubic feet of tub size that can be supported by one kWh per cycle (ft^3/kWh/cycle). In 1994, the present standard was instituted and set at 1.18 EF for top loading machines with a capacity greater than 1.6 ft^3. The standard drops to 0.90 EF for units with a capacity less than 1.6 ft^3. There is presently no standard for front-loading washing machines, except that they must have an unheated rinse option.

Refrigerators. Residential refrigerators can be segmented into seven main product classes based upon freezer section positioning (top mount, bottom mount, and side-by-side), defrost system type (manual, partial, and automatic), and the presence of a through-the-door ice-service feature (TTD). The top mount automatic defrost without a TTD is the most common model sold in the U.S. today.[12]

The energy consumption levels of the product classes described above are significantly different. Side-by-side units use more energy than a similarly sized top mount unit because of the increased door seal area and the proximity of the freezer to the hot motor compartment. Automatic defrost units use more energy than manual defrost unit is due to the circulation of cold dry air, the melting of accumulated frost and the removal of defrost heat. TTD features increase energy consumption since the TTD area can not be as well insulated as the door.

The energy efficiency of refrigerators is measured by an energy factor (EF). The energy factor gives the number of cubic feet of capacity that can be supported by one kWh of electricity per day under test conditions (ft^3/kWh/day). The capacity of a refrigerator is calculated as an adjusted volume and is equal to the capacity of fresh food storage volume plus 1.63 times the freezer storage volume in cubic feet. For any given refrigerator, these definitions allow for direct translation between rated efficiency and expected annual use.

The NAECA efficiency standards establish maximum allowable energy use levels for seven classes of refrigerators. For each class, a formula based on adjusted volume is used to set a maximum allowable energy use. This approach to defining efficiency implies that the limit to energy consumption rises less than proportionally to refrigerator volume. The existing standards were put in place in 1993 and new standards will go into effect in July of 2001. The new standard is expected to decrease energy consumption by roughly 12% for a typical

[12] Association of Home Appliance Manufacturers.

20 cubic foot unit without TTD. However, additional cost-effective efficiency improvements (improved compressors and new refrigerant cycles) are possible beyond this new standard.

Dishwashers. Dishwashers are segmented into three product classes: standard, water heating, and compact. Standard dishwashers are designed for use with water inlet temperatures above 120° F. Water heating units employ a booster heater unit that allows the dishwasher to use inlet water temperatures below 120° F. A compact dishwasher has a width of 22 inches or less. Water heating units are the most common types of unit sold in the U.S. market.

The major factors that determine dishwasher energy use are hot water volume and temperature, motor efficiency, booster heater energy, and the method used during the drying cycle. Hot water use accounts for roughly 80% of total dishwasher related energy use, motor usage accounts for 8%, and the remainder is used in the heat drying process. Improvements in hot water requirements per cycle help to decrease energy usage in newer, lower energy-using models.

Dishwasher efficiencies are typically calculated in terms of energy factors (EF). In the case of dishwashers, the energy factor is defined to be the number of cycles that can be operated with one kWh. The existing NAECA standard for dishwashers was established in 1994 and requires a minimum EF of 0.46 for standard (including water heating models) and 0.62 for compact models. The existing standard is up for review in 2001; however, it is unlikely that the dishwasher efficiency standards will actually be revised before the 2006 revision cycle.

Review of the Residential Appliance Market

Figure 4-6 depicts the typical distribution channel of residential appliances. As shown, manufacturers of major residential appliances interact with distributors, builders, retailers, and consumers. Manufacturers interact with distributors mainly through product transfer. Appliance manufacturers often have their own distribution centers or sell their products to independent distributors. Manufacturers also provide builders, distributors, and retailers with literature and information about their products. Manufacturer-owned distribution centers sell to builders, retail distributors, contract distributors, and directly to retailers. Appliance distributors sell directly to contractors, builders, and retailers.

The clothes washing machine market differs from this typical characterization, as there is considerable consolidation in the distribution channels. This market trend has resulted in manufacturers fostering direct relationships with retail outlets. Distributors in the clothes washer market are virtually nonexistent. Even small appliance stores form buying groups to deal directly with manufacturers.

Table 4-2 includes the major manufacturers and retailers in the residential appliance market.

Figure 4-6: The Residential Appliance Market

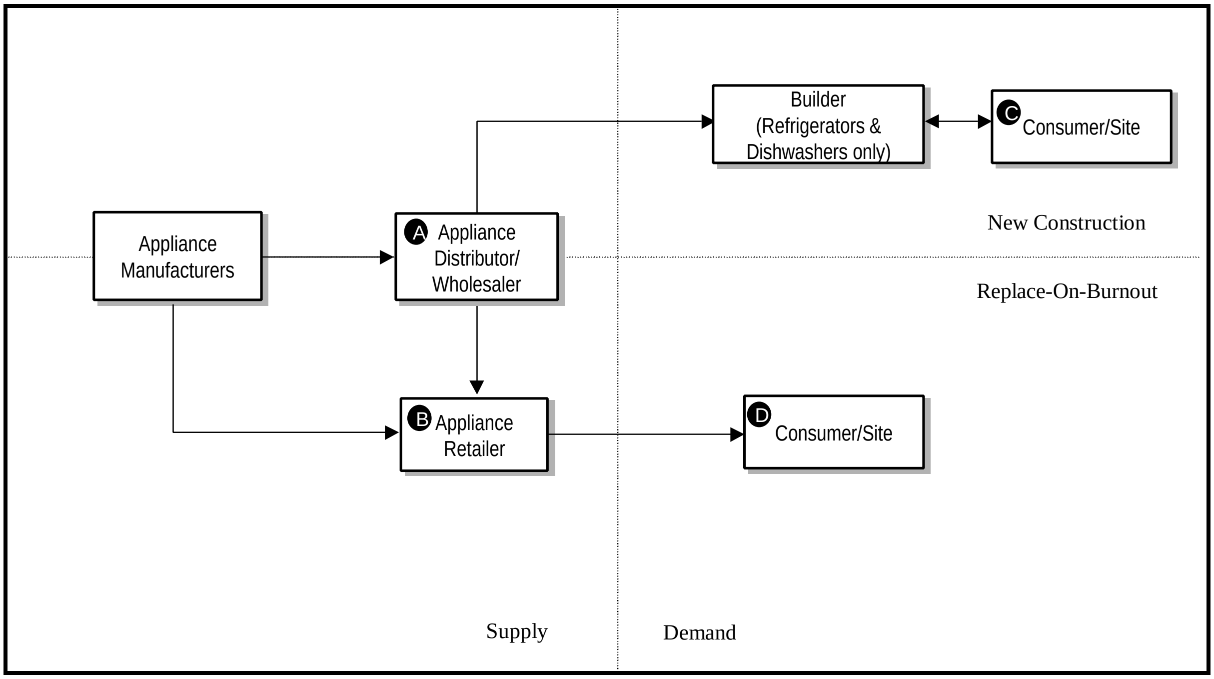


Table 4-2: Major Manufacturers and Retail Establishments of Residential Appliances

Appliance	Major Manufacturer	Major Retail Establishments
Horizontal Axis Clothes Washers	Frigidaire Maytag Whirlpool General Electric	Sears Montgomery Ward Circuit City Home Depot/Expo Loews Adrays Fedco Numerous independent retailers
Refrigerators	General Electric (35%) Whirlpool (26%) Frigidaire (19%) Maytag (10%) Goodman (9%)	Sears Montgomery Ward Circuit City Home Depot/Expo Loews Adrays Fedco Numerous independent retailers
Dishwashers	General Electric (40%) Whirlpool (39%) Maytag (13%) Frigidaire (8%)	Sears Montgomery Ward Circuit City Home Depot/Expo Loews Adrays Fedco Numerous independent retailers

Percentages are unit shares of national market. (Data not available for horizontal axis clothes washers.)
Source: Appliance Magazine, September 1998.

The final end user or consumer is somewhat influential in the purchase decision of major household appliances, even in the new construction market. First, because clothes washers are not typically standard equipment in new construction, the consumer is the primary (only) decision maker with respect to efficiency levels. Second, even though dishwashers and refrigerators tend to be standard appliances specified in the new construction market, many builders give the home buyers options on which appliances are installed, so again, consumers are fairly influential. Replacements for all appliances considered here are typically purchased at a retail establishment by the consumer.

Implications for Tracking Residential Appliances

Data by decision type is probably not ascertainable at the manufacturer level, since most manufacturers do not have the mechanism to (nor do they have an interest to) track sales past the first distribution point. Furthermore, data to support market share tracking would not likely be available from distributors (node A), unless the distributor can identify sales to builders and contractors (indicating new construction installations) and sales to retail establishments (replacement purchases or net acquisitions).

Collecting data at either the retail or end user-level (or both) is more sensible (nodes B, C, and D) because the residential appliance market is dominated by retail distribution, and end users have considerable influence and purchase appliances for both new construction, net acquisition, and replacement installations.

Collecting residential appliance data directly from consumers is more feasible than other measures because consumers are familiar with these products, and the brand/model numbers of these appliances are easily accessible. This can be done via mail or telephone survey.

4.6 Residential Gas Water Heaters

Water heaters are often segmented into five product classes based on the primary heating fuel (natural gas, electric, propane, oil, and solar), heating method (instantaneous or demand), and whether a pre-heated supply of water is maintained (storage or non-storage unit).

Major factors determining water heater energy use are household usage, the number of hot water-using appliances, inlet water temperature, delivery temperature, mechanical efficiency of the heating element (recovery efficiency), the ambient conditions surrounding the unit, and the thermal efficiency of the tank. The recovery efficiency is the most important technology issue pertaining to gas water heaters

The overall efficiency of a gas water heater is measured by an energy factor (EF). The energy factor is a ratio of the delivered heat from the tank (in BTUs) to the heat content of the fuel input (in BTUs). This ratio includes both the recovery efficiency and the thermal efficiency of the unit. For a given water heater unit, this definition allows for direct translation between rated efficiency and annual energy use. The biggest impact on heat recovery efficiencies in gas water heaters is the loss of fuel energy with the exhaust combustion gases. Standby losses also tend to be larger for gas units because the bottom of the tank and the flue can not be insulated.

NAECA standards are defined as minimum EF, which varies by tank size. The existing standard for gas-fired storage units is calculated as $\{0.62 - (0.0019 \times \text{tank volume})\}$. For a typical 30-gallon unit, this translates to an EF of 0.56 and an EF of 0.51 for a 60-gallon unit. The standard is up for review in late 1999. Any new standards resulting from this review are anticipated to put into effect in 2002.

Units with energy factors exceeding the standard are being manufactured. These units are achieving higher efficiencies by capturing energy from moisture in the flue gases or by using power venting or induced draft fans.

Review of the Market for Residential Gas Water Heaters

Figure 4-7 depicts the distribution channel of residential gas water heaters. A small number of manufacturers account for a majority of the gas water heaters sold in the United States. These include A.O. Smith, American Water Heater, Bradford-White, and Rheem. As with other industries, water heater manufacturers interact with distributors mainly through product transfer. Through these interactions, distributors are providing the manufacturers with market signals with respect to the products that market actors downstream are demanding. Distributors, otherwise known as plumbing supply houses, act as intermediaries between the manufacturer and either the plumber or the end user.

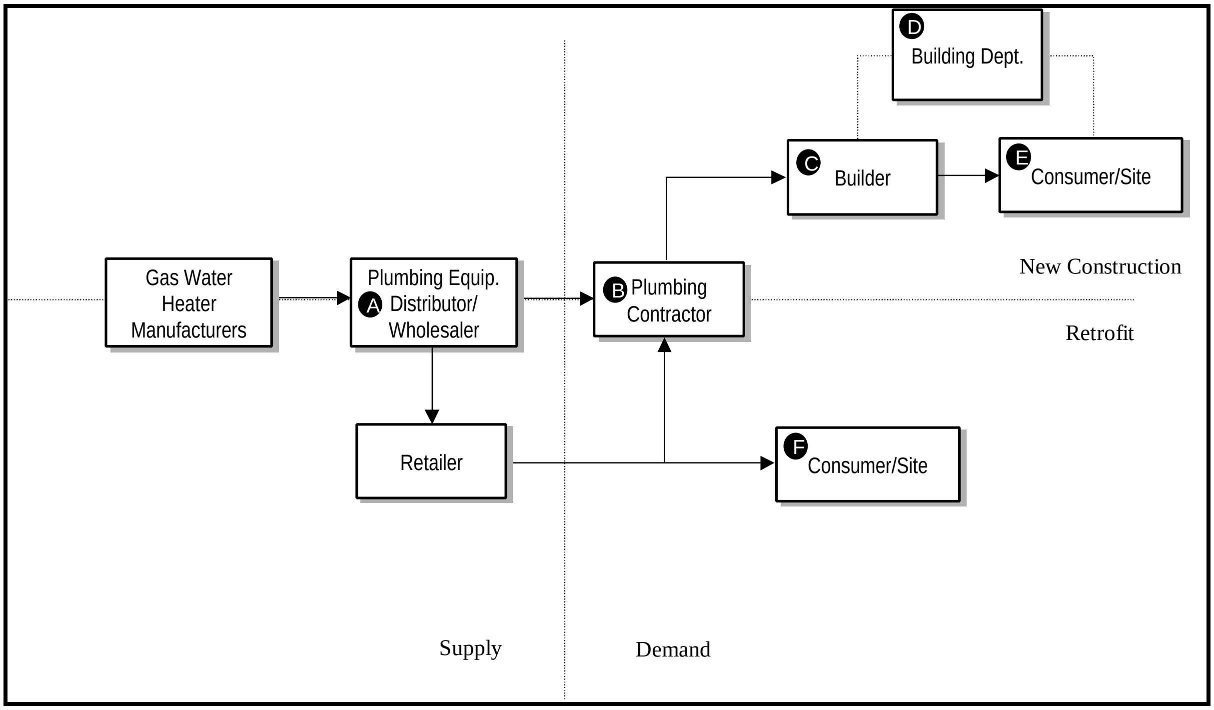
While the production of water heating equipment is their primary function, manufacturers provide a significant amount of information to other market actors, primarily plumbing contractors, builders, and equipment distributors. Such information generally pertains to new equipment and products and is disseminated by literature, sales representatives, and trade associations. One of the largest manufacturers, in particular, is very proactive in its efforts to provide plumbing contractors with information, training, and technical assistance.

There are two primary channels of distribution – the retail channel and the wholesale channel. The retail channel consists of national retail chains that generally procure product centrally through a corporate buyer. Retail chains do not deal in the new construction industry and account for roughly 51% of the entire residential market.

The wholesale channel, which primarily serves the residential new construction market, consists of product distributors (generally plumbing supply distributors) who then sell equipment and related products to plumbing contractors. While most manufacturers sell through both the retail and wholesale channels, none sell directly to builders, primarily because the manufacturer cannot provide the same quality of service as an equipment wholesaler or retailer. In large tract development projects, a wholesaler representative is typically on the job site daily.

The distribution channels for new construction and replacement installations vary slightly. In new construction, the builder is the primary decision marker. The homeowner may have some input on the type of system placed in a custom home, but not in a typical tract home. In a replacement situation, the consumer interacts directly with the plumbing contractor.

Figure 4-7: The Market for Residential Gas Water Heater



Implications for Tracking Residential Gas Water Heaters

As mentioned above, the gas water heater manufacturing industry is fairly concentrated. This consolidation appears to present a good opportunity to track market shares in California at the manufacturer level. Two factors, however, limit the usefulness of doing so. First, interviews with manufacturers indicate that they are unwilling to provide detailed sales data for proprietary reasons.[13] Second, as with most measures, the majority of manufacturers use well established distribution channels and do not have the mechanism (nor do they have a desire) for knowing where the water heaters are ultimately purchased. Manufacturers are simply too far upstream from the end user.[14]

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13 See EPRI, 1997. This finding was corroborated during interviews with manufacturers conducted for RER's Residential New Construction Market Effects Study. Note that the EPRI report also cites the following as reasons for not tracking sales data from manufacturers: 1) manufacturers do not view tracking sales data as important, 2) they currently provide data to trade associations (AHAM) and are unwilling to provide data to another source, and 3) they do not want to jeopardize relationships with distributors by imposing tracking-related constraints, as reasons for not tracking sales data from manufacturers.

14 See Section 6 for a discussion on the usefulness of collecting data at multiple market nodes.

A more viable option is to collect sales data from distributors (node A) or plumbing contractors (node B). Doing so would enable inferences about sales to specific geographic regions as well as new construction and replacement installations, and would put forth the opportunity for collecting data on competing technologies, such as high efficiency electric water heaters. Water heater sales are tracked in Wisconsin by means of a customer survey (nodes E and F). Although the customer survey has proven to be successful in collecting data for some appliances, the system has produced only marginal data on water heaters. Obtaining water heater efficiency data from building departments (node D) or on-site surveys are other options for customer-level data. Building department data, however, would only be applicable to new construction installations.

4.7 Residential Windows

Residential window technology is described in terms of glazing and frame type. For residential windows, there are four basic glazing options and three frame options. Glazing options include: single-pane clear, single-pane tinted, double-pane clear, and double-pane tinted. Frame options include aluminum, wood or wood-clad, and vinyl. In addition to these basic options, several advanced glazing technologies have been developed to increase the energy efficiency of residential window systems. These technologies are described below.

- ***Argon or Krypton Gas Fills.*** Traditionally, the space between glazing layers in double-paned windows was filled with air or flushed with dry nitrogen before sealing. Filling the space with a less conductive gas results in better thermal performance of the window unit. Manufacturers have utilized both argon and krypton fills, resulting in a window system that reduces heat loss relative to traditional double-paned systems.
- ***Low-E Coatings.*** A low-emittance (low-E) coating is designed to reduce heat loss but to admit passive solar gains. These windows are best suited for cold climates but can be disastrous in a very warm climate, where they will cause a very significant increase in cooling energy use. A second type of low-E coating is designed to reduce heat gain in summer while still reducing heat loss in winter. This type of low-E coating is described as “spectrally selective.” These windows are suited to any climate where there is a significant cooling load.

These window components can be combined in different ways and styles, resulting in a vast array of residential fenestration options. However, the primary parameters affecting the energy-related performance of a residential window system can be described by the properties listed below.

- ***U-Factor.*** The U-factor is a measure of how well a window keeps heat inside the home. Lower U-factors imply better insulating properties. U-factors range from 1.3 for a single-pane clear window with an aluminum frame to 0.15 for a triple-pane window with krypton-gas fill, and a vinyl frame with warm-edge spacers.
- ***Solar Heat Gain Coefficient (SHGC).*** The SHGC measures a window's ability to prevent heat gain caused by sunlight. Lower SHGCs imply that the window transmits less heat into the home. SHGCs range from 0.74 for a single-pane clear window with an aluminum frame to 0.29 for a double-paned window with spectrally selective low-E glazing.
- ***Visible Light Transmittance (VT).*** The VT measures how much visible sunlight is transmitted through a window. Higher VTs mean that more visible light is transmitted in the home. There is a tradeoff between lower SHGCs and higher VTs. VTs range from 0.69 for a single-pane clear window with an aluminum frame to 0.35 for a double-pane bronze- or gray-tinted window. Spectrally selective glazing and low-E glazing allows for higher visible light transmittance (0.55 and 0.52 respectively), while allowing for improved SHGCs (0.37 and 0.52 respectively).
- ***Air Infiltration (AI).*** Air infiltration is measured in cfm/ft^2. In cold climates, air infiltration increases heating loads. In warm climates, infiltration contributes to discomfort and higher cooling loads by increasing the humidity level in the home. Air infiltration also contributes to condensation problems.

The National Fenestration Rating Council (NFRC) is a nonprofit, public/private, trade organization consisting of manufacturers, suppliers, builders, architects and designers, specifiers, code officials, utilities, and government agencies. The NFRC has instituted a voluntary national energy performance rating and labeling system for fenestration products. The rating system is based on whole product performance that accurately accounts for the energy-related effects of all of the products' component parts. At this time, NFRC labels provide ratings for U-factor, SHGC, and visible light transmittance. In the near future, labels will include infiltration rates (AL) and an annual heating and cooling rating.

California's Title 24 Energy Efficiency Standards mandate the energy efficiency of glazing. These standards vary by CEC climate zone and performance package used for compliance. In particular, Title 24 mandates the maximum percentages of glazing area (total area, total non-South facing area, and total South facing area) maximum U-values, and, depending on the component package used, the maximum shading coefficient.[15]

[15] The shading coefficient indicates the window's ability to control heat gain. A wall has a shading coefficient equal to 0.0, and an unshaded, unscreened 1/8-inch sheet of glass has a shading coefficient equal to 1.0. The use of special tints and low-E glazing will reduce the shading coefficient. Shading coefficients are particularly important in desert climate zones (CEC zones 14 and 15) and in areas where there is excess glazing on the East, West, or South elevations.

Review of the Residential Window Market

Figure 4-8 illustrates the market for residential windows. Window manufacturers interact primarily with flat glass manufacturers, window distributors, and builders. Because manufacturing is demand driven, the builders and distributors (those that demand the product) have a great deal of influence on manufacturing decisions and the characteristics of the windows produced.

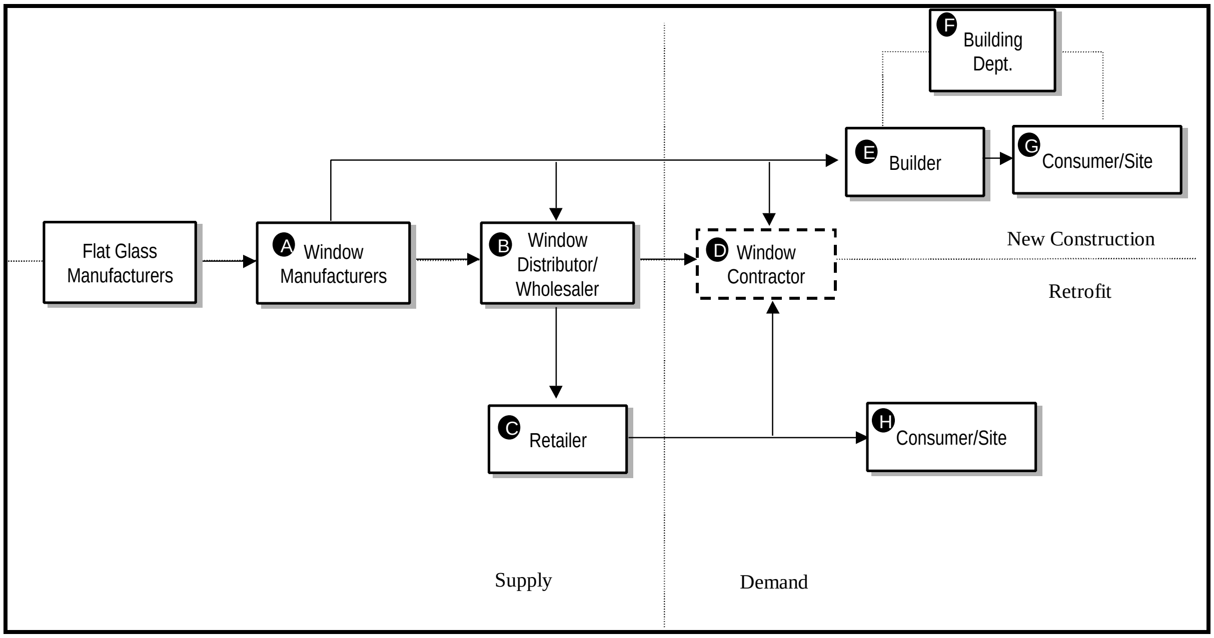
Manufacturers interact with flat glass manufacturers and distributors mainly through product transfer. Nationwide, thousands of window manufacturers exist, who tend to produce a variety of window and non-window products. The largest window manufacturers have international distribution networks. About 12 to 20 firms can be classified as “large” manufacturers, producing more than 1,000 windows per day. The four largest window manufacturers – Anderson, Marvin, Pella, and Weather Shield Manufacturing – account for about 20% to 30% of the overall market (Eto, Arasteh, and Selkowitz, 1996). Roughly 200 medium-sized manufacturers account for roughly 30% to 50% of the window market. The majority of window manufacturers are small firms having small, localized areas of distribution. Although they number in the thousands, their combined share of the window market is estimated to be less than 20% (Eto, Arasteh, and Selkowitz, 1996).

The window manufacturer buys the glass for windows from a flat glass manufacturer and the distributors sell the units that the manufacturer produces. Window manufacturers either exclusively own their own distribution companies or sell to an independently owned distributor. Window manufacturers mostly employ either a “two-step” or a “one-step” distribution process. Two-step distribution involves selling product to distributors, who then sell to either contractors (for installation in new homes) or retail stores (for purchase by contractors and homeowners). In contrast, one-step distribution is the sale of product from the manufacturer directly to the builder or contractor. One manufacturer in particular has about 100 exclusive distributors nationwide to handle its product line. Another manufacturer estimated that more than 90% of its units are distributed through a one-step system by using independent distributors.

Roughly 35% of the builders purchase windows directly from the manufacturer; the remaining 65% are equally split between purchasing from a window distributor or from subcontractors (RER, 1998). With the primary objective of increasing sales and brand/company loyalty, manufacturers provide a great deal of equipment information relating to new technologies and materials. There are several means by which manufacturers disseminate information to the marketplace, including in-person contact between a manufacturer (sales) representative and the builders, trade literature, and trade association meetings and conventions.

New construction and replacement distribution channels in the window market vary slightly. In the new construction market, the homeowner may have some input on the type of windows placed in a custom home, but not in a typical tract home. In retrofit installations, the consumer might hire a window consultant or work directly with a contractor.

Figure 4-8: The Residential Window Market



Implications for Tracking

Both measure and market characteristics provide useful clues for tracking the market shares of residential windows in California. First, characteristics of windows help define the type of data that need to be collected. In particular, tracking residential window installations in California requires the collection of both U-values and SHGC. U-values provide an overall indicator of the efficiency of the window assembly (glazing, frame, fill, and spacing), while the SHGC measures the window's ability to prevent heat gain caused by sunlight.

The window market is somewhat unique from that of other priority measures. In particular, the manufacturing industry is comprised of numerous manufacturers, the majority of which have local areas of distribution. As such, window manufacturers (node A) could be useful data suppliers (those located in California are likely to distribute products in California), provided the largest manufacturers can estimate shipments to California.[16] It is uncertain, though, if manufacturers can provide sales data by decision type. Window contractors and

[16] Discussions with NFRC revealed that shipments to California account for about 15% of the total U.S. window market.

retailers (nodes D and C) should also be considered, as they would likely be the best suppliers of sales data for windows for retrofit installations.

As with most residential measures, one option is to collect data at the end-user level (nodes G and H). The most appropriate vehicle for obtaining efficiencies of installed residential windows is through building department data (node F), or from builders themselves (node E). Other options, such as on-site surveys, are as useful; while information about frame type and if the window is single, double, or triple glazed can be obtained during an on-site visit, U-values and SHGC are not obtainable after the window assembly is installed.

4.8 Nonresidential Windows

In contrast to residential windows, which consist of glazing and a frame that is pre-built, the glass for nonresidential windows is usually installed on-site. Consequently, the efficiency measures described below refer to the glazing, not to a complete window system.

In California, space cooling and lighting are the largest energy uses in nonresidential buildings. As a result, the focus of nonresidential glazing efficiency has been the reduction of solar gains while increasing the transmittance of visible light. Until recently, the primary glazing alternatives available for reducing cooling loads in new nonresidential buildings included tints and reflective coatings. Recent advances in “spectrally selective” glazing allow for higher transmittance of visible light while reflecting radiation outside the visible spectrum.

For glazing products, the following parameters have an important effect on cooling loads: the *solar heat gain coefficient* and the *visible light transmittance*.

- ***Solar Heat Gain Coefficient.*** The SHGC measures a window’s ability to prevent heat gain caused by sunlight. Unlike the shading coefficient (SC), which only accounts for heat gain due to directly transmitted solar radiation, the SHGC takes into account the portion of the solar radiation that is absorbed by the glass and re-radiated inward.
- ***Visible Light Transmittance.*** The VT measures how much visible sunlight is transmitted through a window. A new parameter, *the luminous efficiency constant* (K_e) is beginning to appear in manufacturers’ literature. K_e is the ratio of the visible light transmittance to the shading coefficient. Clear glass has a K_e of about 1, while the ideal window for a commercial building—one which transmits all visible light while blocking the rest—would have a K_e of about 2. Reflective glazing has a K_e of less than 1.
- ***U-Factor.*** The U-factor is a measure of how well a window keeps heat inside the building. Lower U-factors imply better insulating properties.

For retrofit applications, solar control films can be applied to the interior of the window. These products typically darken a window and give a mirror-like look to the glass. However, at least one firm, Southwall Technologies, manufactures a self-adhesive film with properties similar to spectrally selective low-E glazing.

Estimating energy savings from efficient glazing or retrofit window film usually requires the use of a building simulation model such as DOE-2.2. This is because the glazing impacts both heating and cooling loads. Lighting loads are also impacted by glazing changes, which further impact HVAC loads.

California's Title 24 Energy Efficiency Standards mandate the energy efficiency of glazing. These standards vary by CEC climate zone and performance package used for compliance. In particular, Title 24 mandates maximum U-values and maximum shading coefficients of windows installed in nonresidential buildings.

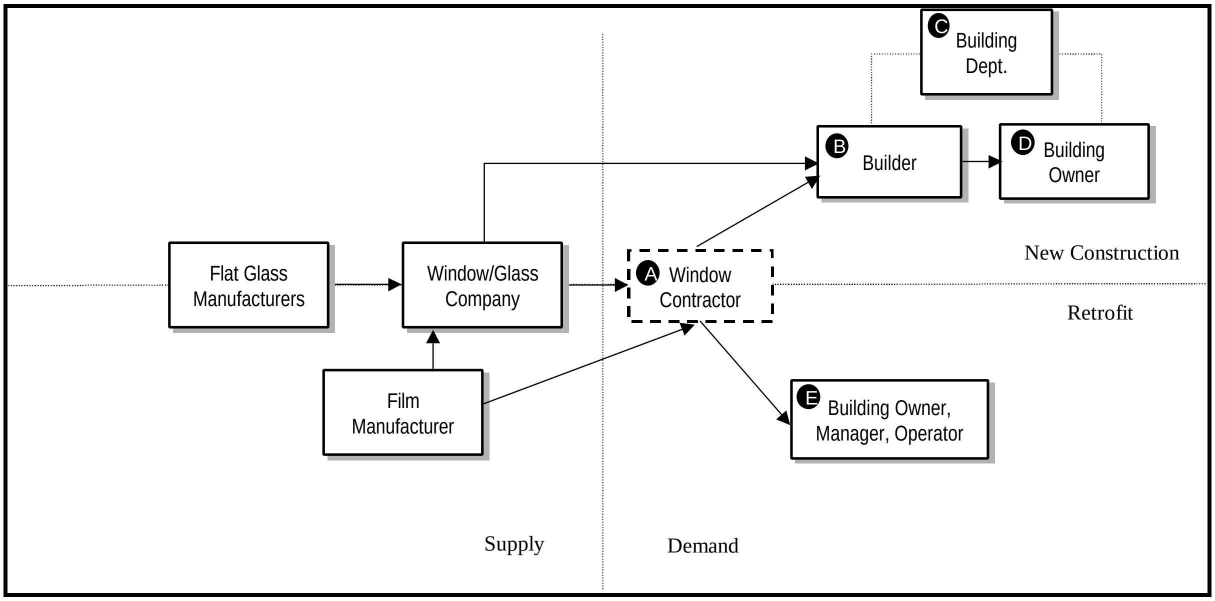
Review of the Market

The market for nonresidential windows is depicted below in Figure 4-9. In the nonresidential market, a glass company interacts with a flat glass manufacturer and the builder through product transfer and possibly installation. The builder will order glass for the windows needed in a building from a glass company. The glass company orders the flat glass with the specified tint or glazing for the windows, delivers, and may even install the glass in the building. Films are typically a retrofit measure, but are also applied in new construction buildings. Manufacturers of window films interact primarily with independent dealers and distributors.

The major manufacturers for nonresidential windows (glass) include AFG Industries, Cardinal IG, Libbey-Owens-Ford, and PPG Industries. The major manufacturers of window films include Courtaults Performance Films, ITD Industries, Southwall Technologies, and 3M Construction Markets.

The distribution channels for new construction and retrofit activities vary slightly. A builder may go directly to a glass company for the windows (glazing) for the building or they may use an independent window contractor. As mentioned above, retrofitting a commercial window is typically done with the application of a film. The distribution channel is identical in either case.

Figure 4-9: Nonresidential Window Market



Implications for Tracking

As with residential windows, more than one efficiency parameter should be tracked to indicate overall window efficiency. For nonresidential windows, these indicators are glazing type and SHGC values.

It is important to note here that, because of the interaction between windows, lighting, and heating and cooling systems, it would be misleading to make inferences about overall building energy efficiency strictly from window efficiency data. In particular, trade-offs are occasionally involved between overall window efficiency and the building heating and cooling loads and lighting energy usage. For example, increasing the tinting would increase window performance relative to space conditioning, but may lead to increased lighting usage. One would also need to assume that the window types are chosen appropriately for the climate, as some glazing is designed specifically for heating climates. Cooling loads might increase should this material be installed in buildings located in a cooling-dominated region.

Tracking window efficiency parameters in the nonresidential sector should target window contractors (node A) who are involved in either new construction and retrofit installations, or both. Window and window film manufacturers are less likely to know geographic region or the decision types of installations (or neither). Building operators or managers (node E) are involved in retrofit decisions, but might not be able to supply the required efficiency parameters, nor would they be likely to know the parameters of new construction efficiencies. One alternative is to collect data from builders (node B), but doing so would only provide information on new construction installations. As with residential windows, efficiency parameters are not likely to be obtainable at the end-user level, except from compliance forms submitted to building departments (node C).

4.9 Nonresidential HVAC Equipment: Chillers

Chillers are classified as central plant equipment, which is typically segmented by Chillers, Heat Rejection Equipment, Air Handling Units, Terminal Units, and Building Automation Systems. Major trends of the U.S. central plant equipment market include the following:

- The use of alternative refrigerants.
- The growing importance of indoor air quality (IAQ) and an emphasis towards the measurement of IAQ and the quantification of productivity/personal comfort.
- Energy efficiency. Operating costs are becoming a more prominent issue. As such, utility rebates are growing in importance and ESCO services are gaining in prominence.
- Microelectronics now contribute to more product-oriented controls and building automation systems.
- Environmental issues are increasingly important as recycling, waste handling, and global warming, as well as ozone depletion, are repeatedly broached in the press.
- There is new legislation being drafted that affects tax standards and forces environmental compliance.
- Finally, there is an increasing globalization of suppliers and customers.

Chillers, specifically, can be segmented according to the following attributes:

- Size (units and dollars for different tonnage),
- Type of compressor (screw, scroll, reciprocating),
- Type of heat rejection (air cooled, water cooled and condensorless),
- Efficiency (kW/ton),
- Building type (hospitals, lodging, manufacturing, office, etc.),
- Type of fuel utilized,
- Manufacturers,
- New versus retrofit/upgrade and
- Refrigerant used.

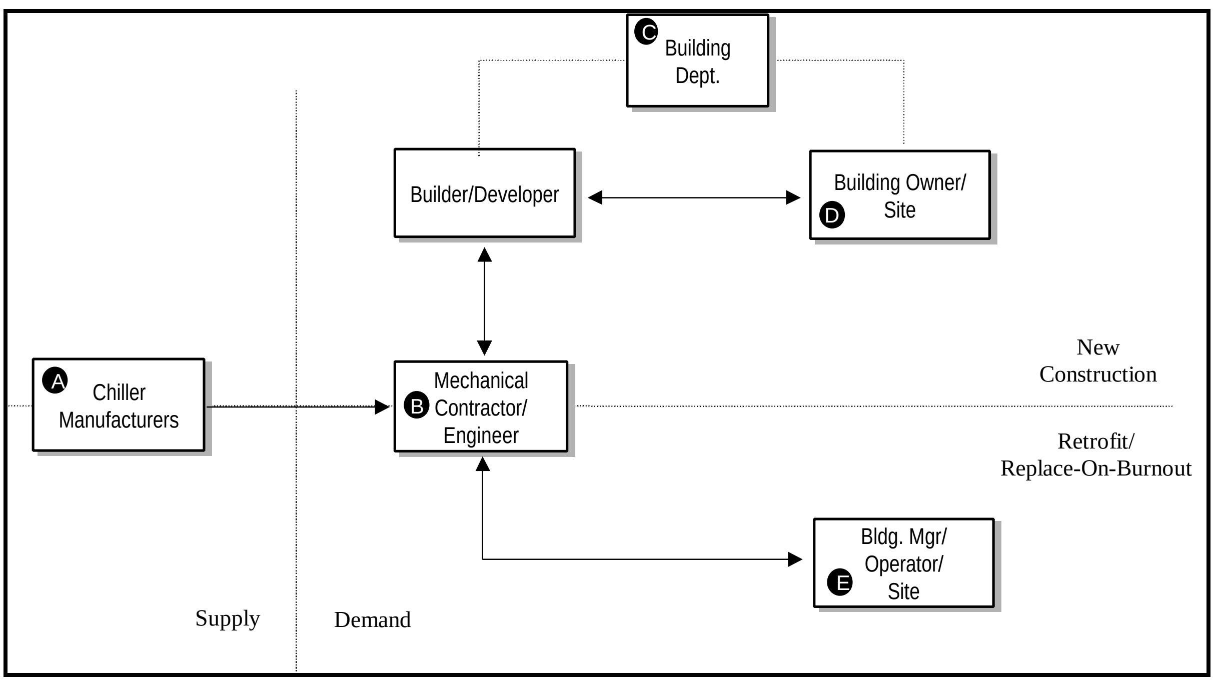
The chiller market is primarily segmented by reciprocating liquid chiller packages (RLCP), large tonnage liquid cooled (LTLC), absorption chillers, and gas engine chillers. Each of these large categories includes various classifications. Tracking market shares of chillers should necessarily account for these segments.

Review of the Chiller Market

Figure 4-10 depicts a simplified distribution channel for chillers. As shown, the key market actors include manufacturers, mechanical contractors and engineers, builders/developers, and building managers and operators. A relatively small number of manufacturers produce chillers, namely York, Carrier, Lennox, McQuay, and Trane. Because chiller design is site specific, most chillers are sold before they are assembled. The builder/developer and mechanical contractor/engineers design the chiller system and specify the equipment, including water cooling coils, pumps, cooling towers/evaporative condensers, and controls. The building owner has significant input into the operation and maintenance protocol and HVAC system operation.

The key characteristic to chiller systems is that they are customized to meet the building's unique load profile. Thus, the efficiency level of the actual chiller represents only a portion of the achievable savings potential. Other factors include distribution system design, controls, and optimal equipment sizing. Building operators or managers typically make all chiller upgrade or retrofit decisions, though these decisions are made with considerable input from mechanical contractors or engineers. Large customers typically plan replacement far in advance of equipment burn-out.

Figure 4-10: The Chiller Market



Implications for Tracking Chillers

Because most chillers are custom built and the manufacturer (a manufacturer representative) is involved in new and replacement chiller installations, tracking the market shares of chiller equipment appears to be relatively straightforward. The methodology for tracking market shares of chillers by size and efficiency level could reasonably be accomplished through the collection of sales data directly from chiller manufactures (node A). Discussions with industry experts reveal that most chiller manufacturers know where their equipment is installed and even the identity of their customers.

As mentioned above, because chiller systems are unique to the building in which they are installed, a large portion of the cost-effective energy savings is achievable not just through equipment specification, but through the overall system design, operation, and maintenance practices. Ideally, therefore, it might be beneficial to consider tracking sales of the chiller itself, in addition to system optimization, optimal equipment sizing, and related operation and maintenance practices (O&M). Doing so could logically be accomplished via an on-site survey of customers with built-up chiller systems (nodes D and E). Building departments (node C) are an option for new construction installations.

Tracking other attributes, such as chiller system optimization, presents some formidable obstacles, but would also be done at the site level. First, one must derive an adequate and useful definition of "market share" with respect to these practices. Note that chiller system optimization typically involves motor retrofits/replacements, and the installation of ASD fans, both of which are considered priority measures for tracking and are discussed in more detail below in Subsection 4.11.

4.10 Nonresidential HVAC Equipment: Energy Management Systems

Energy management systems (EMSs) are computer-based control systems that centralize and coordinate the operation of HVAC equipment in nonresidential buildings. While the Needs Assessment phase of this study specifically identified HVAC controls as a tracking priority, EMSs can manage a variety of building functions such as lighting, security, and fire safety equipment. Combined, an EMS has the potential to increase energy efficiency by automating the building's mechanical systems for optimal comfort levels while using the least amount of energy.

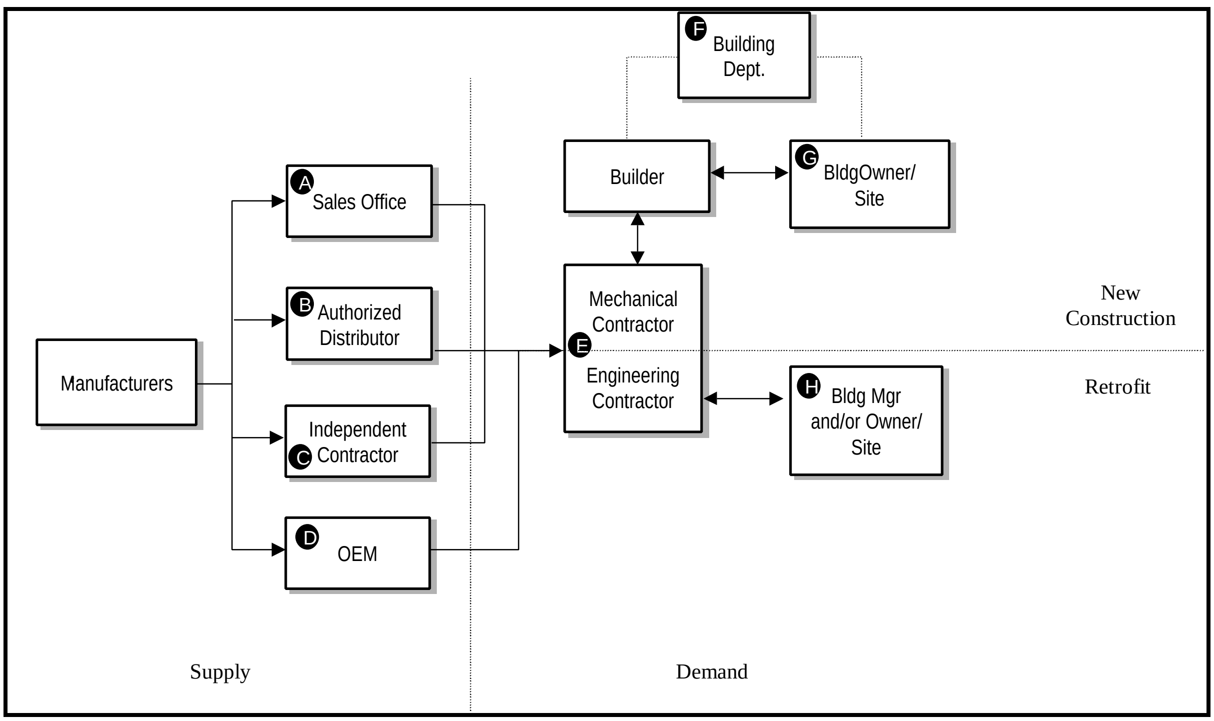
Within this competitive market, four companies are believed to constitute over half of the EMS manufacturing sales: Honeywell, Johnson Controls, Siemens Building Technology Landis Division, and Siebe Environmental Controls. The remaining portion of the market is composed of many smaller manufacturers. Among the manufacturers, efficiency standards have not yet been created, nor is there an industry trade organization.

Review of the Market

Figure 4-11 illustrates the simplified structure of the EMS market. In general, manufacturers (node A) use a variety of distribution methods to reach the end use customer. Most frequently, authorized distributors (node C) and independent authorized contractors (node D) are used to work with mechanical contractors for installing EMS in new buildings. However, manufacturers also sell their products to OEMs (original equipment manufacturers; node E) or use their own distribution system, sales offices (node B), to work directly with the mechanical contractors in designing a system.

For retrofits, end users will use an engineering contractor to perform the same role as a mechanical contractor. In these cases, the engineer will identify the magnitude of the retrofit and work with distributors or sales offices to coordinate purchases and installations.

Figure 4-11: Energy Management System Market



Implications for Tracking

Tracking EMS installation in new and existing buildings presents a somewhat interesting problem, because there are no efficiency levels are associated with energy management systems, *per se*. Market shares in this case could be defined as the percentage of eligible buildings with an HVAC EMS. Note that tracking EMS installations might imply appropriate and optimal use of the EMS, but not necessarily so. Another alternative would be to track the use of specific space conditioning controls, which may or may not be controlled by an EMS. Examples include, but are not limited to, the following:

- Time of day scheduling (have programmable thermostat, time clock),
- Zone temperature control (can control temperature of different areas with one system),
- Static pressure control (automatic control of supply fan to maintain duct static pressure at set point),
- Morning warm-up, (gradual heating of building before beginning of workday)
- Night Purge (bring in outside air over night),
- Supply air reset (supply air temperature is varied and digitally controlled),
- Economizer (enables use of outside air to cool or heat), and
- Optimum start (gradually cooling of building before beginning or workday). [17]

Data for tracking market shares of EMSs should be conducted at either the distributor level (nodes A – D, but B and C in particular) and/or through mechanical contractors who perform installations (node E). Because there are several different avenues of distribution, it might be easier to identify and sample mechanical contractors. Another option is to collect information on EMS installations directly at the site via on-site surveys (nodes G and H); the appropriate contact would be a building owner or facility manager. On-site surveys would also provide more reliable data on EMS installations by building type and size. Building departments (node F) are another option for new construction installations of HVAC controls.

Data for tracking the use of space conditioning controls, such as those listed above, would need to be collected from final end users (node H) via mail, telephone, or on-site survey. Again, the appropriate contact would be a building or facility manager.

[17] Several Needs Assessment interviewees did, in fact, comment that installation of certain technologies does not necessarily to higher levels of energy efficiency; the use of these technologies is also a factor. Tracking the use of certain air distribution controls – either through an EMS, programmable thermostat, or other device, could provide an more accurate indicator of HVAC system energy efficiency.

4.11 Nonresidential Motor System Measures: High Efficiency Motors and Adjustable Speed Drives

Electric motors and motor-driven equipment consume about 70% of the electricity used in the U.S. industrial sector (U.S. DOE, 1996) and 57% of total U.S. electrical consumption (Nadel, Shepard, et. al., 1992), making this sector a prime target for energy efficiency concerns.[18] The most commonly used motor is the integral horsepower (>1 HP), AC, squirrel-cage, polyphase induction motor. Over two million of these units are sold each year, of which more than 60% of the unit sales are rated at below 5 horsepower (HP). However, on the basis of annual capacity sold, AC induction motors rated at more than 20 HP account for over 70% of the capacity sales (and only 15% of unit sales).

High efficiency motors and ASD drives are two elements of a motor system, hence they are considered together here as motor system measures. For the purposes of measure tracking, motors are segmented into HVAC and non-HVAC applications. This distinction is necessary because motor operation for HVAC applications is significantly different than that for non-HVAC applications. Energy use characteristics for these two motor classifications illustrates the need for this distinction. HVAC motor energy use is best calculated using a building simulation program such as DOE-2, whereas non-HVAC motor energy use can be calculated much more simply as a function of motor size, efficiency, and load profile.

A description of the measures, tracking segments, market characterizations, and tracking impacts are discussed below.

Measure Description

Adjustable Speed Drives

Although motors are designed to operate at constant speed, the machines they drive often do not require full output for a large part of the time they are operating. Throttling devices such as valves, inlet vanes, or dampers are typically used to adjust the output of these machines. Such control devices have been compared to driving a car with the accelerator floored and using the brake to control speed. ASDs offer a more efficient alternative. The desired machine output is achieved by adjusting the motor speed rather than using a throttling device.

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[18] One interviewee during the Needs Assessment phase of this study estimated that electric motors make up to 60 to 70% of California's electricity demand. "For cost-effective demand reduction, emphasis must be made on motor demand. Anything else is dealing with the narrow end of the wedge." Interestingly enough, this interviewee also explained that the greatest potential for large energy savings is through variable speed drives and the modification of pumps and fans with "realized savings as large as 60% with no reduction in work output … So-called energy efficiency motors produce savings in the 5 to 6% range and are rarely cost effective except in [the] long term."

In regards to the physical configuration of an ASD, the units are usually contained in a box that is located as close as possible to the motor or motors being served. The predominant ASD technology is the Pulse Width Modulated (PWM) ASD controlling a squirrel cage induction motor. PWMs use computer software to control/create the modulated frequency and voltage delivered to the motor. These are the most common type of ASDs and are available for a large number of motor sizes.

Centrifugal pump and fan applications are by far the most common applications for ASDs. Together, fans and pumps comprise more than 40% of the total motor-related electricity consumption in the manufacturing sectors or approximately 18% of the total manufacturing electricity consumption (Suozzo and Nadel, 1998). In these applications, speed control is used to regulate the flow of a liquid or gas. A large proportion of flow control drives are used in building heating, ventilating, and air conditioning (HVAC) systems. Municipal water and waste treatment systems also represent a substantial market for adjustable speed drives. There are many other applications for flow control drives in industrial processes.

One important issue that affects application potential is the distinction between energy efficiency versus process control applications of ASDs. An energy efficiency application is one where the goal is saving energy by better matching device operation to the load. A process control application is one where the primary goal is to control the speed of a process. Examples include conveyor belts and assembly lines. The issue here is that process control ASD applications should not be considered when evaluating energy savings potentials for ASDs.

High Efficiency Motors

Motor efficiency standards are established by the National Electrical Manufacturers Association (NEMA) for general purpose, polyphase, squirrel-cage, 1 to 200 HP induction motors. Two categories of motor efficiency are specified: "standard" and "energy efficient." Energy efficient motors are those that exceed the standard efficiency ratings. This includes motors that are compliant with the energy-efficient motor ratings, as well as "premium efficiency" motors that exceed the energy-efficient ratings. The NEMA standards for energy-efficient motors were adopted into law by the Energy Policy Act of 1992 (EPAct 1992), which specifies that all motors in this category *manufactured* after October 1997 are required to meet these efficiency requirements.

Prior to the passage of EPAct, many utility programs were set up to encourage the use of energy-efficient motors. Now that EPAct motor efficiency requirements have been activated, there is probably no need for such promotions, unless there is a desire to accelerate the use of these motors for retrofit applications. One uncertainty is how long it will be before the manufacturers and OEM vendors exhaust their supply of old standard efficiency motors.

Another question concerns motors that are rewound instead of replaced. While new motors fall within the mandatory requirements of the EPAct, motor repair standards are voluntary. The Electrical Apparatus Service Association (EASA), is a trade organization that has created motor repair standards. However, because of the standard's "rigor and burdensome record-keeping requirements, … only three shops in the U.S. qualify as EASA-Q certified" (Suozzo and Nadel, 1998 page 138).

HVAC Motors. This motor category is limited to HVAC motors that can be replaced, (e.g., if the motor in the system fails), you would replace the motor rather than the whole pump/fan unit. Package HVAC units are excluded from this group. Typical HVAC motor applications include air distribution system fans, cooling tower fans, chilled/hot water circulation pumps, and chillers. High efficiency motors could potentially be used for any of these devices but typically are not because this equipment is purchased from OEMs as a complete unit. ASDs can also be used for any of these devices, but by far the most common application is on air distribution system fans for a Variable Air Volume (VAV) type system.

One engineering contractor commented that use of ASDs for VAV systems is actually becoming standard practice in some markets due to decreased price and increased reliability. Title 24 may also be indirectly encouraging the use of ASDs. Fans greater than 50 HP are required to have special controls that limit energy use at a given fraction of load. There are mechanical control devices that can be used to meet this requirement, but it may be that ASDs are more cost-effective when additional energy savings are considered, hence the apparent tendency towards using these as standard practice.

Non-HVAC Motors. This motor category encompasses primarily industrial motors such as pumps, fans/blowers, air compressors, and other process applications. High efficiency motors would be especially applicable to larger motors with long operating hours. ASDs are most applicable to large HP motors which operate more than 2000 hours per year and have loads that very over time, typically by at least 30% of full load. There are application opportunities in almost any industry, but pumps and fans/blowers in water treatment facilities have been one of the most common applications. However, ASD applicability is highly dependent on the process specifics.

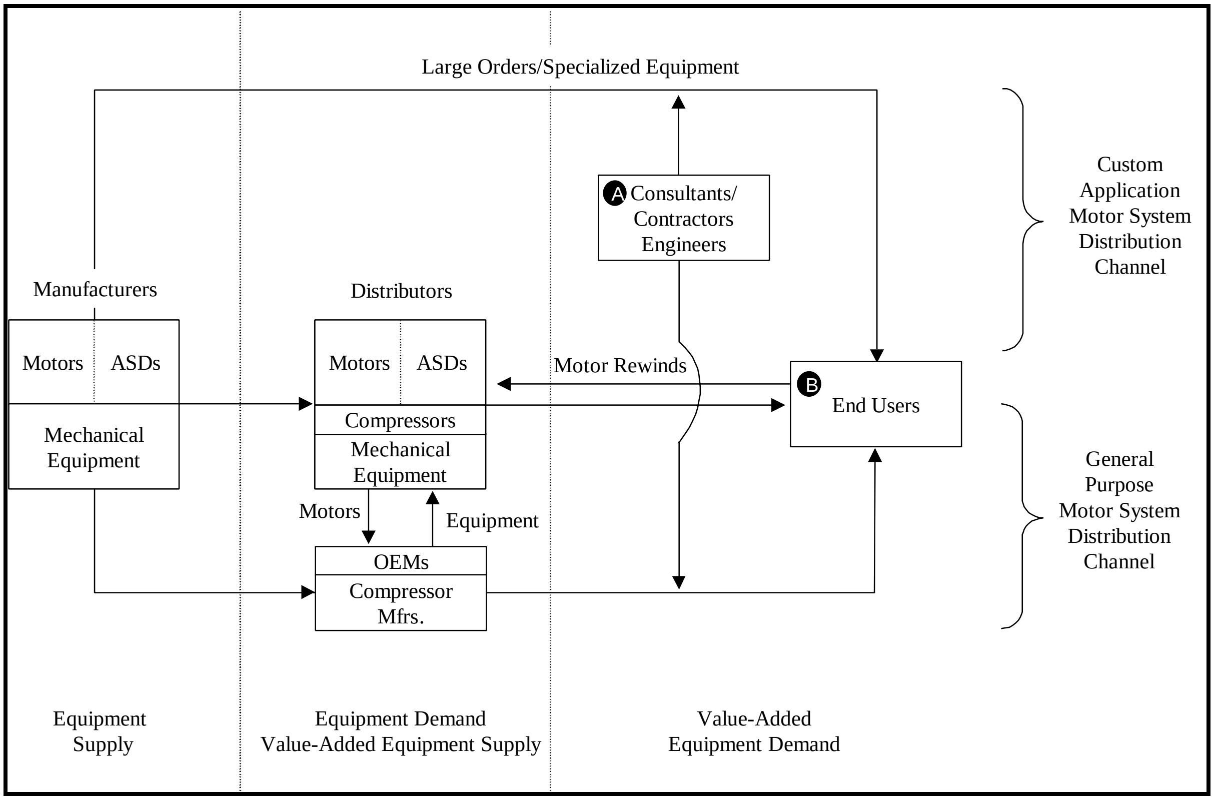
ASDs are most applicable to centrifugal devices. The industrial fan market is dominated by the centrifugal fan, which accounts for more than 90% of fan energy consumption. From these statistics, there are many potential applications. The fan manufacturers tend to be decentralized and no manufacturer has more than 12% of the market. Centrifugal pumps represent 80 to 90% of annual sales and account for 25,000 to 30,000 pumps sold annually.

Review of the Motor Systems Market

Figure 4-12 provides a very simplified illustration of the motor systems market for the measures that are the focus of this study.

- The market path starts with the motor, ASD, and mechanical equipment (pumps, fans, etc.) manufacturers. Several companies make both motors and ASDs, hence the dotted line in the figure. In fact, some motors and ASDs are integrated together into a drive system (28% of ASDs), but most motors and ASDs are shipped as separate units.
- Motors, ASDs, and mechanical equipment go to OEM's for assembly into motor-driven products (pumps, fans, etc.), or directly to distributors for sale to contractors or end users. In terms of number of units shipped, motors and mechanical equipment go primarily to OEM's while ASDs go primarily to distributors (95%).
- Motors, ASDs and/or mechanical equipment for custom applications (large motors, special processes, etc.) requires direct interaction of end users and/or their consultants/contractors with the manufacturers. A good example is pumps for municipal water and waste treatment plants. For these projects the pump manufacturers usually specify, build, and install the whole project.
- For the replacement market, the path depends on whether or not the end users motor system is one for which the motor and motor driven mechanical equipment are separable. If they are assembled as a unitary device and are not separable, then an OEM will be involved. If they are separable, then the end users options are to replace the entire unit, to replace the motor, to rewind the motor, or to replace the motor-driven mechanical equipment (pump/fan).
- Rewinding of motors is important because it affects the assessment of potential for replacing existing standard efficiency motors with high efficiency motors.

Figure 4-12: The Nonresidential Motor Systems Market



This figure taken from (Nadel, Shepard, et. al. 1992)

The major manufacturers of electric motors include Baldor Electric, General Electric, Magnetek, Marathon Electric, Reliance Electric, Siemens, and Toshiba. These manufacturers sell well over half of all their units to OEMs. The remaining units are sold either through motor distributors or directly to end-users. It is unknown how many of the motors sold through the distribution channel go to new applications or to replace a burned out motor.

Retrofits and motor repairs are based upon decisions made over just days, not weeks. In many processes, the lost time of motor operation costs more than the replacement of the motor itself. As a result, most retrofits and replacements are obtained through established relationships with distributors. In many cases, replacements are made from available distributor stock.

High Efficiency Motor Market. Motors in the 1 to 200 HP range comprise more than half of the AC induction motor sales and 25% of the annual energy consumed by integral HP motors.[19] In 1996, the estimated share of energy-efficient motors was 25% of all units sold, with nearly half occurring in the distributor sales market. This is in part a result of utility-sponsored rebate and incentive programs. Sales of energy-efficient motors in the OEM market are low, around 10%. Results of an extensive study of industrial motors recently completed by the DOE, 1996 shows that energy-efficient motors account for 9.1 percent of all motors currently in use, with the highest concentration (25.5%) in the 101- to 200 HP range. Motor repair shops have indicated that they are beginning to repair a significant amount of energy-efficient motors.[19] This seems to indicate that new energy-efficient motors are replacing less energy-efficient motors.

In general, although large motors (greater than 200 HP) as a group consume more electricity than small motors, the potential savings from implementing energy-efficient motors is higher with smaller motors because of the greater potential for improvements and also because the current penetration of efficient motors is lower in the smaller size classes.

ASD Market. The ASD industry is still somewhat immature, although some specific applications are quite mature. 300,000 drives were sold last year. 15 companies account for about 90% of the market, and only two companies account for about 40% of the market. Currently, growth in the market has slowed to 3% to 8% due to slumps in the Brazilian and Asian economies. As a result, there appears to be some consolidation of the industry going on with smaller firms merging or being purchased by other competing firms.

The major manufacturers of ASD drives include Reliance/Alan-Bradley, ABB, and Yaskawa, which manufacturers units for resale under the trade names of MagneTek, IDM Controls, EMS, and SAFTronics. Note that several of these manufacturers are also major motor manufacturers. Most ASDs are manufactured here in the United States, with 15% of these being exported. About 95% of all units are sold through distributors and the balance are sold to OEMs. Approximately 20% of sales are replacements. However, units are typically replaced not due to burnout, but to upgrade to the latest technology in order to further increase production efficiency.

One source stated that 15% of motors in the existing market are controlled by ASDs and that most of the larger motors are already outfitted with drives, hence the largest potential for growth is in the smaller HP market (essentially HVAC). Although energy use is much less for the HVAC motor sector than the non-HVAC motor sector (a factor of 3 or 4), there are

[19] See U.S. DOE, 1996.

many more HVAC motors and hence greater sales potential. The market average size of ASD units reflects this trend; last year it was 15 HP versus 18 HP for the previous year.

HVAC/Non-HVAC Market. Energy use for HVAC fans and pumps in the commercial and industrial sectors is about 7% of total U.S. motor energy use. Although this is a relatively small amount of motor energy, there are many smaller motors. Energy use for non-HVAC pumps and fans is 48% of total U.S. motor energy use. Energy use for non-HVAC compressors is estimated at 16% of total U.S. motor energy use.

Implications for Tracking Motor Measures

The complexity of the motor systems market presents a tracking challenge for several reasons.

- The dearth of applications (HVAC and non-HVAC, pumps, fans, motors, etc.) and motor system configurations (motor only, integrated motor/driven device, separable motor/driven device, rewind issues, etc.) would make data gathering quite complicated and costly.
- Relatively detailed knowledge of the end use application is required in order to thoroughly evaluate ASD potentials. This essentially implies the need for an on-site survey.
- Because of the many market paths available to the end user, some data would have to be gathered from all of the market players (manufacturers, distributors, OEMs, contractors, and end users) which would be difficult and cost prohibitive.
- Manufacturers have no interest in looking at state-level activity trends, and they do not have the resources to commit to such a limited scope effort. Their concerns are at a national, or even a regional (e.g. North America) basis.

Although some sources of motor and ASD tracking information exist, there are no data available at the level needed to track these measures for California. For instance, NEMA collects motor shipment statistics from its members on a quarterly basis. DrivesMag, an internet magazine for the motor controls trade, gets quarterly information on ASDs from most of the major manufacturers, but these are dollar-sales numbers and they are for the North American (U.S., Canada, and Mexico) market.[20] One other source of ASD information was Automation Research Corporation (ARC), a marketing information company. A.R.C. has detailed information about the ASD market and good, long term connections to the manufacturers. However, the ARC data only represents a “snapshot” not a quarterly basis, statistics are on a dollar-sales rather than unit basis, and the market is again North America.

[20] See http://www.drivesmag.com.

One possible option might be to collect data from end users (nodes B) and/or those working for end users in consulting and contracting (node A). However, because consultants and contractors might be difficult to identify, and because of the number of eligible ASD applications required to calculate a market share, collecting the required data via on-site surveys of end users is probably the only viable means for tracking motor systems equipment, particularly for retrofit installations.

In regards to tracking of high efficiency motors, the impact of EPAct would need to be considered and in fact might make it difficult to assess the effect of any high efficiency motor program. Since high efficiency motors are now mandated by law, they will gradually (or not so gradually) take over the entire 1 to 200 HP motor market as existing supplies of standard efficiency motors are exhausted.

In regards to tracking of ASDs, on-site data collection would have to include not only motor information (size, control type, age, efficiency, etc.) but also relatively detailed information about the motor system application (HVAC or non-HVAC, pump, fan, etc.). For HVAC motors, data would have to include not only motor characteristics such as size, application type (air distribution fan, cooling tower fan pump), and existing fan/pump control type (one-speed, two-speed, throttle valve, etc.), but characteristics of the HVAC system configuration such as HVAC system type (VAV, CV, etc.), and other inputs required to do a building simulation.

For non-HVAC motors, although the data collected would be fairly straight-forward, the collection effort would probably require an extensive amount of work to collect data.

The challenge would be to collect data at the required level of detail for the many motors contained in a typical manufacturing facility. Another challenge would likely be gaining access to the facility in the first place. Most manufacturers are on tight production schedules, and there is evidence to show that as a result, not many would participate in such a survey. However, if on-site surveys of industrial sites were to be conducted, the DOE’s recently completed study “United States Industrial Motor Systems Market Opportunites Assessment” provides some excellent guidelines on how such a study should be conducted.

4.12 Compressed Air Optimization

Air compression systems are as essential as electricity, gas, and water in the manufacturing industry and represent a major cost of production. Compressed air systems are used to power tools, equipment, and industrial processes in the chemical, plastics, glass, pulp and paper, electricity generation, textiles, petroleum, automobile, and aircraft industries. Configurations for compressed air systems vary greatly, but all systems contain the following basic components: an electric motor, compressor air-ends/package, filters and/or dryers, pressurized air reservoirs, distribution piping and valves, and point-of-use tools.

Each year, more than one million compressed air systems are sold, of which 98% are 5 HP or smaller. These smaller systems are primarily sold to commercial and residential markets, where they receive relatively low usage. Thus, these small units only account for 12% of the annual compressor energy consumption. Large compressors of 25 HP or greater, consume 80% of the electricity of new units, while accounting for less than 1% of unit sales.

The Compressed Air and Gas Institute sets compressed air standards, though compliance with the organization standards is voluntary. Instead, major manufacturers dominate decisions of equipment specification. As a result, data accuracy and standard compliance vary greatly across compressor types and manufacturers.

Despite their wide use in industrial facilities, air compression systems are highly inefficient, converting less than 20% of the energy input into compressed air power. Significant sources of energy losses in a compressed air system include air leaks, improper pressure regulation, and restricted air distribution. In addition, because the compressor system is a result of integrated components, efficiency may be gained through efficiency improvements of any component of the compressor system. These components include controls, motor(s), the drive train, compressor, ancillary components, and the distribution system.

The Pacific Energy Center (PEC) provides useful guidelines for reducing system air losses and optimizing the entire compressed air system.[21]

- ***Detect, monitor, and repair leaks in the air distribution system on a periodic basis.*** The PEC estimates that a typical site loses 20% of compressed air to leaks, which are relatively easy to detect and repair.
- ***Use efficient pneumatic tools with efficient nozzles, squeeze handles, shut-off valves, and timer controls.*** Pneumatic tools tend to operate at lower pressure, yet can perform the same work as a typical compressed air system.

[21] See http://www.pge.com/pec/.

Automatic sensors are available options that shut off the air supply to work areas not in use.

- ***Reduce air-pressure losses by increasing size of piping, air coolers, dryers, and filters, and by eliminating pipe turns.*** Doing so will not only save energy but will improve overall compressed air system performance.
- ***Improve compressed air system pressure control with regulating pressure control valves as well as larger air storage tanks.*** Regulating valves help to supply air at the appropriate pressure without losing work output. Doing so can help to reduce leakage, as well as pressure on the entire system.
- ***Efficiently manage multiple compressors with advanced control systems.*** Advanced control systems can minimize operating time and more precisely regulate air pressure.
- ***Improve efficiency at partial loads by installing controls that adjust compressor output appropriately.*** When a compressor drops below 60-80% capacity, efficiency of the system also significantly drops. Controls can be installed on a new compressor or can be retrofit to an existing system.
- ***Install controllers to vary compressor speeds.***
- ***Use outside air for intake when it is cooler than indoor air.***
- ***Choose high efficiency equipment.***
- ***Recover waste heat.*** Almost 90% of the energy input for an air compression system is used to heat the compressed air temperature. The resulting air or water from this process can be used for other applications or processes at the site.

Note that these are general aspects of compressed air optimization. It is important to recognize that each system is customized to meet the compressed air needs for each site. Thus, the compressed air optimization strategy would likely differ across sites.

Review of the Air Compressor Market

Figure 4-12 above also includes the market for compressed air equipment. In general, compressor manufacturers package compressor components and sell to distributors, and in some instances, directly to end-use customers and their consultants or design engineers. Distributors differentiate products by further customization of packaged compressors by offering service and parts, or offering price discounts through warehouse operations.

There is high market concentration of compressor manufacturers, with only a few manufacturers (Ingersoll-Rand, Gardner Denver, and Sullair) accounting for over 75% of the market. Compressor manufacturers are considered the OEM and are primarily involved in component design and manufacturing, package design, and assembly. The majority of distribution takes place through distributors, which account for nearly 90% of total compressor sales. Distributor services vary, but most distributors derive their revenue from the sale of parts and service.

The retrofit market is small and accounts for less than 5% of the market. End users are more likely to purchase new, low-cost compressors when their old compressors fail rather than retrofit their existing compressors.

Implications for Tracking Compressed Air Optimization

Compressed air optimization is a practice or service that presents tremendous challenges for market share tracking. As discussed with residential duct sealing in subsection 4.2, one must first define the "market share" of this measure that should be tracked before considering tracking alternatives. Only one element of compressed air optimization presented above involves the purchase of new or replacement equipment, so using actual sales data to infer market shares of compressed air optimizations is not possible. Second, nearly all of the elements of compressed air optimization involve a behavior or practice, most often overseen by a facility operator, system designer or engineer, or other personnel involved in facility operation and maintenance. The market share of compressed air optimization would necessarily need to reflect either the proportion of applicable sites at which one or more of these optimization practices are implemented, or the level of compressed air system optimization undertaken at each "eligible" site.

Tracking the incidence of these practices would need to be accomplished at the customer/end-user level (node B in figure 4-12), ideally with an on-site survey or a telephone interview with the facility manager or engineer at a minimum. While equipment and compressor component sales could be collected at the distributor level, doing so would only capture one aspect of compressed air optimization.

4.13 Nonresidential Lighting: T-8 Lamps and Electronic Ballasts

Lighting equipment is categorized by the light source within the luminaire, rather than by the luminaire, itself. Three types of light sources are in common use: incandescent, fluorescent, and high intensity discharge.

Fluorescent lighting is the most common light source for nonresidential applications. Fluorescent systems consist of mainly of tubular lamps in recessed luminaires (troffers). In retail and warehousing applications, surface mounted or suspended luminaires are common. General-use fluorescent lamps can be straight tubes in lengths varying from 2 to 8 feet or U-tubes. Lamps are historically designated by a letter designating its shape, followed by a number indicating the maximum diameter in eighths of an inch. Hence, T-12 indicates a tube with a diameter of $^{12}/_{8}$ or 1½ inches. T-8 lamps have a diameter of 1 inch.

Fluorescent lamps produce light by generating an electrical discharge between the two electrodes at the ends of the lamp bulb. This discharge is developed by the ionization of mercury gas sealed in the tube. Because of the mercury in the lamps, many fluorescent lamps are classified as hazardous waste.

Fluorescent lamps require a ballast to operate. A ballast is an electronic device that provides high initial voltages for starting the lamp and regulates the lamp current during operation. Ballasts, like lamps, consume electricity and are therefore a source of potential energy savings. Three types of ballasts are presently sold for commercial applications: energy-efficient magnetic ballasts, cathode disconnect ballasts, and electronic ballasts. Electronic solid state ballasts (dimmable) are the relatively new family of high efficiency electronic ballasts that are capable of operating fluorescent lamps below their rated wattage. A single ballast can serve between one and six lamps, depending on the configuration of the system. Two, three, and four lamp ballasts are the most common.

Energy efficiency of lighting systems is measured in lumens per watt. A system with T-8 lamps and electronic ballasts has an efficiency of approximately 92 lumens per watt, compared with approximately 67 lumens per watt for a standard 34-watt T-12 with a high efficiency magnetic ballast. However, efficiency depends on the specific luminaire, lamp, and ballast in the system.[22]

Review of the Nonresidential Lighting Market

There are several key players in the market for commercial lighting equipment. Manufacturers, wholesale distributors, contractors, lighting designers, and building owners and managers all play a significant role in the market. Figure 4-13 presents a simplified view of the distribution channels for commercial lighting equipment.

There are numerous manufacturers of commercial lighting equipment. In 1996, the Illuminating Engineering Society of North America (IESNA) listed nearly 300 manufacturers of luminaires for fluorescent lamps, 65 manufacturers of fluorescent light sources, and close to 100 manufacturers of fluorescent ballasts. However, a few large companies dominate the market for general use fluorescent lamps and ballasts. These companies include General Electric, Osram Sylvania, Phillips Lighting, Motorola Lighting, and Magnetek.

One of the key trends in the commercial lighting market is the movement towards viewing commercial lighting as a system rather than as separate components. Manufacturers have addressed this trend through mergers (such as the merger of lamp manufacturer Sylvania and

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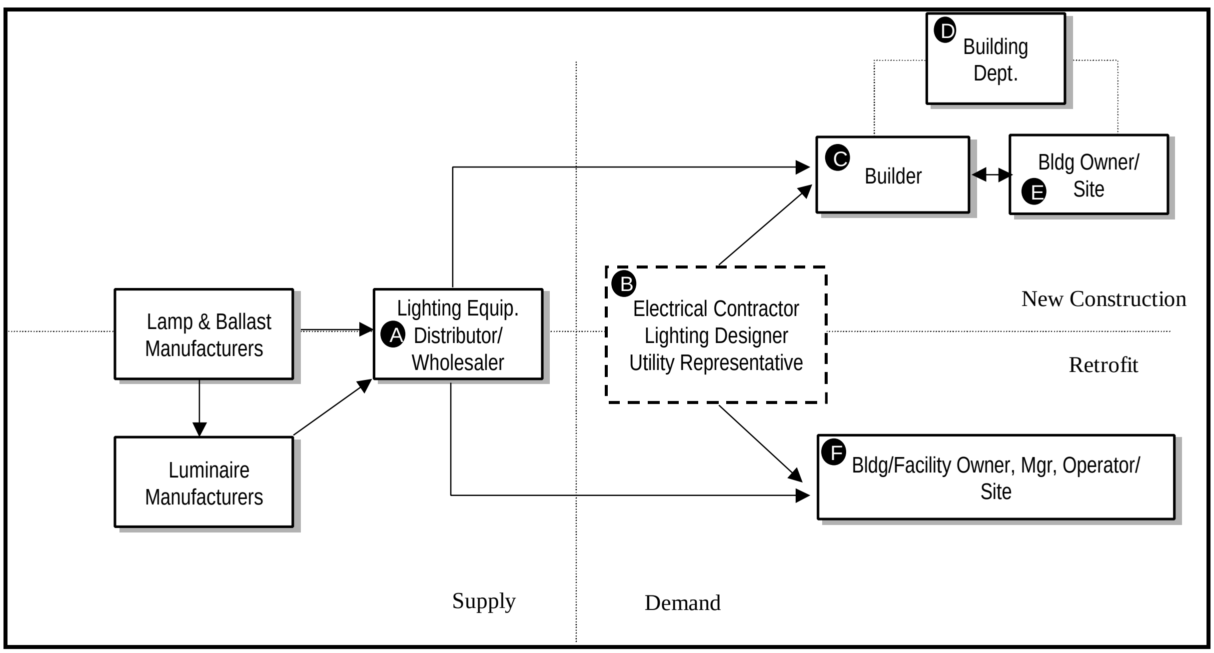
[22] The CEC's *Advanced Lighting Guidelines* is an excellent source for efficiency information for different system configurations (California Energy Commission, 1993).

ballast manufacturer Osram) and through market alliances. In September 1997, lamp manufacturer General Electric announced an alliance with Magnetek, a leading ballast manufacturer. As part of the agreement, GE began marketing combinations of Magnetek ballasts and GE fluorescent lamps as complete lighting systems for the wholesale market. Previously, GE had co-branded ballasts with Motorola.

Manufacturers of commercial lighting equipment rarely sell directly to the end user. Most manufacturers of lamps and ballasts sell to wholesale lighting distributors. A significant number of fluorescent ballasts are sold to luminaire manufacturers who market to lighting distributors as well as contractors and lighting designers. According to the Bureau of the Census, approximately 70% of general use fluorescent ballasts are distributed as shipments to OEMs, while the remaining 30% are distributed as shipments to distribution (U.S. Bureau of the Census, 1997).

Figure 4-13: Nonresidential Lighting Market – T-8 Lamps and Electronic Ballasts



In the new construction market, it may be the general contractor, electrical contractor, lighting designer, or building owner that specifies the lighting system. In California, the combination of strong utility conservation programs and Title 24 requirements have made utility representatives a significant player in the decision.

Recent revisions in Title 24 requirements will result in a decrease in the kWh/ft^2 allowed for lighting. In particular, the "lighting energy allowed [has been adjusted to assume the installation of] T-8 fluorescent lamps with electronic ballasts, in place of T-12 lamps with energy saving magnetic ballasts …. [these revisions] are not ‘pushing the envelope’ on lighting energy efficiency. [They are] really catching up with what is becoming common practice.”[23]

Lighting differs from many types of equipment in that there is no “replace-on-burnout” decision. Burned out lamps are almost universally replaced with the same type of lamp. Ballasts have very long lives (roughly 15 years) and thus rarely fail. When they do, they are usually replaced with stock on hand. Conservation opportunities are available, however, when lighting is retrofitted as part of a tenant improvement (TI). Strong utility conservation programs in California have also increased owner awareness of the benefits of retrofitting existing lighting with a more efficient option. In the retrofit market, it is usually the building owner or operator who decides to undertake a lighting conversion. However, the lighting contractor and utility representative often have a significant impact on the equipment that is specified.

Lighting equipment distributors deal directly with contractors, lighting designers, utility representatives, and building owners or managers. Increasingly, these businesses deal with all aspects of commercial lighting rather that with a single component. By combining luminaires, ballasts, and lamps into efficient lighting systems, distributors make it easier for contractors and designers to specify systems that meet Title 24 requirements, utility incentive requirements, and the needs of the building occupants.

Implications for Tracking T-8 Lamps with Electronic Ballasts

The market for T-8 lamps with electronic ballasts has some interesting characteristics that should be taken into account with respect to market share tracking. First, as indicated in Figure 4-13, tracking data could be collected from distributors (node A), contractors (node B), from building departments (node D), or at the site level (nodes E and F).

Second, and more importantly, evidence suggests that the market for T-8s with electronic ballasts has been transformed. As explained above, recent Title 24 revisions pertaining to lighting are based upon the assumption of T-8s with electronic ballasts, as a means of “catching up with what is becoming common practice.”[24] Several interviewees also commented that the market for T-8s with electronic ballasts is “mature.”

Tracking a high efficiency measure that has already been widely adopted in the marketplace has both advantages and disadvantages. Although this measure was identified as a priority

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23 John E. Sugar, Program Planning & Process Energy Office of the California Energy Commission, September 29, 1998 (from letter to Mr. Robert Mowris regarding changes to Title 24 Building Efficiency Standards).

24 Ibid.

by interviewees in the Needs Assessment phase of this study, tracking T-8s with electronic ballasts might not be a productive use of funding. In other words, there is an opportunity cost associated with committing funding for a measure whose market is fairly mature. On the other hand, tracking T-8s with electronic ballasts provides an opportunity to ascertain sustainability in the marketplace in a relatively short period. Has this market *truly* been transformed?

4.14 Packaged Refrigeration Equipment

In the context of this study, packaged refrigeration equipment includes refrigerated display cases, small walk-in/reach-in coolers, icemakers, and vending machines.[25] Such equipment accounts for approximately 50% to nearly 65% of electricity usage by refrigeration systems. Reach-in coolers and display cases, walk-in coolers, and beverage merchandisers account for roughly half of the load. Vending machines account for about 20% of the load and icemakers use about 15%. (Suozzo and Nadel, 1998; ACEEE, et. al., 1998).

There are several industrial trade organizations related to food services and equipment manufacturing. The major organization for equipment manufacturers is the North American Association of Food Equipment Manufacturers (NAFEM). Because most manufactures rely on equipment dealers for moving their products to the market place, the equipment dealers formed the Foodservice Equipment Distributor Association (FEDA). Both of these organizations focus on product information, creating a voice for their clients, and management practices, not energy efficiency.

The establishment of mandatory energy efficiency standards for packaged refrigeration equipment is still in the relatively early stages of development. The Canadian Standards Association (CSA) has developed efficiency rating procedures for some equipment, but not all. Furthermore, CSA’s standards have yet to be adopted as mandatory energy efficiency standards in some Canadian provinces. In the U.S., the Environmental Protection Agency (EPA) is exploring voluntary energy efficiency specifications for an Energy Star® label for some packaged refrigeration equipment. The EPA has also begun to promote high efficiency vending machines and merchandisers to large-volume consumers of such equipment. Despite these efforts, mandatory efficiency standards for packaged refrigeration equipment have not yet been developed in the U.S. Increases in the energy efficiency in both the production and use of packaged refrigeration equipment market will likely come about on a voluntarily basis (Suozzo and Nadel, 1998; ACEEE et. al., 1998).

[25] The large built-up refrigeration equipment as found in supermarkets is not included.

Review of the Market for Packaged Refrigeration Equipment

As shown below in Figure 4-14, the market for packaged refrigeration generally involves packaged refrigeration equipment manufacturers and a variety of distribution channels. Among the variety of packaged refrigeration products, the primary means of distribution may vary.

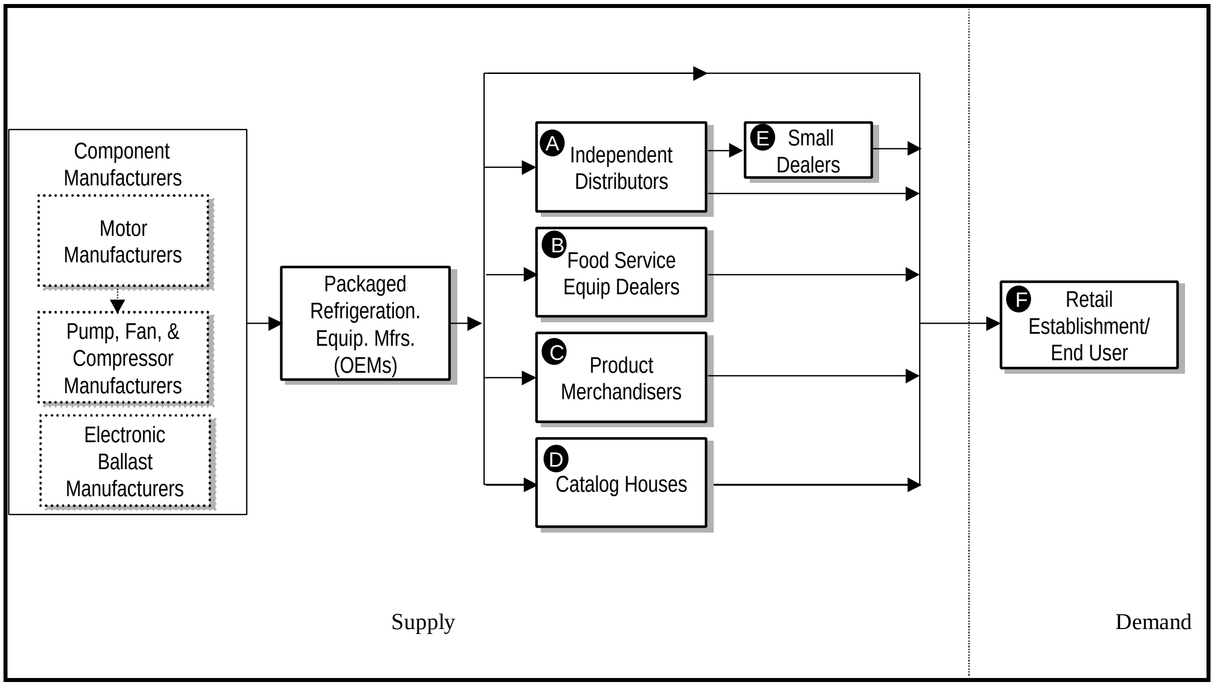
The market for packaged refrigeration equipment can be segmented into two general markets. The first market is for refrigeration units that are not bundled with food or beverage products. Within this market, the primary mode of distribution is through food service equipment dealers. These dealers serve large end-use customers and serve as general equipment suppliers. Smaller channels of distribution involve catalog houses and independent distributors. Furthermore, the independent distributors use a secondary layer of dealers to reach small end-use customers. Only under rare circumstances will a refrigeration unit manufacturer sell equipment directly to an end user.

The second market is for refrigeration units that are bundled with food or beverage products. This market is characterized by

1) Product merchandisers (e.g., soft drink, ice, or food product manufacturers that purchase refrigeration units from the refrigeration manufacturer, and
2) "Planting" (to provide at no cost) the refrigeration units at the end users site.

The product merchandisers work with the end user to supply the food and/or beverage products as well as the refrigeration units. Only under rare circumstances will the end user ever actually need to purchase a refrigeration unit in this market.

Figure 4-14: Packaged Refrigeration Equipment Market



Implications for Tracking Packaged Refrigeration Equipment

As with some of the other priority measures, several factors need to be considered with respect to tracking efficiency levels of packaged refrigeration equipment. First, packaged refrigeration equipment is comprised of numerous equipment types, so before developing a tracking system, the types of equipment to be tracked need to be identified. Second, because minimum efficiency levels are not mandated by any government organization, the efficiency indicators that need to be collected and how subsequently to classify a “high efficiency unit” will also need to be determined.[26]

There are two possibilities for collecting data for tracking packaged refrigeration equipment. First, data collection could be obtained at the distributor level (nodes A through E). However, as in many other markets, data specific enough to meet the CBEE’s needs are more likely to be obtained from distributors. However, as indicated in Figure 4-14, a variety of market actors distribute packaged refrigeration equipment; sampling would be relatively complicated. The only alternative is to collect the necessary data at the final end user level (node F). The main issue with this option is that end users, including convenience stores, hotel and motels, and grocery stores are not likely to be able to retrieve efficiency measures or even model numbers from the equipment once it is installed, which implies an on-site survey would likely be the best alternative.

[26] One source for such information is Suozzo and Nadel (1998), which provides “base case” and “new measure” efficiency levels for every measure included in the analysis.

5

Review of Market Share Tracking Methods

5.1 Overview of Approach

This section identifies and summarizes alternative methods and data sources that could be used for state-level or regional tracking of the market shares of the priority measures identified in the Needs Assessment phase of this study. Note that none of the sources investigated for this study can readily supply the "ideal" data that would meet the three criteria presented in Section 4.1. When possible, the potential for customizing these pre-existing methods to better meet the CBEE's data needs was explored and will be further investigated during the Feasibility Assessment phase of this study.

The tracking options considered in this analysis were categorized according to the maturity of their data collection infrastructure. The methods reviewed here have data collection infrastructures at various stages of development. Some methods are fairly developed and are already used to collect data that are somewhat similar to these needed for market share tracking, while some have not yet been developed. *Existing* methods are defined as having a data collection infrastructure that is relatively mature, despite the fact that the data collected with these methods still do not precisely meet the CBEE's MA&E needs. The *existing* methods reviewed for this study include the following:

- Consumer panel data,
- Scanner (point-of-sale) data,
- Shipments data, and
- Market research data.

The remaining six methods might already exist in some form, but their infrastructures for collecting data have not yet been developed specifically for tracking the market shares of key measures. For lack of a better term, these methods are referred to as *undeveloped* methods. (For example, although market actor surveys are a common method for data collection, they have not been developed specifically for meeting CBEE's MA&E needs.)

- In-store surveys (mystery shoppers),
- Building department and on-site inspection data,
- Warranty card data,

- Interviews with market actors,
- Downstream market actor surveys, and
- Upstream market actor surveys/data collection.

Market research is another potential source of tracking data that often utilizes one or more of the above methods. RER does not consider market research a method for tracking market research firms can be retained to implement the desired tracking method.

The remainder of this section presents a summary of each tracking method listed above according to numerous characteristics. Each characteristic and its corresponding description or definition is provided below.

- ***Description.*** Extended description of tracking method.
- ***Applicable Sector.*** Sectors covered by the method (e.g., residential, nonresidential).
- ***Applicable Measures.*** Description of the products and services that could reasonably be covered by the tracking method.
- ***Applicable Decision Type.*** If available, the decision type covered by the tracking method (e.g., new construction, retrofit, or replace-on-burnout installations).
- ***Data Availability.*** Detailed description of data, such as units and availability of data by efficiency level and/or by decision type distinction.
- ***Possibility of Tracking Other Market Effects Indicators and/or Market Characteristics.*** Discussion summarizing the extent to which the tracking strategy can collect other market effects indicators, such as stocking practices, consumer awareness, decision-making processes, prices, etc.
- ***Market Actor(s)/Market Node(s).*** The market actors involved in or targeted by the tracking method. This characteristic also refers to the point(s) in the distribution channel at which data are or can be collected.
- ***Geographic Scope.*** The geographic coverage or segmentation of data by geographic area (e.g., national, regional, statewide, countywide).
- ***Data Format.*** The format of the database that would be obtained from the data collection agent (e.g., spreadsheet, CD-ROM), if applicable.
- ***Reporting Frequency.*** Time intervals of data collection and/or reporting frequency, if applicable.
- ***Set-Up Procedure.*** The tasks involved or the procedure that would or might be necessary for setting up the tracking method, if available.
- ***Costs.*** Summary of cost estimates, including data purchase costs, set-up costs, and implementation costs, if available.

- ***Time.*** Estimate of time required to set up the tracking strategy, if available. This estimate would include the time required for all preparation and activities before actual data collection.
- ***Major Suppliers or Sources.*** List of primary companies that are implementing/or that could implement the tracking strategy. Note that company-specific information is presented in Appendix J.
- ***Customization/Joint Venture Possibilities.*** Discussion regarding whether the tracking method could be customized or augmented to accommodate the CBEE's specific data collection needs, if they are not met by the current data collection structure. This information is only applicable to the data sources that are already in place and from which data can be obtained.
- ***Advantages.*** Advantages of method as a strategy for tracking market shares of key measures.
- ***Disadvantages.*** Disadvantages of method as a strategy for tracking market shares of key measures.
- ***Information Sources.*** Primary sources of information on the tracking option.

Note that the method descriptions provided in this section are general descriptions. In other words, the information here is generalized across all reviewed data sources. Information pertaining to specific data sources for both *existing* and *undeveloped* methods is presented in Appendix J.

5.2 Consumer Panel Data

Description

Consumer panel service suppliers recruit a fixed sample of respondents and measure various attributes, purchasing behavior, and other factors repeatedly over time. Consumer panels consist of two types: *true* and *omnibus*. In *true* consumer panels, the variables being measured are always the same. In omnibus panels, the variables can change from measurement to measurement. Consumer panel services could be conducted via mail or in-home surveys.

Applicable Sector

Residential

Applicable Measures

Consumer panel suppliers monitor a wide range of products, services, and attitudes. Examples include personal care products, various types of foods, apparel, home appliances, and opinions regarding certain brands, new products, services, etc.

Measures covered by consumer panels that were identified as priorities in the Needs Assessment include residential lighting, water heating, clothes washers, central furnaces, and central air conditioners.

Applicable Decision Type

New construction
Retrofit/replace-on-burnout

Data Availability

Availability of data varies across consumer panel data suppliers, ranging from providing information on just whether equipment was purchased in the last 12 months to providing brand name, whether it is a first-time purchase or replacement, location of purchase, and size in BTUs for furnaces and EERs for air conditioners.

Possibility of Tracking Other Marketing Effects Indicators

Other indicators that could possibly be tracked through this method are changes in consumer attitudes, opinions, and retail prices of various products and services.

Market Actor(s)/Market Node(s)

Consumers

Geographic Scope

Consumer panel data suppliers use sample design methodologies that allow them to project the results on a national level. For one supplier, the sample is also representative with respect to city size, head of household age, number of people in the household, and annual family income. Another supplier's sample is representative of five pre-defined marketing regions, one of them being Pacific, which can be further broken down into Los Angeles and Remaining Pacific. Also, this supplier conducts a quarterly mail survey of roughly 35,000 homes that can be segmented by state.

Data Format

In general, the data are provided on a CD-ROM in Excel spreadsheets.

Reporting Frequency

The reporting frequency varies by supplier and ranges from monthly to quarterly.

Set-Up Procedure

Not applicable.

Costs

Costs are a function of geographic coverage, numbers of measures, type of information of interest, and whether customization of data is needed. Cost estimates from one supplier indicate that pre-existing data for one product can be obtained on a quarterly basis at the cost of $8,000. For reporting on two to three products, it is an additional $2,000 and for four or more, it is an additional $1,000. These cost estimates include national data with reporting on brand name, location of purchase, price, first-time purchase/replacement, and EERs for air conditioners and size in BTUs for furnaces.

Time

Not applicable.

Major Suppliers

Simmon's
Industrial Market Research

Customization/Joint Venture Possibilities

Suppliers interviewed were asked if they would be amenable to including additional questions in their survey to investigate the percentage of energy-efficient equipment being sold. One of the suppliers, Industrial Market Research (IMR), is willing to syndicate some questions aimed at obtaining energy-efficient equipment information for tracking market share at no cost, provided some of their main clients think it is valuable information to collect. IMR also conducts follow-up surveys on a sample pre-screened through the first panel survey. See Appendix J for more details.

Advantages

Consumer panels are very useful in tracking trends and shifts in market share activity on a systematic basis.

Disadvantages

Consumer panels are prone to self-selection and attrition bias. Furthermore, energy efficiency information is not currently available for most of the relevant products.

Information Sources

Internet, personal communication with data suppliers.

Table 5-1: Summary Profile of Major Suppliers of Consumer Panel Data

	IMR	Simmon’s Market Research
Market Nodes	End Users	End Users
Equipment Type	AC, Dryers, Dishwashers, Furnaces, Washers	Lighting, AC, kitchen and bathroom faucets, dryers, water heaters
Geographic Scope	Sample projected to national population	Sample projected to national population
California Possible (as is?)	Yes	Greater Los Angeles and Remaining Pacific
Other Market Effects	Yes, if administer follow-up survey	No
Customization	Yes, can administer a follow-up survey of pre-screened sample of equipment purchasers	No
Cost		
Available Data		
Model No. and Brand Name	Yes	Yes, only for lighting
Decision Type	First-time or replacement purchase	No
Efficiency Levels	EERs for air conditioning equip. and BTUs for furnaces only	No
Dist. Channel Information	Yes	Yes
Unit Sales Share	Yes	Yes
Dollar Sales Share	Yes	Yes
Reporting Frequency	Quarterly	Quarterly, Annual

5.3 Scanner (Point-of-Sale) Data

Description

Scanner or point-of-sale data are collected with equipment designed to read Universal Product Codes (UPCs). UPCs are 11-digit numbers that are imprinted on each product or product label. There is a unique UPC associated with each product. Associated with each UPC are the product price, a description, and sometimes other characteristics of the product. As each product is pulled across the UPC scanner at the point-of-sale, the scanner identifies the 11-digit number. At the same time, the computer also keeps track of the movement of every item that is scanned. Retailers, including grocery stores, drug stores, and mass merchants, sell such point-of-sale databases to various companies who then package it and resell it to interested clients.

Applicable Sector

Residential

Applicable Measures

Data are available on every UPC scanned product sold in mass merchandising stores, drug stores, and grocery related businesses. The most applicable measures relevant to this study include light bulbs, refrigerators, clothes washers, and dishwashers.

Applicable Decision Type

Retrofit/replace-on-burnout

Data Availability

The data include number of units sold, average retail price, dollar sales, market share, merchandising conditions, and distribution items. Information can be purchased at the UPC-code level in regional segments. Historical data are also available for purchase. Basic tracking information is available at multiple levels, from category level to total U.S. sales volume to single item performance in one market.

Possibility of Tracking Other Marketing Effects Indicators

Other indicators that could be tracked through this method include changes in demand due to changes in retail prices and promotions of various products and services, increased ability to link customer purchase behavior to demographics, and monitoring performance trends by tracking and forecasting non-promoted versus promoted product movement.

Market Actor(s)/Market Node(s)

Final customers and retail establishments.

Geographic Scope

Suppliers that were investigated for obtaining such data use sample design methodologies that allow them to project the results on a national level. Companies have different definitions of the marketing regions and markets used to present the data. One supplier can provide the information by the four major markets in California: San Francisco, Los Angeles, Sacramento, and San Diego.

Data Format

In general, the data can provided on CD-ROMs, diskettes, or in Excel spreadsheets.

Reporting Frequency

The data could be provided on monthly, quarterly, or annual basis.

Set-Up Procedure

Not applicable.

Costs

Costs are a function of geographic coverage, numbers of measures, type of information of interest, number of distribution channels of interest, and whether customization of data is needed. Data reports could range from $1,000 to $18,000 per product. Cost estimate from one supplier regarding scanner data on light bulbs (on an annual basis) for four markets in California, namely Los Angeles, Sacramento, San Francisco, and San Diego is $5,135. Aside from the breakdown by four cities, this includes providing information by outlet, lamp type (various fluorescent and incandescent types), brand, and other variables, such as dollar volume and share, unit volume and share, and average retail price.

Because UPCs are recycled as products enter and exit the market, additional costs are incurred to maintain and keep the UPC code in the system current.

Time

Not applicable.

Major Companies/Suppliers

A.C. Nielsen
Information Resources Inc.
ASW/Triad

Customization/Joint Venture Possibilities

Suppliers interviewed were asked if they would be amenable to including additional questions in their survey to investigate the percent of energy-efficient equipment being sold. One of the suppliers, ASW/Triad, was willing to explore such possibilities.

Advantages

Aside from tracking market shares, scanner data are very effective in helping identify changes in demand due to changes in retail prices and promotions of various products and services. It also provides an increased ability to link customer purchase behavior to demographics, and helps in monitoring performance trends by tracking and forecasting non-promoted versus promoted product movement. Data are also available in a very timely manner.

Disadvantages

The majority of existing scanner firms provide good coverage for mass merchandise, grocery, and drug stores only.[1] This practice limits the usefulness of this method in tracking measures other than compact fluorescent lamps.

Sales data for some categories are not "clean," since manufacturers recycle UPC codes of products that are eliminated from their product line. Unless considerable funds are available to maintain and keep the UPC code in the system current, data produced with this method can become inaccurate and misleading very quickly. Scanner data would require a considerable amount of work and funds to be useful because information is presented at the UPC code level and would require further classification or aggregation into useful categories.

Information Sources

Internet; Rick Winch, Opinion Dynamics (608) 276-9880; and personal communication with data suppliers.

1 Some firms offer tracking for niche type markets. For instance, ASW and TRIAD provide tracking of electronic appliances at the national level. For a detailed description of their offerings, see Appendix J.

Table 5-2: Summary Profile of Major Suppliers of Scanner Data

	A.C. Nielson	IRI	ASW/Triad
Market Nodes	End users	End users	End users
Equipment Types	Light bulbs, air conditioners, refrigerators, and freezers	Light bulbs	Room air conditioners, refrigerators, freezers, washers, dryers, ranges, ovens, dishwashers
Geographic Scope	Sample projected to national population. Also representative by 51 markets	Sample projected to national population. Also representative by eight marketing regions	Sample projected to national population.
California Possible (as is?)	Yes; by four major markets namely San Francisco, Los Angeles, Sacramento, San Diego	No	No
Other Market Effects			
Possibility of Joint Venture	No	No	Yes
Cost	$1,000 to $18,000		$24,000
Available Data			
Model No. and Brand Name	Yes	Yes	Yes
Decision Type	Retrofit/replace-on-burnout	Retrofit/replace-on-burnout	Retrofit/replace-on-burnout
Efficiency Levels			
Dist. Channel Breakdown	Yes	Yes	Yes
Unit Sales Share	Yes	Yes	Yes, including inventory levels
Dollar Sales Share	Yes	Yes	Yes
Reporting Frequency	Monthly, Quarterly, Annual	Monthly, Quarterly, Annual	Monthly, Quarterly, Annual

5.4 Shipments Data (Existing)

Description

This *existing* method refers to data on equipment shipments that are currently being collected by various trade associations and other organizations. Shipments data are collected from manufacturers and aggregated to protect the manufacturers' strategic interests before becoming publicly available.

Applicable Sector

Residential
Nonresidential

Applicable Measures

Measures for which shipment data are collected vary greatly from residential appliances to commercial and industrial equipment. Shipments data are available for many of the measures identified as priorities in this study, including refrigerators, water heaters, air conditioning units, clothes washers, windows, and dishwashers, and some nonresidential measures.

Applicable Decision Type

New construction
Retrofit/replace-on-burnout

Data Availability

Shipments data reporting differs by information source. Typically, these sources are trade associations or government departments that report data on the number of units shipped and some limited data on efficiency levels. Data sources investigated for this study include the following:

- ***AHAM.*** AHAM tracks shipments data directly from the manufacturers as products leave the manufacturing plant. National shipments data are available through AHAM's monthly newsletter. Note that even though the manufacturers report the data to AHAM on a county level, data are only publicly available on a national level. Further, AHAM has a nonnegotiable policy to report data only at the national level.

  Appliances tracked by AHAM include refrigerators, freezers, home laundry, gas and electric cooking ranges, ovens and countertops, microwave ovens, dishwashers, food disposals, compactors, room air conditioners, and dehumidifiers. Details about measures covered by this study are included below.

  Refrigeration. AHAM tracks shipments of residential refrigeration equipment by size and type (door orientation), but not by efficiency level. Even less information is tracked at the county level, though the county-level data are proprietary and not publicly available. AHAM may implement a model-based tracking system, but is not likely to do so in the near future.

Clothes Washers and Dishwashers. Information regarding clothes washer orientation is not available, though AHAM may track this information in the future. Dishwasher details include the size and type (built-in or stand-alone). County level data are not available.

- ***ARI.*** ARI tracks shipments data directly from the manufacturers as the equipment leaves the manufacturing plant. This organization provides data on the number of units sold and efficiency levels of residential and small commercial HVAC equipment. ARI estimates that they cover 98% to 100% of the market. Again, data are available at the national level only. The monthly national shipments data are posted on ARI's website (http://www.ari.org).
- ***GAMA.*** GAMA tracks shipments data directly from the manufacturers as the equipment leaves the manufacturing plant. This organization provides data on units shipped and some limited data on efficiency levels for residential gas furnaces and water heaters. Monthly national shipments data on GAMA's website (http://www.gamanet.com).
- ***The U.S. Department of Commerce*** collects data on several technologies including lighting, motors, and household appliances on an annual basis. These data are limited in the coverage of efficiency levels and are generally not available in a timely manner.
- ***NEMA.*** NEMA is the predominate trade association for motor manufacturers. Manufacturers provide data periodically to NEMA, who aggregates and provides these data to contributing members only. In general, the data is comprehensive at a national level only. RER's conversations with representatives of NEMA's statistical department indicate that NEMA does not generate data on a regional or state level, is unwilling to provide the data to nonmembers, and cannot disaggregate the data by distribution channels.
- ***NFRC*** is a nonprofit trade organization comprised of various market actors, including manufacturers, suppliers, builders, architects and designers, code officials, utilities, and government agencies. Although collecting shipments data is out of NFRC's scope, the distribution of window products by U-factor is provided in its *Certified Products Directory*.[2] The data in this directory is aggregated across all window manufacturers. However, it is possible to obtain data only for manufacturers located in California to more precisely estimate the efficiency mix of products available in California. The data provided in this directory might be available online in the near future.

[2] National Fenestration Rating Council. *Certified Products Directory*. Seventh Edition, December 1997. Page 17.

Possibility of Tracking Other Marketing Effects Indicators

Because of the manner in which shipment data are typically collected, additional data on other market effects is not available through this tracking method. However, product availability data for the residential windows by efficiency level (e.g., the number of available of window products by U-factor) is maintained by the National Fenestration Rating Council.

Market Actor(s)/Market Node(s)

Shipment data are typically gathered directly from the manufacturers as the equipment leaves the manufacturing plant.

Geographic Scope

Shipment data are most often publicly available at the national level. Because most shipments data are collected from the manufacturer, and manufacturers do not have the mechanism for knowing where or to whom the product is sold, these data most accurately represent shipments to the first distribution point, often a centralized distribution center with a large, regional scope of sales to distributors. Shipments data presented at the state level or by a smaller region have probably been estimated.

Data Format

Data are typically available on the internet or by subscription.

Reporting Frequency

The reporting frequency is typically monthly and annually.

Set-Up Procedure

Not applicable.

Costs

Costs for existing vary depending on the source. Monthly press releases are currently available on the internet for no cost from ARI and GAMA. Appliance Magazine produces an annual statistical review in their April issue; an annual subscription to Appliance Magazine costs $75. AHAM produces monthly newsletter for an annual fee of $300.

Time

Not applicable.

Major Companies

Numerous trade associations and other organizations collect shipment data. Those reviewed for this study include NEMA, AHAM, GAMA, ARI, and NFRC.

Customization/Joint Venture Possibilities

Associations interviewed were not amenable to extending their service or any joint venture possibilities to supply data that would better meet the CBEE's MA&E needs.[3]

Advantages

Shipment data are useful in indicating general trends in national market shares for broad categories.

Disadvantages

The majority of the trade associations collect data from manufacturers with the understanding that the data will be kept proprietary. This causes a number of disadvantages, including (1) the reported statistics are often aggregated to the national level, thus limiting regional inferences, (2) resistance by the trade associations to work with outside organizations to provide data tailored to a particular region, and (3) limitation of the availability of efficiency data.

Information Sources

Internet; personal communication with trade association staff; and Appliance Magazine.

[3] The authors of the EPRI market tracking study proposed a number of joint ventures with ARI and NEMA but were ultimately rejected. See EPRI, 1997.

Table 5-3: Summary Profile of Major Suppliers of Shipments Data

	NFRC	AHAM	ARI	GAMA	NEMA	Appliance Mag.
Market Nodes	Manufacturer	Manufacturers	Manufacturers	Manufactures	Manufactureres	Manufacturers
Equipment Type	Windows, window assemblies	Refrigerators, home laundry, dishwashers.	Central air conditioning and commercial refrigeration equipment	Gas space heating, water heating and commercial food service equipment, and certain oil-fired and electrical appliances.	Motors	
Geographic Scope	National	National	National	National	National	National
California Possible (as is?)	Yes	No	No	No		No
Other Market Effects	Window efficiency mix of product availability	No	No	No		No
Possibility of Joint Venture	No	No	No	No		No
Cost		$300	No Charge	No Charge		$75
Available Data						
Model No. and Brand Name	Yes	No	No	No	No	No
Decision Type	No	No	No	No	No	No
Efficiency Levels	Yes	Yes	Yes	No	Yes	No
Dist. Channel Information	No	No	No	No	No	No
Unit Sales Share	No	Units shipped	Units shipped	Units shipped	Units shipped	
Dollar Sales Share	No	No	No	No	No	Yes
Reporting Frequency	Annual	Monthly	Monthly	Monthly	Monthly	Annual

5.5 In-Store Surveys

Description

In-store surveys, most often conducted by "mystery shoppers," collect data on the percentage of shelf or floor space devoted to a particular product, brand, or manufacturer. This method can be customized to meet the specific needs of the client, who specifies the information the mystery shopper collects during their "shopping spree."

Applicable Sector

Residential

Applicable Measures

Products most often investigated using mystery shoppers can be any product or brand sold in retail establishments. Those relevant to this study include compact fluorescent lamps and fixtures, horizontal axis washers, refrigerators, dishwashers, and possibly gas water heaters.

Applicable Decision Type

Retrofit/replace-on-burnout

Data Availability

Data availability is limited to the type of information that a mystery shopper or in-store surveyor is able to collect without having to solicit that information from store employees. Thus, equipment sales (units or dollars) by efficiency level would not be available.

Possibility of Tracking Other Marketing Effects Indicators

Mystery shoppers would be most useful in characterizing retail establishments and their propensity to stock and/or advertise high efficiency equipment.

Market Actor(s)/Market Node(s)

Retailers

Geographic Scope

As specific as desired.

Data Format

There are many options for data delivery, including e-mailed results, databases, and summarized trend reports.

Reporting Frequency

As often as desired.

Set-Up Procedure

The protocol for setting up an in-store survey is as follows: 1) contact company and explain project, 2) arrange contractual agreement, 3) develop survey instrument and specific instructions and guidelines for implementation/data collection, and 4) train shoppers.

Costs

Costs vary by company and typically range between $20 to $50 per "shop."

Time

Set-up time takes approximately one month.

Major Companies

Guest Perceptions, Inc.
Sights on Service
Sinclair Service Assessments

Customization/Joint Venture Possibilities

Not applicable.

Advantages

In-store surveys do not require consent or cooperation from other market actors; short lead times and quick data turnaround; possibility of collecting other market effects indicators, such as stocking practices; that can indicate general trends over time.

Disadvantages

Sales data by efficiency level is not available; limited to residential measures sold in retail establishments and/or those not installed in new construction; must rely on the subjective judgment of shopper with respect to information collected (thus training of shoppers would be essential)

Information Sources

Internet

Table 5-4: Summary Profile of Major Suppliers of In-store Surveys

	Guest Perceptions, Inc.	**Sights on Service**	**Sinclair Service Assessments**
Market Nodes	Retailers	Retailers	Retailers
Equipment Type	Compact fluorescent lamps and fixtures, horizontal axis washers, refrigerators, dishwashers, and gas water heaters.	Compact fluorescent lamps and fixtures, horizontal axis washers, refrigerators, dishwashers, and gas water heaters.	Compact fluorescent lamps and fixtures, horizontal axis washers, refrigerators, dishwashers, and gas water heaters.
Geographic Scope	As desired	As desired	As desired
California Possible (as is?)	Yes	Yes	Yes
Other Market Effects	Some	Some	Some
Possibility of Joint Venture	n/a	n/a	n/a
Cost		$25 to 47 per shop	$20 to $35 per shop
Available Data			
Model No. and Brand Name	Yes	Yes	Yes
Decision Type	No	No	No
Efficiency Levels	Yes	Yes	Yes
Dist. Channel Breakdown	n/a	n/a	n/a
Unit Sales Share	No	No	No
Dollar Sales Share	No	No	No
Reporting Frequency	As desired	As desired	As desired

5.6 Building Department Data

Description

Three distinct methods identified here rely on building department data and practices, all of which are categorized as *undeveloped* methods. Two of these methods entail the collection of data from Title 24 compliance forms that are submitted to building departments at various stages of construction. The third is a tailored survey that would dovetail off of existing building department practices.

Documentation certifying compliance with Title 24 energy building regulations must be filed with an enforcing agency for construction activity in all residential and nonresidential buildings requiring a building permit. The enforcing agencies are the city, county, or state agency responsible for issuing building permits. City and county building departments issue the vast majority of building permits.[4] Before issuing a permit, building department staff (plans examiners or reviewers) review the Title 24 compliance package and construction plans to ensure that the building specifications meet the Title 24 regulations. At various stages of the construction, field inspectors perform on-site visits to ensure that the equipment and shell measures are installed properly and coincide with those specified on the plans.

A considerable amount of data useful for tracking the market shares of key, energy-using measures is either collected or observed during the certification process performed by building departments.

The three distinct alternative tracking methods differ according to the availability of the data and the timing of the data collection. These data sources include compliance documentation, verification documentation, and field inspector on-site surveys.

- ***Compliance Documentation.*** During the building permit application process for both residential and nonresidential buildings, Title 24 compliance documents are filed with the building departments. These documents include, at the least, the CF-1R form for residential buildings and the envelope (ENV-1), lighting (LTG-1), and mechanical (MECH-1) compliance forms for nonresidential buildings. Tracking market shares via compliance documentation entails the collection of CF-1R, ENV-1, LGT-1, and MECH-1 compliance form data from building departments. The data collected from compliance documentation would represent planned, not actual, installations.
- ***Installation Verification Documentation.*** For residential buildings, documentation of the installed equipment and shell measures are posted at the job site during construction.[5] These include the CF-6R and IC-1 forms. These forms must be provided to the homeowner and must be made available to the building

[4] There are roughly 500 city and county building departments in California issuing building permits.

[5] See Blueprint #46, Efficiency Standards Office, California Energy Commission, July/August 1993, and Blueprint #55, Efficiency Standards Office, California Energy Commission, Spring 1996, for a discussion of these requirements.

department if requested.[6] For the nonresidential sector, there are no similar requirements. However, the CF-6R form is designed to be applicable for the residential and nonresidential sectors.

Tracking market shares through installation verification documentation would require the collection of the residential CF-6R and IC-1 forms from the builders, and for the development of a similar requirement for the nonresidential sector. The latter requirement involves making the filing out of the CF-6R form (or similar documentation) mandatory in the nonresidential sector. One option is to have building departments request these forms from the builders – the building departments would then submit the forms to the data collection agent. The other alternative is to collect these forms directly from the builders.

- ***Field Inspector On-Site Surveys.*** Building department field inspectors perform on-site inspections of residential and nonresidential construction at critical phases during construction. As such, they observe and have access to all installed equipment and shell measures, and could be a good source for objective information. Though building departments differ with respect to their staffing, most departments have different mechanical, electrical, plumbing, and general inspectors. This tracking method would require field inspectors to record certain attributes of the installed equipment and shell measures (e.g., model number, size, and manufacturer). This information would then be submitted to the data collection agent.

Applicable Sector

Residential
Nonresidential

Applicable Measures

The compliance and verification forms are relatively detailed. Data pertaining to residential buildings include:

- ***Building Shell.*** Wall, roof, and floor insulation R-values; and fenestration U-values, and window framing type.
- ***Mechanical Systems.*** HVAC equipment type and efficiency; duct and piping insulation R-values, and water heating equipment type and energy factor.

Data of nonresidential installations include:

- ***Building Envelope.*** Window U-values, frame, and glazing types, insulation levels, and heat gain and loss parameters.
- ***Lighting.*** Type and number of lamps, watts/lamp, and controls.
- ***Mechanical Systems.*** Heating, cooling, and ventilation equipment type, control

[6] The CF-1R, MF-1R, CF-6R, and IC-1 forms are required to be included in the Home Owners Manual that is provided to the home owner.

type(s), model number, and manufacturer, equipment size and efficiency, controls, and duct and pipe insulation levels.

If the field inspector on-site survey method were adopted, the type and amount of data collected could be tailored specifically for the CBEE's MA&E tracking needs.

Applicable Decision Type

New construction
Retrofit (only if major remodel requires building permit)

Data Availability

Substantial amounts of useful data are required and/or collected by building departments. However, these data are not available in a format compatible with tracking purposes.

Possibility of Tracking Other Marketing Effects Indicators

During the compliance certification process, the building department staff interacts almost solely with the builder or contractor. However, RER's Residential New Construction Market Effects study revealed that interaction between building department staff and builders or contractors typically occurs only if there are questions or problems with the submitted Title 24 compliance forms. As such, there appears to be little opportunity to ascertain other market effects through this method.

Market Actor(s)/Market Node(s)

Building department staff.

Geographic Scope

The protocol for each of the methods could be designed to capture data from any geographical region.

Data Format

Building departments vary with respect to their record keeping practices. Building departments generally keep the *compliance* documentation in hard copy format only, and departments differ in how these forms are organized and stored. Generally, these forms are clipped to the original plans submitted as part of the permit application procedure. However, in some cases the documents are stored separately in well organized files.

Reporting Frequency

Insofar as compliance certification is an ongoing activity in building departments, the frequency of data collection can be flexible. A decision on the frequency of data collection should be an element of the design of the data collection protocol.

Set-Up Procedure

Features of the set-up procedures for each of the methods include:

- ***Compliance Documentation.*** This method requires developing a system to collect the compliance form data from building departments periodically. There are roughly 500 building departments in California. As such, this data collection effort would require either a central clearinghouse for all compliance documentation (e.g., the data collection agent) or collection of a sample of the compliance forms. The latter requires a detailed sampling plan that, if needed, could support inferences by geographic zone.
- ***Verification Documentation.*** This method requires the design of a protocol to have building departments request the CF-6R and IC-1 forms in the residential sector and to require the collection of similar forms in the nonresidential sector and for these data to be collected periodically from the building departments. Requiring building departments to collect the verification data would require voluntary cooperation by all building departments or passage of a state regulation requiring the collection of these forms. Again, there are roughly 500 building departments in the California and the data collection effort would require either a central clearinghouse for the verification documentation or the collection of a sample of the compliance forms.
- ***Field Inspector On-Site Surveys.*** This method requires field inspectors to complete a brief form listing relevant data on equipment and shell measures. This would require the design of a survey instrument, setting up a central clearinghouse to receive, review, and record the survey data. More importantly, this method would need the cooperation of building department staff and or passage of a state regulation requiring the collection of the verification data. This method could be implemented as (1) a census, thereby requiring all building inspectors to fill out the survey for all inspected buildings, or (2) a statistical sample in which a sampling procedure would be developed.

Costs

The estimated costs associated with each method is presented below:

- ***Collect Compliance Documentation.*** The costs of collecting data from compliance documentation the first year would be roughly $100,000 to $150,000, assuming 1) a stratified sampling approach, 2) participation of 50 building departments, 3) an annual completed sample size of 5,000 residential and 1,500 nonresidential buildings, and 4) the data are collected quarterly.[7] This cost would include sample design, database development, data collection, data entry, and administration. The cost would vary depending on the level of cooperation from building department staff.
- ***Collect Verification Documentation.*** Given the availability of the verification

[7] The estimated sample of residential buildings is roughly a 5% sample based on the total number of building permits issued in 1997 (Construction Information Research Board).

data the costs should be similar to collecting the compliance documentation. However, given that collecting of the verification documentation by the building departments would be something done specifically for the tracking effort, this should cut down data collection costs. Costs for the first year would be roughly $50,000 to $80,000 assuming 1) a stratified sampling approach, 2) participation from 50 building departments, 3) a completed sample size of 5,000 residential and 1,500 nonresidential buildings, and 4) the data are collected quarterly. This cost would include sample design, database development, data collection, data entry, and administration. The cost would vary depending on the level of cooperation from building department staff.

- ***Implement Field Inspector On-Site Surveys.*** This method has the advantage of eliminating the need to deal with the varying record keeping practices of the numerous building departments to collect data. In particular, the data collected on site would be developed specifically for the tracking effort and would be sent directly to a central location for processing. The estimated cost for the first year is roughly $80,000 to $100,000 assuming 1) a statistical sampling approach were used, and 2) an annual completed sample size of 5,000 residential and 1,500 nonresidential buildings. This cost would include the sample design, the design of the survey instrument, implementation of the data collection protocols (assuming a central processing location), and data entry. The cost would vary depending on the level of cooperation from building department staff.

Time

In general, these three alternative methods could be put in place relatively quickly, certainly by mid-1999. However, these methods rely to varying degrees on the cooperation of building department staff. As such, the ultimate timing of these methods depends on the willingness of building departments to support the tracking effort. The CEC, CPUC, and CBEE could expedite the implementation of these methods by encouraging building departments to participate in this effort.

Major Companies

Not applicable.

Customization/Joint Venture Possibilities

There are engineering companies specializing in Title 24 compliance that have assembled considerable data from building departments on Title 24 compliance documentation. These companies might have developed contacts at each of the building departments that could be useful in developing tracking methods in a joint venture. In addition, there are organizations that track permit and construction data in California. These organizations have well developed relationships with building departments throughout California and could prove useful in collecting compliance data in a joint venture.

Advantages

Advantages of each of the methods include:

- ***Collect Compliance Documentation.*** The compliance documentation provides detailed equipment and shell measure data. All building departments presently collect this data. There are historical data are available.
- ***Collect Verification Documentation.*** The verification data provides detailed data on installed equipment and shell measures. Builders and contractors presently generate this data. There are some historical data available from building departments that presently require filing the verification documentation.
- ***Implement Field Inspector On-Site Surveys.*** The collected data would be tailored to meet the objectives of the tracking effort. The data would be sent directly to a central location eliminating dealing with varying building department filing practices. This method would also eliminate the need for sampling and, as such, a census of data on all construction activity in California would be collected.

Disadvantages

Disadvantages of each of the methods include:

- ***Collect Compliance Documentation.*** The biggest disadvantage of compliance documentation is the lag time between filing for a building permit and the actual construction. In particular, it is common for changes in equipment to take place, especially in the residential sector, with no change made to the compliance documentation.[8] The Title 24 regulations state that compliance documentation needs to be redone only if changes in equipment and/or shell measures cause the building to fall out of compliance.
- ***Collect Verification Documentation.*** The biggest disadvantage of this method is convincing the building departments to collect the verification forms and/or obtaining the passage of a regulation to require building departments to do so.
- ***Implement Field Inspector On-Site Surveys.*** Building department staffs tend to be small departments with relatively high workloads. As such, the biggest disadvantage of this method is gaining the cooperation of the building department inspection staff to gather data for a tracking system.

Information Sources

Discussions with various building department staff, California Energy Commission staff, and the Construction Industry Research Board.

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[8] There have been some studies recognizing this difference that have suggested ways to calibrate estimates of efficiencies and size based on secondary data.

5.7 Warranty Card Data

Description

Sales data can be collected via inclusion of a product tracking card included with the standard equipment literature. Equipment installers or final consumers would be asked to complete additional questions and mail the product tracking card to the data collection agent. Equipment model number and efficiency level can be derived from the bar code, and additional questions could be included to solicit additional information, such as purchase location (city/county), installation date, and the reason for the installation (e.g., new construction, retrofit, replacement, or other). Installers/consumers would be offered a gratuity as an incentive for returning the card.

Applicable Sector

Residential
Nonresidential

Applicable Measures

This covers measures that provide warranty cards and other installation materials and product information with the equipment. Measures identified as priorities in this study that could be included in a warranty card tracking system include water heaters, horizontal axis clothes washers, refrigerators, dishwashers, gas furnaces, central air conditioning, packaged air conditioning, and packaged refrigeration.

Applicable Decision Type

New construction
Retrofit/replace-on-burnout

Data Availability

Warranty card data include equipment model number (and therefore efficiency level) and any additional information desired, such as information pertaining to other market effects and market characteristics (i.e., the consumer's purchase decision process, geographic location of purchase, the market actor from whom the equipment was purchased, etc.).

Possibility of Tracking Other Marketing Effects Indicators

The warranty card return stub could be designed to include some brief questions relating to other market indicators. However, increases in the requirements for warranty card submittals will effect the response rate and increase survey response.

Market Actor(s)/Market Node(s)

Final consumers, plumbing and HVAC contractors, and/or any market actor installing the applicable measures.

Geographic Scope

Data by geographic region would be available only if questions were included on the card to collect such information.

Data Format

As desired.

Reporting Frequency

As desired.

Set-Up Procedure

Contact manufacturers; determine incentive; develop warranty card; distribute warranty cards to manufacturers willing to participate.

Costs

No cost estimates are available at this time.

Time

Recruiting manufacturer and/or distributor participation would require the most time. Based on the experiences in Wisconsin, this could take considerable time and effort.

Major Companies

RER is unaware of any major companies that sell warranty card services.

Customization/Joint Venture Possibilities

Not applicable

Advantages

Sales by efficiency level would be available; information is solicited directly from the consumer or the installing contractor; it is possible to obtain data by geographic region; possible to collect additional information on other market effects.

Disadvantages

Self-selection bias could be a problem; the inclusion of response cards with equipment warranty information requires the participation of manufacturers; it may be difficult to track only California products and imported equipment.

Information Sources

None at this time.

5.8 Interviews with Market Actors

Description

Interviews with key market actors can be used to collect information regarding a broad range of topics and can be customized to meet the specific needs of the client. Interviews can be conducted via telephone or in person, and can be as structured or unstructured as desired. Interviews are typically conducted by personnel trained in survey research and interviewing techniques that enable the interviewer to obtain the desired information without biasing or leading responses. Interview respondents are often offered incentive payments or other compensation to encourage their participation.

Applicable Sector

Residential
Nonresidential

Applicable Measures

Interviews can be designed to collect information on nearly any product, equipment type, or topic.

Applicable Decision Type

New construction
Retrofit/replace-on-burnout

Data Availability

This method is most appropriate for collecting data of a qualitative nature. Such information relevant to this study includes market characteristics, interactions between key market actors, attitudes, perceptions, and other market effects indicators. Sales and other quantitative data might be available to a limited extent, provided the interviewee can prepare and have the necessary information ready before the interview. Such data might include efficiency level mixes of production, inventory stock, and/or sales.

Possibility of Tracking Other Marketing Effects Indicators

Market actor interviews would be very useful for tracking other market effects indicators and market characteristics. Interview questions, however, should be carefully developed to minimize self-report bias. However, because of the qualitative nature of the information retrieved with this method, intertemporal comparisons of data are not recommended.

Market Actor(s)/Market Node(s)

Interviews can be designed to solicit information from any or all market actors.

Geographic Scope

Information can be obtained from market actors in any specified region.

Data Format

As desired.

Reporting Frequency

As often as necessary.

Set-Up Procedure

Hire survey research firm to conduct interviews; develop interview guide(s); train interviewers; pretest interview guide(s); administer interviews; prepare results and conclusions.

Costs

Costs vary depending on the length of the interview and frequency and mode of administration.

Time

The time required to set up this method is minimal and depends largely upon the time required to develop the interview guide(s).

Major Companies

Many survey research and consulting firms can be hired to conduct interviews.

Customization/Joint Venture Possibilities

Not applicable.

Advantages

Interviews with market actors can be designed to collect information about other market effects and could be particularly useful in developing market characterizations; can be used to gather qualitative information to investigate and explain trends in shares uncovered through other tracking methods; interviewer can probe the respondent for additional information, to clarify answers, or to investigate additional discussion topics as deemed necessary.

Disadvantages

This method is not as appropriate for collecting quantitative data as other survey methods; potential for self-report response bias; interview guide needs to be designed to minimize respondent burden; can be costly; not as appropriate for collecting time series data as other methods because it relies on the interviewer’s questioning and probing techniques to gather the desired information.

Information Sources

RER staff.

5.9 Downstream Market Actor Surveys

Description

Surveys of downstream market actors can be administered via mail, telephone, or on-site visits to solicit data pertaining to a broad range of topics.[9] Those relevant to this study include the efficiency levels of energy-using equipment recently purchased by the final end user, other purchasing and decision-making practices regarding energy-using equipment, and demographic or firmographic characteristics. Respondents are often offered incentive payments to encourage participation.

Applicable Sector

Residential
Nonresidential

Applicable Measures

Surveys of downstream market actors can be customized to collect information required for the tracking system. Although this method can be used to gather data for nearly all of the measures identified as priorities in this study, applicable measures vary by survey method.

- ***Mail and Telephone Surveys.*** Mail and telephone surveys of downstream market actors are most appropriate in obtaining data about measures with which consumers are most familiar and can easily access. In the residential sector, these measures include refrigerators, dishwashers, clothes washers, and possibly compact fluorescent bulbs. Collecting measure-specific data in the nonresidential sector using these methods is more problematic and is not recommended.
- ***On-Site Surveys.*** On-site surveys can be designed to collect efficiency data for all residential and nonresidential priority measures, provided the equipment is accessible by the on-site surveyor.

Applicable Decision Type

New construction
Retrofit/replace-on-burnout

Data Availability

Data availability varies by survey type.

- ***Mail and Telephone Surveys.*** The respondents' knowledge of and willingness to inspect the measures limit the availability of information on equipment characteristics. However, data on a variety of other market effects indicators can

[9] For purposes of this report, RER considers downstream actors to be actors on the demand side of the market. In the residential sector, these tend to be end users (customers) and on the nonresidential side, these are typically building owners, managers, facility managers, and facility engineers (more broadly customers or building occupants).

be collected including, prices paid for equipment, operation and maintenance practices, and purchasing and decision-making practices.

- ***On-Site Surveys***. Substantial details on measure characteristics are available from on-site visits. Knowledgeable technicians familiar with energy-using equipment and building practices usually conduct on-site visits. The data collected are limited only by accessibility to the equipment. Data on other market indicators are also available provided a knowledgeable site contact is assigned to assist in the on-site visit.[10]

Possibility of Tracking Other Marketing Effects Indicators

Mail, telephone, and on-site survey instruments can be designed to collect information on some market effects and market characteristics.

Market Actor(s)/Market Node(s)

Consumers in the residential sector.

The downstream market actors in the nonresidential sector vary, depending on the building type. Examples include building owner, building manager, facility manager, facility engineer.

Geographic Scope

Sampling design can be customized to collect data from downstream market actors in any geographic region.

Data Format

Mail, telephone, and on-site survey data can be supplied in any number of formats. Most telephone surveys now use a computer-assisted system that permits direct entry of survey responses into a database. There are some limits to this approach depending on the number of open-ended questions. On-site survey instruments tend to be more complex and require relatively more time to specify a data entry protocol and to develop the final.

Reporting Frequency

Mail, telephone, and on-site surveys can be implemented and data can be provided as often as necessary and plausible. The sample size and length of survey would affect the frequency of on-sites significantly.

Set-Up Procedure

There are four major elements to implementing a mail, telephone, or on-site survey. These include sample design, survey instrument design, survey implementation and database development. There are firms that can provide all of these services. However, it is more

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[10] Some survey efforts entail a combination of on-site visits and telephone follow-ups to collect data on other factors.

common to contract with a firm that is responsible for the sample design, survey instrument design, and who subcontracts to firms specializing in data collection.

Costs

Costs vary according to mode of administration, survey length, sample size, and frequency of implementation. On-site surveys are costly but will yield the most accurate data of efficiency levels of equipment installations. Some typical costs are provided below.

- ***Mail Survey.*** Costs per completed survey vary by availability of contact names and addresses, initial sample size, and completion rate. Some economies of scale are achievable when conducting mail surveys due to printing and processing charges. A typical ten-page mail survey, with an initial sample of 5,000 and an anticipated completion rate of 30% will cost $12 to $15 per competed survey.
- ***Telephone Survey.*** Costs per completed survey vary by availability of contact names and telephone numbers, survey length, completed sample size, required type of respondent, and the number of open-ended questions. Some economies of scale are achievable when conducting telephone surveys due to fixed set up costs.[11] A typical 15-minute telephone survey, with a completed sample size of 1,000 will cost $15 to $20 per competed survey.
- ***On-Site Survey.*** Costs per completed on-site survey vary by level of detail of the data collection, building type and size, required expertise of the on-site surveyor needed to complete the survey, geographical dispersion of the sample, and availability of contact names and addresses. Costs vary considerably from the residential to the nonresidential sector. The cost for a residential on-site lasting a one to two hours would be roughly $150 to $250 per completed survey. The cost per completed survey in the nonresidential sector could range from $250 to $1,000.

Time

Mail and Telephone Surveys. Mail and telephone surveys could be developed and administered relatively quickly, certainly within three to four months.

On-Site Surveys. On-site surveys would take longer to setup and implement due to the typically complex sample design, survey instrument, and length of time to complete the on-site.

Major Companies

Many survey research companies and consulting firms will administer telephone and mail surveys; on-site surveys are typically conducted by engineering firms.

[11] The type of respondent affects the number of callbacks per contact and to some extent the expected response rates. These factors heavily impact cost estimates for telephone surveys. Typically, commercial surveys cost more than residential surveys because it is more difficult to contact a knowledgeable person willing to complete the survey in the commercial sector.

Customization/Joint Venture Possibilities

See Subsection 5.11 below for a discussion of incorporating market share tracking needs into possible future customer-level data collection activities conducted by the California Energy Commission.

Advantages

Advantages of mail, telephone and on-site surveys include:

- ***Mail Surveys.*** Mail surveys are relatively cheap, less intrusive, and can be implemented relatively quickly. Mail surveys can be used to pre-screen consumers for recent purchases of equipment and to track other market effects indicators and attitudinal information, such as consumer awareness, perceptions of energy-efficient measures, decision-making practices, operation and maintenance practices, etc.
- ***Telephone Surveys.*** Telephone surveys can be implemented relatively quickly. Interaction with telephone interviewer can assure that the correct person is responding to the survey. Further, interaction with the telephone interviewer expands the usefulness of open-ended questions. Telephone surveys can be used to pre-screen consumers or as a follow up for recent purchases of equipment and to track other market effects indicators and attitudinal information, such as consumer awareness, perceptions of energy-efficient measures, decision-making practices, operation and maintenance practices, etc.
- ***On-Site Surveys.*** On-site surveys yield the most accurate data of actual equipment installations. Face-to-face meeting with an appropriate on-site contact enables the collection of other market effects indicators and attitudinal information, such as consumer awareness, perceptions of energy-efficient measures, decision-making practices, operation and maintenance practices, etc.

Disadvantages

Disadvantages of mail, telephone and on-site surveys include:

- ***Mail Surveys.*** Mail surveys tend to suffer from self-selection bias. Further, one can not ensure that the most appropriate, knowledgeable person is completing the survey.
- ***Telephone Survey.*** Telephone surveys suffer from self-selection bias.
- ***On-Site Surveys.*** On-site surveys are relatively expensive, intrusive, time consuming, and suffer from self-selection bias. Participation rates for on-site surveys tend to be lower than mail or telephone surveys.

Information Sources

Commercial survey research firms specializing in on-site, mail, and telephone surveys; RER staff.

5.10 Upstream Market Actor Surveys/Data Collection

Description

This tracking strategy involves either the surveying or collecting of shipments or sales data from upstream and midstream market actors, including manufacturers, distributors, and installation contractors.

- ***Surveys.*** Surveys of upstream and midstream market actors can be administered via mail or telephone to solicit data pertaining to a broad range of topics. Topics relevant to this study include efficiency levels of energy-using equipment for either new construction or as a retrofit/replace-on-burnout installation, other purchasing and decision-making practices regarding such measures, and firmographic and other market characteristics. Respondents are often offered incentive payments to encourage participation.
- ***Data Collection.*** Collecting data from upstream and midstream market actors would be modeled after the tracking system currently in place in Wisconsin, which involves the collection of residential heating and cooling equipment sales data from HVAC distributors throughout the state. Because this study covers HVAC and non-HVAC measures in both the residential and nonresidential sectors, RER researched data collection from not only distributors, but other market actors as well.[12]

There is a subtle difference between these two methods. The Wisconsin experience indicates more success with a less intrusive system that focuses on data collection. Further, they recognized that regular surveys of the same market actors tended to be perceived as adding more work when compared to submitting existing data on sales and shipments. Appendix J presents a detailed discussion on collecting data from upstream and midstream market actors.

Applicable Sector

Residential
Nonresidential

Applicable Measures

Surveys and data collection systems can be designed to collect information on nearly any product, equipment type, or topic.

Applicable Decision Type

New construction
Retrofit/replace-on-burnout

[12] The review of markets presented in Section 4 and the Wisconsin tracking experience reveals that, because of the inherent differences in measures and their distribution channels, tracking the sales of different measures requires that data be collected from different points (e.g., from different market actors) in the distribution system.

Data Availability

Data availability for surveys and data collection include the following:

- ***Surveys.*** A wide range of data can be available through telephone and mail surveys of upstream and midstream actors, depending on the market actor surveyed and/or the node of the market at which the data are collected. Quantitative data that may be available include the efficiency levels of shipments, efficiency mixes of production, inventory, or sales, price data, model numbers, operation and maintenance practices, purchasing and decision-making practices, and other market effects indicators and market characteristics.
- ***Data Collection.*** The most logical vehicle for collecting sales or shipments data by efficiency level might appear to be a mail or telephone survey, through which the market actor reports sales of equipment by predefined efficiency levels. However, the experience in Wisconsin reveals that a more successful approach is to collect sales data from the market actor in their format of choice. The data collecting/analytical agent is then responsible for converting all data into a common and usable format. The Wisconsin experience shows that most, if not all, distributors have different methods of record keeping. Administering a survey that defines the data format will impose constraints and additional work for distributors and other market actors and, therefore, would be a disincentive for their participation and detrimental to the system's success.

Possibility of Tracking Other Marketing Effects Indicators

Tracking of other market effects varies by method.

- ***Surveys.*** Mail or telephone surveys offer the possibility of tracking other market indicators beyond shipments and/or sales data. This can include information on stocking practices, attitudes, and changes in production.
- ***Data Collection.*** Data collection focuses on reporting shipments and/or sales data only.

Market Actor(s)/Market Node(s)

The sampling approach can be designed to target any upstream market actor or market node. The appropriate point for implementing surveys and data collection in the distribution channel depends largely upon the measure.

Geographic Scope

The sampling approach can be designed to collect data from market actors in any geographic region, including a comparison region.

Data Format

There are a few major issues relating to data format when considering these two methods:

- ***Surveys.*** Insofar as mail and telephone surveys are designed from the ground up, data formats can be specified as part of the survey design.

- ***Data Collection.*** Data collection efforts are most successful when the work required of the respondent is minimized. Typically, this implies that data on shipments and sales is delivered in a variety of formats. This can include formats ranging from hard copy data to detailed spreadsheets or customized software output.

Reporting Frequency

Either of these methods would support reasonable reporting frequencies.

Set-Up Procedure

The development of an upstream market actor tracking system using either a survey or data collection focus entails the following, sometimes overlapping, steps: 1) become familiar with the market and develop a relationship with market actors, 2) construct sample design and recruit data suppliers, 3) determine the method for data collection, and 4) negotiate agreement with data suppliers. See Appendix H for the protocol followed in Wisconsin.

Costs

Survey. Costs vary according to mode of administration, survey length, sample size, and frequency of implementation. Some typical costs are provided below.

- ***Mail Survey.*** Costs per completed survey vary by availability of contact names and addresses, initial sample size, and completion rate. Insofar as the number of targeted upstream market actors would be small, a rigorous multiple mailing protocol is required to ensure a reasonable response rate. Cost for a mail survey is $12 to $15 per competed survey.

- ***Telephone Survey.*** Costs per completed survey vary by availability of contact names and telephone numbers, survey length, completed sample size, required type of respondent, and number of open-ended questions. Some economies of scale are achievable when conducting telephone surveys due to fixed set-up costs. Telephone surveys of upstream market actors require telephone interviewers knowledgeable with the objectives of the tracking survey. This will increase the cost. A typical 15-minute telephone survey will cost approximately $20 to $25 per competed survey.

Data Collection. The costs of developing a market share tracking strategy that involves the collection of data from upstream market actors varies according to the following:

- The number of market actors required to be recruited as data suppliers, which is directly related to 1) the type of market actor supplying the data (for example, fewer distributors would need to supply data than contractors to cover the same proportion of the market), and 2) the number of measures for which sales data will be collected,

- The time needed to recruit data suppliers, which is a function of travel time and costs and the time needed to become familiar with the market and develop a relationship with the market actors, and

- The time and effort required to develop a system that will convert all data into a common and usable format.

The development of the HVAC distributor data tracking system in Wisconsin took approximately six to eight months and cost roughly $100,000.

Time

Surveys. Mail and telephone surveys could be set up and implemented relatively quickly, certainly within three to four months. Administering a survey could require less set-up time; however, the Wisconsin experience reveals that a survey would be less successful.

Data Collection. The data collection agent for the Wisconsin tracking initiative explained that setting up a data collection tracking system with upstream market actors could take at least several months.

Major Companies

Many survey research companies and consulting firms will administer telephone and mail surveys. In addition, a variety of companies could serve as the data collection agent.

Customization/Joint Venture Possibilities

There would be tremendous advantages in forming an alliance with one or more trade or government organizations whose membership is comprised of a variety of upstream and midstream market actors. The organization would then serve as a liaison between the market actors and the data collection and/or analytical agent(s).

The involvement of one or more organizations in a market share tracking strategy can be on one of two levels:

1. At a minimum, the organization(s) can provide support and help to recruit data suppliers. This role would include identifying all potential market participants, making the initial contact and arranging meetings between the data collecting agent and the market actors, helping to forge agreements for the submission of data, and other tasks supportive of recruiting data suppliers.
2. In addition to a supportive role in recruiting data suppliers, the organization(s) would serve as the data collection agent. This role would include collecting and converting the data into a common and usable format, providing quarterly reports to the analytical agent, and providing the data suppliers with any agreed upon deliverables in return for providing their sales data.

RER has identified the ENERGY STAR® program as one such opportunity. See Subsection 5.11 below for a discussion of the ENERGY STAR® program and the potential for coordinating efficiency market share tracking with data collection under the ENERGY STAR® program.

<u>*Advantages*</u>

Surveys. Advantages of mail and telephone surveys of upstream market actors include the following:

- ***Mail Surveys.*** Mail surveys are relatively cheap, less intrusive, and can be implemented relatively quickly. Mail surveys can be used to track other market effects indicators and attitudinal information, such as consumer awareness, perceptions of energy-efficient measures, decision-making practices, operation and maintenance practices, etc. Data would be available in a consistent format.
- ***Telephone Surveys.*** Telephone surveys can be implemented relatively quickly. Interaction with the telephone interviewer can assure that the correct person is responding to the survey. Further, interaction with the telephone interviewer expands the usefulness of open-ended questions. Telephone surveys can be used to track other market effects indicators and attitudinal information, such as stocking practices, changes in manufacturing techniques, and marketing efforts.

Data Collection. The following are advantages of the data collection tracking strategy:

- Enables the collection of sales data for equipment that is not easily accessible by consumers (e.g., HVAC equipment),
- Possibility of tracking additional measures not identified as priorities, particularly from distributors and retailers, and
- Sales by geographic region (state and smaller-than-the-state) could be derived from distributor and contractor data.

Additional benefits could be realized through an alliance with a trade organization include:

- Forming an alliance with a trade organization could reduce the time needed to recruit data suppliers,
- Market actors would be more willing to release proprietary data to a trade organization rather than a consultant, utility, or government agency,
- The EGIA, in particular, is familiar with the energy efficiency industry in California and could provide a valuable link between upstream market actors and data collection and/or analytical agents, and
- The EGIA has data collection and processing capability and experience.

<u>*Disadvantages*</u>

In general, the data collected would not represent actual installations, and recruiting and maintaining the participation of data suppliers could be time intensive. There is the potential for low participation if a survey was used instead of direct data collection. Further, depending upon the market actors providing the data, segmentation by geographic region and/or decision type might not be feasible. Other issues are discussed below.

Surveys. The following are some disadvantages of using mail and telephone surveys include:

- ***Mail Surveys.*** Mail surveys tend to suffer from self-selection bias. Further, one can not ensure that the most knowledgeable person is completing the survey.
- ***Telephone Survey.*** Telephone surveys suffer from self-selection bias.

Data Collection. The following are disadvantages tracking market shares with data from distributors and contractors:

- Recruiting data suppliers might be difficult and time intensive.
- Depending on the market actors supplying the data (e.g., manufacturers), market shares by region might not be ascertainable.

Disadvantages specific to forming an alliance with a trade organization, include the following:

- Nonmember market actors would need to be recruited because 1) trade organization membership is not likely to include every market actor, 2) trade organization membership might not be representative of the population, and 3) trade organization membership might not be statewide.[13]
- Data by decision types might not be available or accurate because data would be collected from upstream rather than downstream market actors.
- There may be a possible conflict of interest with the EGIA because they implement or have implemented energy efficiency programs for PG&E.

Information Sources

RER staff; discussions with EGIA and other organizations.

5.11 Examples of Collecting Data from Downstream and Upstream Market Actors through Joint Ventures

Subsections 5.9 and 5.10 above provide general descriptions of downstream market actor surveys and data collection from upstream market actors as alternatives for market share tracking. However, throughout the course of this research, RER identified unique “joint venture” opportunities for efficiency market share data collection that offer significant economies. These opportunities include incorporating tracking into possible future data collection efforts of the California Energy Commission (CEC) and ongoing data collection under the DOE/EPA ENERGY STAR® program. Each of these opportunities are introduced below, and are discussed in more detail in Sections 9 and 10.

[13] Tim Michels, Executive Director of the EGIA, explained that the EGIA is in the position to recruit both EGIA members and nonmembers as data suppliers.

California Energy Commission Customer Surveys

Background

On September 25, 1998, the CEC's Demand Analysis Office presented a proposal to the California Board for Energy Efficiency (CBEE) for co-funding the CEC's data collection efforts. Until this year, customer surveys and the Database for Energy-Efficient Resources (DEER) updates were funded and performed by the utilities through DSM funds. Because this funding source is no longer available, the CEC sought funding from the CBEE to supplement funds requested by the CEC in its budget change proposal (BCP). The proposal submitted to the CBEE provided background on the CEC data collection efforts and summarized the budget requirements for continuing the survey implementation and DEER updates through 2002.

During its September 25 1998 meeting, the CBEE did not commit to fund CEC data collection for all four years included in the proposal, but agreed to earmark funding for the first year of the data collection effort in 1999 and return to the issue of future funding after more experience was gained in designing joint projects.

> "After discussion, the CBEE recommended that the CPUC direct the Interim Administrators to put $2.1 million in 'placeholder' funding in their filings for 1999 only. In addition, the CBEE's support for funding for these activities will depend in part on successful resolution of issues such as availability of information produced from these surveys to market participants, the CBEE and Interim Administrators, review of the survey questions, etc."[14,15]

On January 13, 1999 the CBEE's technical service consultants (TSCs) presented their understanding of the use of the $2.1 million:

> "… fund DEER; for remainder, [provide] support for survey activities, with stated priority for commercial survey amongst the sectors (but not necessarily limited solely to commercial survey in [the] event [that] some PCG [funds] could result in higher value by also providing some support for other surveys), but direction was to shape use of the money as well as possible to meet both CEC and CBEE information needs."[16]

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[14] California Board for Energy Efficiency Meeting Minutes, September 25, 1998.

[15] The CBEE determined $2.1 million was determined according to priorities for 1999 data collection - $1.75 million for the commercial survey and $0.4 million for DEER database update. These figures were presented in the CEC's September 25, 1998 proposal to the CBEE.

[16] MA&E Issues at January 13 CBEE Meeting. Proposed Order of CBEE Decisions and Related TSC Recommendations, January 13, 1999.

To provide guidance to the CBEE regarding future CEC data collection funding issues, the TSCs also recommended that the CBEE adopt their understanding of the use of funds as stated above. As noted in the minutes of the January 13, 1999 CBEE meeting, the CBEE voted unanimously to award the CEC $2.1 million of MA&E funds for data collection activities.

> "Regarding III B, the technical consultants understanding of an earlier Board recommendation on funding to the CEC for specific load forecasting and energy efficiency database projects, the Board reaffirmed the summary contained in Item IIIB. The CEC will keep the Board apprised of its efforts to obtain co-funding as well as make information collected in the surveys more available to the public and useful to stakeholders interested in energy efficiency. This motion passed with a vote of 6-0…"[17]

The final transfer of funds is dependent upon CPUC authorization of the MA&E budgets in the 1999 program budget filings.

RER met twice in person and had numerous telephone discussions with CEC staff to discuss the potential for using CEC customer surveys to track market shares of key energy efficiency measures. If a series of logistical problems can be resolved, the CEC's survey efforts could play an important role in the development of a statewide tracking system for both residential and nonresidential energy efficiency measures. The remainder of this subsection discusses the results of these meetings.

CEC Survey Proposal

The CEC's proposal to the CBEE identified two surveys that show some promise as elements of a tracking system: a commercial survey and a residential survey.[18] The preliminary designs of these surveys are presented below.

Commercial Survey. In its September 25, 1998 proposal to the CBEE, the CEC explained that the commercial customer survey would entail conducting roughly 8,000 on-site surveys. These surveys would be conducted biannually, with data collection and analysis each taking several months to complete. The estimated cost for the on-site surveys was estimated to be $4 million, or $500 per survey.[19] RER's understanding is that this sample size is not definite and could vary

[17] California Board for Energy Efficiency, Minutes for the Meeting of January 13, 1999.

[18] The CEC industrial surveys focus on specific industries and would be phased over time. In essence, they would be case studies. Both RER and CEC staff agreed that the industrial survey would probably not be as useful for market share tracking as the residential and commercial surveys because of its focus on selected industries.

[19] This estimate does not include funding for the average equipment energy use follow-up study or the load-metered sites customer characteristics analysis.

depending on the per-unit cost. The CBEE agreed to recommend the earmarking of $1.75 million for this effort in 1999.

Residential Survey. The CEC's proposal for the residential customer survey entails conducting roughly 100,000 mail surveys and 2,000 on-site follow-up surveys. Again, the surveys would be conducted biannually. Because the residential survey was just conducted in 1998, it would not scheduled to be conducted again until the year 2000. The CEC's estimated cost for the residential surveys was estimated at $4 million.[20]

Steps Needed to Use the CEC Surveys for Market Share Tracking

The results of RER's meetings with the CEC suggest that the CEC is willing to further investigate the possibility of incorporating market share tracking into their data collection effort. We are particularly interested in two applications of these survey efforts:

- The direct use of the commercial survey to collect customer-level information on efficiencies of recent equipment purchases.
- The use of the residential mail survey as a means of identifying residential customers who have recently purchased lighting and/or appliances.

It would also be possible to use the residential on-site survey results, but this would almost certainly require the oversampling of households who had recently purchased equipment. In this event, the on-site surveyor would simply use the survey to record the model number and/or other information needed for market share tracking. However, oversampling these homes could have serious drawbacks for the CEC's forecasting-related sample design, and may not be feasible. An alternative would be to have a separate non-CEC telephone and/or on-site survey of the homes reporting purchasing activity.

Some design changes to the CEC surveys would be necessary to accommodate these two primary uses. These changes include the addition of some questions in the questionnaires, the acceleration of the implementation of the residential and commercial surveys, and the phasing of these surveys on a quarterly basis.

- ***Questionnaire Designs.*** The residential mail survey questionnaire would not need substantial revisions to accommodate the CBEE's tracking needs, primarily because it would be used only to identify sites where new equipment was purchased or measures were replaced on burnout. Questions on recent acquisitions and replacements traditionally have been included in utility appliance saturation surveys, and would presumably be included in the CEC questionnaire one way or the other. The commercial mail survey also would need only minor changes to

[20] This estimate does not include funding for the average equipment energy use follow-up study or the load-metered sites customer characteristics analysis.

accommodate the collection of the appropriate tracking data. Again, utility instruments have included a variety of questions on equipment characteristics and recent equipment purchases, and these would presumably be retained by the CEC. Overall, we anticipate that tailoring the CEC instruments for the collection of tracking data would add little to the lengths of these instruments or field time.

Although the CEC recognizes the need and is willing to accommodate additional questions in the customer surveys, it is necessary to ensure that the survey length remains reasonable. Furthermore, CEC staff is dedicated to revising the survey instrument to yield more useful and more accurate data. This will involve not only revising and pretesting the questionnaire to reduce the number of “don’t know” and “not applicable” responses, for example, but will also require more thorough training and monitoring of on-site surveyors. Mark Ciminelli, the manager of the commercial survey, expressed interest in working with all involved parties in developing a survey that will be useful to both the CBEE and the CEC.

- ***Frequency of Survey Implementation.*** The current plan is to implement CEC customer surveys on a two-year cycle. This is similar to the approach previously used by the utilities to support the Common Forecasting Methodology (CFM) process. In this plan, surveys would be administered during the first year and data analysis would be conducted during the second year. This cycle has served the CEC forecasting needs well, but would be disadvantageous for market share tracking. Given the CBEE’s four-year outlook (the “transition period” until 2002), the CEC’s two-year cycle would produce only one data point for market shares.

  RER proposes that the CEC consider implementing the customer surveys on a quarterly basis. This will provide an adequate number of data points for market share tracking. The CEC could then combine the quarterly data to meet its forecasting needs. Implementing surveys on a quarterly basis implies the following:

  1) Surveys will need to be conducted *statewide* on a quarterly basis, which will be more costly than conducting all surveys at the same time.

  2) The total number of completed surveys will not change, rather, they will be conducted in phases during the two-year period.

  3) Conducting the on-sites on a quarterly basis could provide advantages relating to the quality of the fieldwork. A contract for ongoing quarterly data collection could provide data collection contractors with baseload work for a long period. This might mean that they would be able to hire full-time surveyors for the contract, which could result in more better survey results and more accurate data.

- ***Oversampling New Construction.*** It was suggested that oversampling new construction sites could be beneficial for the CBEE’s tracking needs, insofar as new construction constitutes an important market event. RER will recommend systems for tracking market shares of new construction, retrofit, and replace-on-burnout installations, and oversampling new construction sites would make the

CEC surveys more useful in this regard. While the CEC did not commit to oversampling new construction, they are very aware that oversampling could have benefits for the development of marginal EUIs, UECs, and saturations to be used in forecasting.

- ***Acceleration of the Commercial and Residential Surveys.*** Another issue with respect to timing is the implementation of the surveys. According to the CEC, it might be possible to begin commercial survey implementation by the late spring of 1999. While this would require the acceleration of retaining data collection contractors, it would serve the purposes of market share tracking well. If data analysis takes place about one month after the completion of each quarter's round of surveys, initial tracking results could be ready by early autumn.

  In order to spread out data collection activities to match available funds, the CEC did not plan to begin the residential survey until 2000. This will clearly be too late for the purposes of market share tracking. To support the needs of tracking, some means of accelerating the residential survey initiation (say, to the spring of 1999) will need to be determined.

Logistical Problems

Several logistical problems must be confronted and overcome to permit the use of the CEC surveys for tracking market shares of energy efficiency measures. These problems are discussed below.

- ***Confidentiality.*** Confidentiality refers to the data supplied by the utilities (billing data in particular) and collected via customer surveys. Survey data is automatically confidential, but the confidentiality of the sampling and billing frame data supplied by the utilities is another issue that must be addressed.
- ***Obtaining sampling frame and billing data from utilities.*** The CEC's biggest concern and obstacle at this point is obtaining a sampling frame and billing data from utilities. These are necessary for implementation of the customer surveys. Utilities are hesitant to supply billing frame data to a state public agency, but might be more amenable if the surveys are used for market share tracking. If the CBEE assists the CEC in this regard, the CEC's overall efforts will clearly benefit.
- ***Funding.*** Funding for the data collection is still unclear and unresolved (e.g., BCP approval, CPUC approval of the CBEE budget). Moreover, the CBEE has earmarked 1999 funds only for the commercial survey and DEER updates. As discussed above, if the residential survey was used to collect market share data, it would have to be funded somehow in 1999. One option is for the CBEE to allocate funds for this purpose.
- ***CEC Contracting Mechanism.*** The CEC contracting mechanism is time-consuming and constitutes a major obstacle for this effort. Time is quickly becoming a critical factor for CBEE's tracking needs. Given the deliberate pace of

the public procurement process, an RFP will need to be submitted to the CEC Contracts Office by the end of December in order for contractors to be selected during the current fiscal year. One possible solution to this timing problem is to begin the data collection efforts under an *existing* contract with the CEC.

<u>*Summary of Advantages and Disadvantages*</u>

Making use of CEC surveys to track market shares of some technologies will obviously have some advantages and disadvantages, as summarized below.

Advantages include:

- Infrastructure is already in place and CEC staff has been using these surveys since the mid-1970s.
- By oversampling new construction, downstream tracking could allow for distinction by decision type of installation.
- Enables the tracking of other market effects, providing the surveys are not bogged down with too many questions.
- Market share tracking should be a long-term commitment (i.e., should continue beyond CBEE's four-year outlook). The CEC is good candidate for long-term data collection.
- Data would also be disaggregated on a regional level – by weather zone, utility area, county, etc.
- This process might motivate utilities to provide CEC with sample frame and billing data.

Disadvantages include:

- Additional costs/funding required in 1999.
- CEC contracting mechanism is slow.
- Need to convince utilities to provide sampling frame and billing data and address confidentiality issues.
- CEC will need to change normal procedure – conducting surveys on a quarterly basis statewide. This introduces some logistical issues.
- Political environment might not be amenable to increased role of the CEC.

Summary of ENERGY STAR® and Current Data Collection Efforts

ENERGY STAR® is a joint program of the U.S. Department of Energy (DOE) and the Environmental Protection Agency (EPA). The purpose of this program is to encourage the development of a sustainable consumer market for energy-efficient technologies by educating consumers and creating partnerships with manufacturers, retailers, and utilities. The focus of the ENERGY STAR® program is the ENERGY STAR® label. A product receives the distinctive ENERGY STAR® label if it exceeds the Federal energy efficiency standards by a specified amount. Typically, a product must be 13% to 25% more efficient than the Federal standard to receive the label, though in some cases (e.g., clothes washers) the requirement is 111%.[21] If there are no Federal minimum energy use standards for a specific appliance, the product may earn the ENERGY STAR® label if it has special energy-saving features that enables it to use less energy than similar products. For example, computer monitors with a "sleep" mode earn the ENERGY STAR® label.

The ENERGY STAR® program covers the following products:

- Room air conditioners,
- Clothes washers,
- Dishwashers,
- Windows and doors,
- Refrigerators,
- Lighting fixtures,
- Televisions and VCRs, and
- Various plug-load office equipment, including copiers, fax machines, multifunction devices, printers, scanners, computers, and monitors.

The important aspect of the ENERGY STAR® program relating to market share tracking is the retail partnership arrangement. ENERGY STAR® Retail Partners receive free point-of-purchase and sales training materials, listing on the ENERGY STAR® website and Federal consumer information hotlines, access to utility and manufacturing programs, and leverage from ongoing national brand awareness campaigns. In return, Retail Partners agree to 1) label qualifying products, 2) display the point-of-purchase materials and brochures, 3) advertise and offer promotions on the ENERGY STAR®-labeled product, 4) train retail staff using ENERGY STAR® promotional materials, and 5) <u>provide sales data for tracking and other analytical purposes</u>.

[21] Note that Federal standards do not yet apply to front-loading washers.

Transactions data are obtained from nearly all Retail Partners for both ENERGY STAR® and non-ENERGY STAR®-qualified products, though the data fields collected from the Retail Partners vary. There are currently 18 Retail Partners representing over 1,100 storefronts nationwide:

- 49er Window & Door
- Alexander's Appliances
- BGE Home Products and Services Inc.
- Circuit City Stores Inc.
- Conser Homes Inc.
- Deranleau's
- G&T Enterprises
- Goldcoast Ltd.
- Home Base
- Howard's TV & Appliance
- Liberty Appliance
- Montgomery Ward
- Mosee Brothers Inc.
- Pacific Sales
- Renwes Appliances
- The Hodges Company
- TOPS Appliance City
- Warehouse Discount Center

These Retail Partners account for nearly 15% of the retail market for the products covered by the ENERGY STAR® program.[22] They are currently under negotiation with Sears to become a Partner, at which point they will cover from 25% to 40% of the retail market, and are also negotiating an agreement with Best Buy. Data are not obtained from non-ENERGY STAR® Retail Partners, which are typically smaller, independent stores, representing about 40% to 50% of the California market.

[22] In addition to the Retail Partners, there are six Retail Buying Group partners, Utility Partners, 91 Manufacturer Partners, four Government Partners, and two Energy Service Partners. California Utility Partners include PG&E, SMUD, SDG&E, and SCE.

6

Methods Assessment Summary

This section summarizes the implications for tracking resulting from the market reviews as presented in Section 4 and the methods review in Section 5. While the implications for tracking and appropriate tracking methods varied across priority measures, the focus of this section is to provide some general observations and to point out obvious exceptions, rather than tediously present every conclusion. Subsection 6.1 provides some general observations about the appropriate market nodes at which useful data can be obtained, and Subsection 6.2 summarizes the available tracking options for priority measures.

6.1 Summary by Market Actor

Manufacturers

For most measures, manufacturers cannot provide shipments data at a level specific enough for tracking market shares by efficiency level, decision type, and state-level geographic region. This is particularly true for industries in which manufacturing is dominated by a handful of producers that have well developed channels of distribution. These manufacturers do not have the mechanism or the desire to track product sales to the retail level.

However, manufacturers might be able to provide useful tracking data in industries that have a less-concentrated manufacturing industry (e.g., residential windows), or with a relatively low production volume (e.g., chillers).

Distributors

Some distributors in some markets appear able to provide data specific enough to meet market share tracking needs in California. First, state-level sales data would be fairly reliable from distributors, even though some distributor sales regions might cross state boundaries. Second, to the extent that distributors can identify sales to builders or contractors working primarily in the new construction market, distributors can supply data by decision type. Third, fewer distributors would be required to supply data than contractors or retail establishments to cover the same portion of the market.

There are a few exceptions. First, measures such as motors, ASDs, and compressed air equipment, are primarily retrofit measures installed at the site and distributors are not likely to be involved in these transactions. Furthermore, because motors are components of larger and often customized equipment, distributors are not likely to know the efficiency levels of equipment components. In other words, distributors record sales of equipment, not equipment components. Second, note that in some industries, including residential appliances and windows, product distribution is sometimes directly from the manufacturer to the builder, retailer, or contractor. Therefore, even if a distributor does exist in the market, they are not likely to account for a large portion of the market.

Retail Establishments

Collecting data from retail establishments is most appropriate for tracking consumer goods – those in which the consumer is the primary decision maker in both net acquisition and replacement purchases that occur at the retail level. In particular, tracking at the retail level might be appropriate for some residential appliances, such as dishwashers, refrigerators, and clothes washers, and those that the consumer purchases replacements, such as compact fluorescent lamps and windows.

Tracking sales by efficiency level at the retail level could be difficult, particularly for products that are sold in a variety of stores. For example, retailers of compact fluorescent lighting include mass merchandisers, chain home improvement stores, small hardware stores, and specialty lighting supply stores. Sampling and recruiting data providers to quantify sales accurately is a primary issue for collecting data at the retail level.

Contractors

Like distributors, contractors in most industries appear to be a viable node at which market share tracking data can be collected. The segmentation and reliability of data would primarily depend upon sampling methodology and contractor record keeping practices. For example, in some industries, contractors work in both the new construction and replace-on-burnout/retrofit markets, though they tend to specialize in one or the other. Sampling would need to account for this. Furthermore, contractors are the only market node at which information pertaining to duct sealing methods and HVAC contractor practices can be tracked.

Builders

Builders do not appear to be a particularly useful node in tracking any of the measures. First, data can be obtained only for new construction installations. Though general contractors are often retained for major remodeling projects, relying on builders for sales data for retrofit or replace-on-burnout installations would be a mistake, as market coverage would be poor for these measures and decision types.

An alternative is to collect data from the Title 24 compliance forms that builders are required to submit to building departments rather than from the builders themselves. While this option is theoretically attractive, it might be logistically difficult to develop and implement.

Customers/Final End User

Sales data can be collected at the customer level through a variety of methods. *Undeveloped* methods for collecting data from final end users include mail, telephone, and on-site surveys. Theoretically, mail, telephone, or on-site surveys can be administered to collect data relating to most priority measures considered in this study – both residential and nonresidential. The reliability, usefulness of the data, and the cost and feasibility of collecting data from customers through these mediums will vary depending on the measure. For example, the Wisconsin tracking experience reveals that data for appliances with which residential customers are very familiar (dishwashers, refrigerators, and clothes washers) are reliable and accurate when obtained from final end users (e.g., with a mail or telephone survey). In contrast, data pertaining to equipment that is not easily accessible and/or that the customer is less familiar with are not very accurate when obtained directly from final end users. However, on-site surveys can be administered to obtain efficiency data on installed equipment for most residential and nonresidential measures.

Other Market Actors

Other market actors who are not involved in product distribution could participate in a market share tracking system. These include building departments, government agencies, and trade organizations. As detailed in Section 5, building departments collect information useful for tracking through required compliance forms. Trade organizations typically collect sales and shipments data directly from manufacturers, though information is aggregated to the national or state level before becoming publicly available and is often not segmented by efficiency level.

6.2 Summary of Tracking Alternatives by Measure/Market and Method

Table 6-1 and Table 6-2 summarize the available tracking alternatives by market/measure for both *existing* and *undeveloped* methods for residential and nonresidential measures, respectively. In these tables, an "**X**" indicates a *viable* method – one that provides data that meet the following four requirements for market share tracking in California:

- Data represent unit sales, and
- Data are/can be segmented by efficiency level, and
- Data are/can be segmented by geographic region, at least at the state level, and
- Decision type (new construction and replace-on-burnout/retrofit) must be identifiable, when applicable.[1]

As shown in Table 6-1 and Table 6-2, several of the options are viable for efficiency market share tracking in California. Surveys of downstream market actors can be developed to collect the required data for all priority measures. Not surprisingly, on-site surveys can be developed to collect data on all priority measures. Data can also be obtained from upstream and midstream market actors for many of the residential and nonresidential measures. The viability of these methods essentially depends upon each measure's market structure and ability of various market actors to supply the needed data.

Reasons for Judging a Method Non-Viable

A method is considered non-viable if it cannot produce the data required for efficiency market share tracking in California (e.g., the data does not meet the four requirements listed above.) Blank cells or those with a "DT" in Table 6-1 and Table 6-2 indicate that a method is not viable for efficiency market share tracking of the corresponding measure.

As mentioned above, the decision type or market event must be identifiable in the data in order for a method to be considered a viable tracking alternative. RER has considered the decision type requirement essential to market share tracking and necessary for market transformation evaluation efforts, primarily because of the structure and design of California energy efficiency programs. Individual programs are being designed to target specific market events. As discovered throughout the course of this project, requiring data that distinguishes decision type limits the number of viable tracking alternatives. The methods that were deemed non-viable solely because they did not meet the decision type viability criteria primarily include data collection from upstream market actors – manufacturers, distributors, and some retailers, depending on the measure. In Table 6-1 and Table 6-2, the methods that failed only the decision type criteria are identified with "DT."

General observations and reasons for judging a method non-viable are provided below.

- Several methods are non-viable for tracking any of the priority measures. These include all of *existing* data sources reviewed for this study, in-store surveys, and market actor interviews.[2] As explained in Section 5, RER's review of existing

[1] Note that it is not necessary for the method to produce data by all decision types for all measures.

[2] A few of the *existing* options, including consumer panels and scanner data, can be customized or further developed. Therefore, in these limited circumstances, these methods are also considered *undeveloped* and

data sources revealed that none of these methods produce the data needed for market share tracking. For example, most shipments data are available only at the national level and/or is not segmented by efficiency level. Scanner, or point-of-sale, data are not available for any of the priority measures (with the exception of light bulbs) and are not segmented by efficiency level. Sales records and efficiency levels of equipment sold are not obtainable with in-store surveys or from market actor interviews.

- Building department compliance/installation records cannot provide data for any retrofit, replace-on-burnout, or net acquisition installations. Furthermore, data availability from building departments on new construction installations is limited by reporting requirements. For example, the required data on residential lighting cannot be obtained from building department installation certificates. Appendix I includes samples of forms for reference.
- The warranty card method cannot cover measures that are not accompanied with product literature at the point-of-sale, or those that are installed by a market actor that would not reliably return the card. Measures that cannot be covered by a warranty card method include duct sealing, compressed air optimization, residential windows and lighting, and most nonresidential measures.
- Mail and telephone surveys are not viable tracking methods if the end user is unfamiliar with the measure or if they would have difficulty reporting, or would be unwilling to report the required information. For example, homeowners would not be able to provide information about duct sealing because ducts are not easily accessible to the homeowner, and because most are not familiar with this measure.
- Data collection from midstream market actors, including installation contractors, design consultants and engineers, and builders is not a viable method for those measures with which these market actors are not directly involved in the transaction. For example, these market actors are generally not involved in the purchase of residential appliances. Builders will not be able to provide information on retrofit, replace-on-burnout, or net acquisition installations.
- With a few exceptions, data collection from upstream market actors is not a viable method for tracking efficiency market shares. In particular, manufacturers and distributors either cannot provide (reliable) shipments data segmented by state or by decision type, or both.

are accounted for under downstream market actor surveys (in the case of consumer panels) and upstream/midstream market actor data collection (in the case of scanner data).

Table 6-1: Review of Alternative Tracking Options for Residential Measures, by Measure and Method

Priority Measure/Market and Decision Type		Existing Data Sources[4]	In-Store Survey	Building Dept. Data[5]	Warranty Card Data	Interview Market Actor	Downstream Surveys[6]			Upstream/Midstream Market Actor Data Collection					
							Phone	Mail	On-Site	Manufacturer	Distributor	Retailer	Builder	Contractor	Engineer/ Designer
Residential Duct Sealing	NC			X					X				X	X	
	Retro								X					X	
Residential HVAC [1]	NC			X	X				X	DT	X		X	X	
	ROB				X				X		X			X	
Residential Lighting [2]	NC						X	X	X	DT	DT		X	X	
	Retro						X	X	X			X		X	
Residential Appliances [3]	(n/a)				X		X	X	X	DT	DT	X			
Dishwashers	NC				X		X	X	X	DT	DT		X		
Residential Gas Water Heating	NC			X	X				X	DT	X		X	X	
	ROB				X				X		X	X		X	
Residential Windows	NC			X					X	DT	DT		X	X	
	Retro								X			X		X	

1 Includes residential gas furnaces and central air conditioning.
2 Includes compact fluorescent fixtures and lamps.
3 Includes refrigerators, dishwashers, and clothes washers.
4 Includes consumer panels, scanner data, and shipments data.
5 Building department data sources include compliance forms, verification forms, and field inspector on-site inspections.
6 Included in this category are developing consumer panels and collecting scanner data that specifically meets the CBEE's market share tracking needs. Recall from Section 3 that some existing data collection activities can be customized or further developed.

Table 6-2: Review of Alternative Tracking Options for Nonresidential Measures, by Measure and Method

Priority Measure/Market and Decision Type		Existing Data Sources[2]	In-Store Survey	Building Dept. Data[3]	Warranty Card Data	Interview Market Actor	Downstream Surveys			Upstream/Midstream Market Actor Data Collection					
							Phone	Mail	On-Site	Manufacturer	Distributor	Retailer	Builder	Contractor	Engineer / Designer
Nonresidential Windows	NC			X					X	DT	DT		X	X	
	Retro								X					X	
Packaged Air Conditioning	NC			X	X				X	DT	X		X	X	
	ROB				X				X		X			X	
Nonresidential HVAC: Chillers	NC			X			X	X	X	X				X	X
	ROB						X	X	X	X				X	X
Nonresidential HVAC: EMS	NC			X			X	X	X	DT	DT			X	
	Retro						X	X	X					X	
Nonresidential Motor System: Motors & ASDs	NC			X			X	X	X	DT	X				X
	Retro						X	X	X		X				X
Nonresidential Ancillary Equip: Compress Air Opt.	(n/a)						X	X	X						
Nonresidential Lighting: T8s w/Electronic Ballasts	NC			X					X	DT	DT		X	X	
	Retro								X					X	
Nonresidential Packaged Refrig. [1]	(n/a)								X	DT	DT				

1 Includes display cases, walk-in/reach-in coolers, icemakers, and vending machines.
2 Includes consumer panels, scanner data, and shipments data.
3 Building department data sources include compliance forms and field inspections.

7

Overview of Feasibility Assessment, Evaluation Methodology, and Issues to Consider

The objective of the Feasibility Assessment, the third and final phase of this study, is to evaluate alternative tracking methods for each priority measure in a systematic, consistent manner and devise final tracking recommendations. This Assessment essentially integrates the first two phases of the study - the Needs Assessment, which prioritized efficiency measures, and the Methods Assessment, which identified and reviewed alternative methods for efficiency market share tracking.

Figure 7-1 depicts the conceptual framework for the Feasibility Assessment of market share tracking for high efficiency measures in California. As shown, the data and information utilized for this analysis include the following:

- A review of existing tracking initiatives and interviews with tracking system developers, and
- Interviews with key market actors, industry participants, and potential tracking data suppliers.

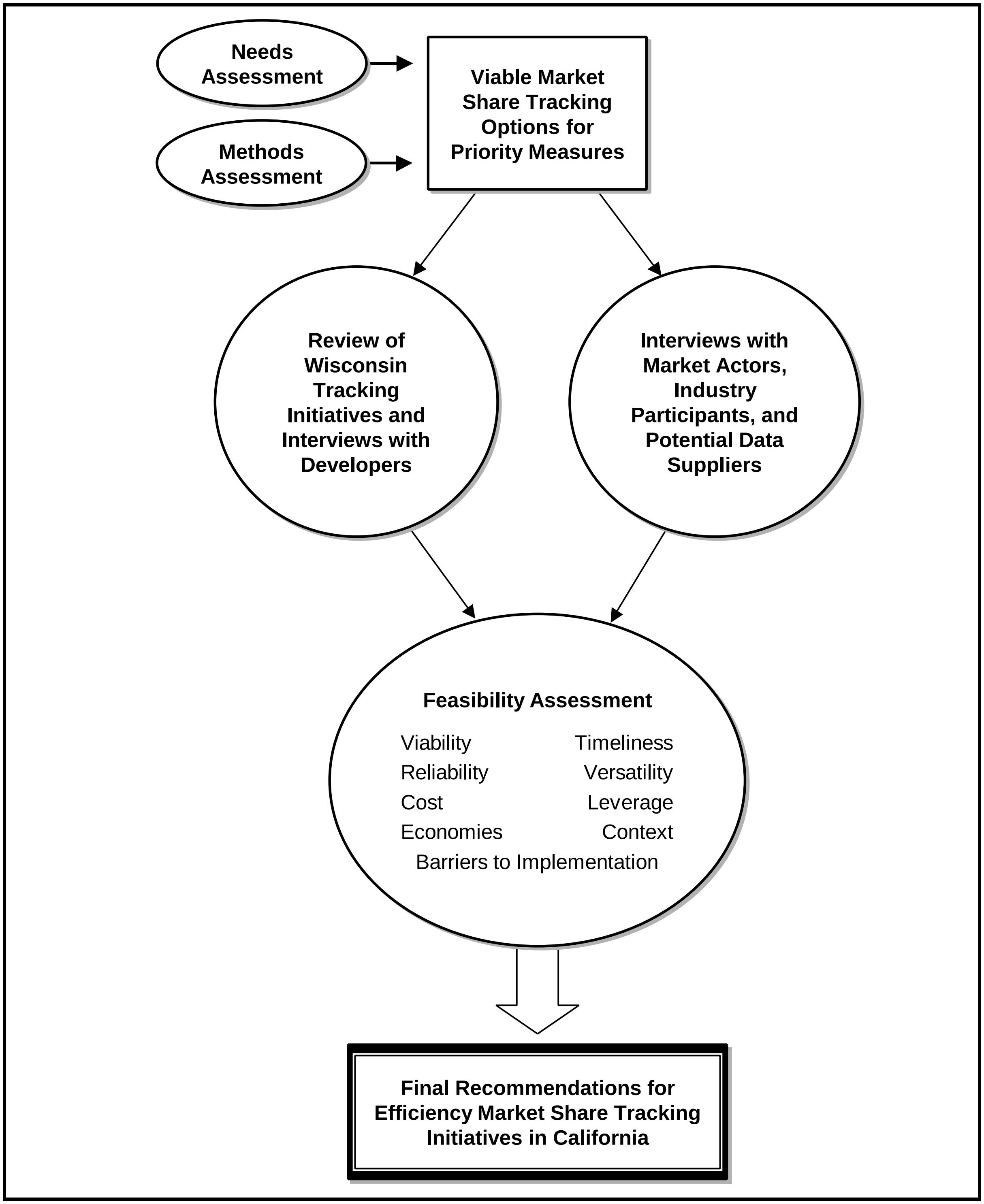
Review of Other Tracking Initiatives and Interviews with Developers

RER reviewed other market share tracking systems and analyses to obtain information on assessment criteria from a variety of sources. The primary sources investigated were the Electric Power Research Institute's Market Tracking study and the tracking initiatives currently in operation in Wisconsin.

Interviews with Key Market Actors, Industry Participants, and Potential Tracking Data Suppliers

As emphasized in the Methods Assessment, a variety of market actors will have a critical role in the development and implementation of tracking systems. These include manufacturers, distributors, retailers, final end users, building departments, CEC staff, and others. RER interviewed numerous individuals who would either participate in data collection or be data suppliers. These interviewees included ENERGY STAR® representatives, trade organizations, CEC staff, building department staff, and key market actors, including manufacturers and distributors.

Figure 7-1: Conceptual Framework for Feasibility Assessment



Feasibility Analysis

The information and data collected during the Methods Assessment were used to evaluate the feasibility of each tracking alternative for each measure according to nine criteria:

- Viability,
- Reliability,
- Cost,
- Economies,
- Timeliness,
- Versatility,
- Leverage,
- Context, and
- Barriers to implementation.

The remainder of this Section discusses these evaluation criteria, provides an overview of the Feasibility Assessment approach, and details the scoring of various means of tracking high priority energy efficiency measures.

7.1 Summary of Evaluation Criteria

Viability

Viability refers to the capability of the method to yield data required for efficiency market share tracking in California. In particular, a method is considered "viable" if it can produce data that meet the following requirements:

- Data represent unit sales, <u>and</u>
- Data are/can be segmented by efficiency level, <u>and</u>
- Data are/can be segmented by geographic region, at least at the state level, <u>and</u>
- Decision type (new construction and replace-on-burnout/retrofit) must be identifiable, when applicable.[1]

Reliability

In the context of this study, reliability connotes both the accuracy and consistent availability of the data. Tracking systems should produce reasonably accurate data, in the sense of having relatively low biases and fairly small standard errors on estimated shares. Sampling issues, data collection methods (e.g., telephone, mail, or on-site survey), whether the data represent actual or planned purchases/installations, market coverage, and the market node or

[1] Note that it is not necessary for the method to produce data by all decision types for all measures. This was discussed in the Needs Assessment.

market actors from which data are collected are examples of factors considered under this criterion.

Cost

The cost of developing and operating a tracking system will also be important. In general, the cost should be justified based on the importance of the covered measure(s), as well as the level of accuracy yielded by the tracking method in question. Both development and operation costs are estimated for each method (and, therefore, first-year and subsequent-year costs are estimated as well), to the extent possible.

Economies

The economies criterion refers to the extent to which economies can be realized by tracking numerous measures with the same tracking initiative. This criterion accounts for two types of economies: 1) tracking multiple priority measures with the same initiative, and 2) tracking other non-priority measures with the same initiative. The former directly influences the estimated per-measure costs. As the number of measures covered by the method increases, the per-measure tracking costs decrease. Because of this correlation, and to avoid double-counting, this first type of economy is not accounted for in the method scoring.[2] Non-priority measures refer to both competing and substitute measures.

Timeliness

Timeliness refers to the time lapse between the onset of development and the time at which the first tracking data point will be available. Throughout the course of this study, RER recognized that the development time would be a critical factor, as the results of the tracking efforts are to be utilized by several statewide MA&E priority projects, as well as by utility-specific evaluation efforts.

Barriers to Implementation

The barriers to implementation criterion is intended to represent how likely the method can be implemented as designed. Cooperation by potential data suppliers and the endurance of their participation are examples of factors considered under this criterion.

Leverage

Leverage refers to the extent to which existing CBEE relationships with other market actors, such as private service providers, program administrators, manufacturers, distributors, trade associations, and government agencies, can be used to facilitate the collection of data useful for market share tracking. Leverage can arise from program participation, financial relationships, or commonality of purposes.

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2 However, scores for economies of other priority measures were counted, as evident in Section 8.

Versatility

Versatility refers to the ability of the tracking system to generate information on other market effects, such as awareness or key perceptions, stocking practices, and product availability. Such data could be extremely useful to the CBEE for monitoring market effects and the assessment of overall program effectiveness in achieving market transformation objectives. Changes in market shares—by themselves—do not necessarily signal true market transformation unless these changes are attributable to interventions that are to some extent permanent. Being able to assess program impacts on market barriers could help to ascertain the likely permanence of changes in market shares stemming from programs.

Context

Context refers to the ability of the system to yield comparable data from a control area or multiple areas. Context could be important for two reasons. First, discerning program impacts might entail comparing changes in market shares in California to those occurring in other parts of the country. To this extent, it will be necessary to have access to information on efficiency market shares elsewhere. Second, if a source could yield information on market shares in the rest of the country, it might eventually be possible to form a multi-state collaborative to support the development of one or more tracking systems. Pooling resources like this could yield major economies.

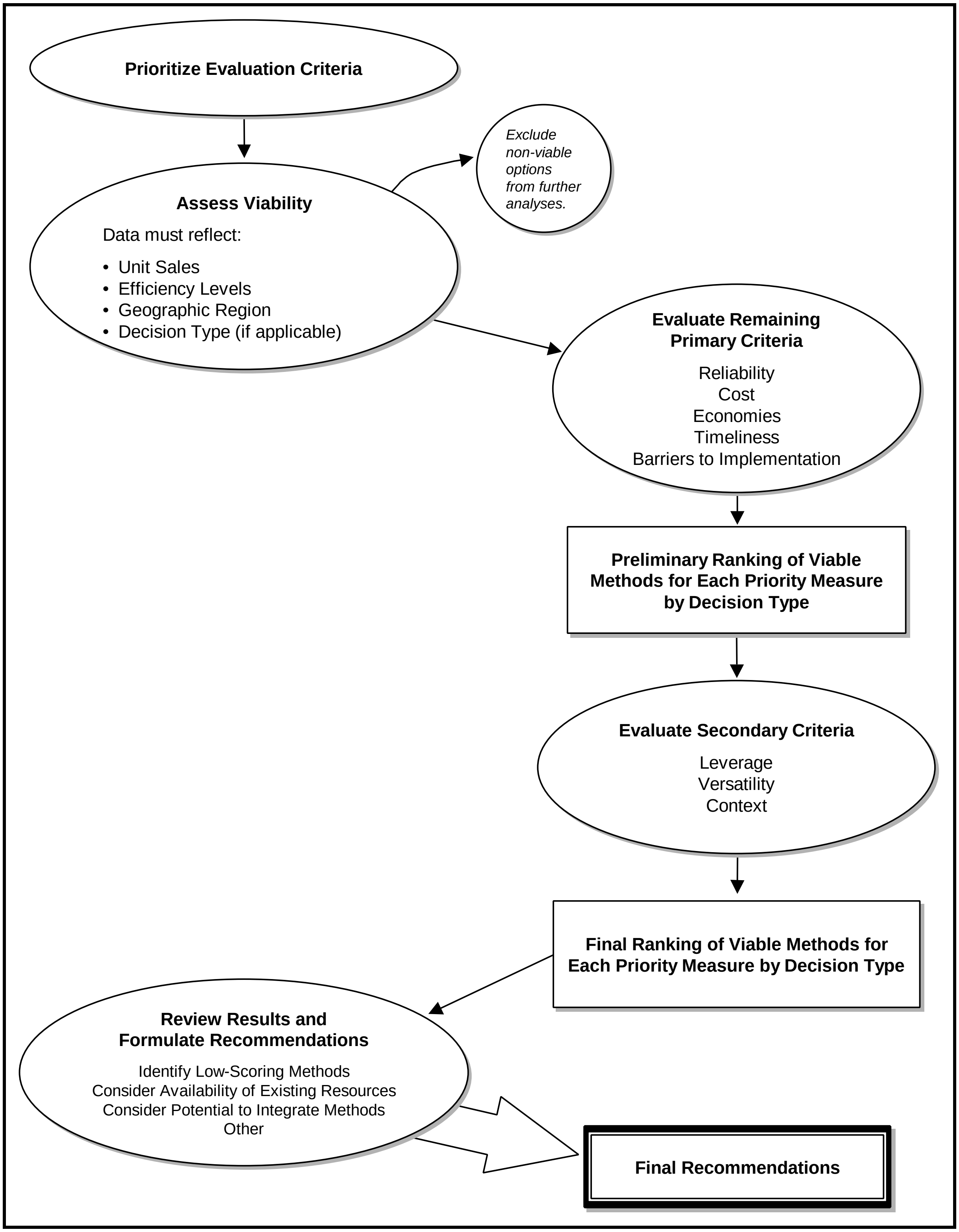
7.2 Overview of Feasibility Assessment

As shown in Figure 7-2, the Feasibility Assessment involved five major steps: 1) prioritize the evaluation criteria, 2) assess the viability of each tracking option for each method and applicable decision type, 3) evaluate methods according to the *primary* criteria, 4) evaluate methods according to the *secondary* criteria, and 5) review results and formulate recommendations.

Prioritize Evaluation Criteria

In the process of developing an evaluation scheme, it became quite clear that some criteria should be weighted more heavily than others. For example, while the collection of information pertaining to other market effects indicators is preferred, doing so is not the primary objective of an efficiency market share tracking initiative. The versatility score, therefore, would need to have less weight than some others, such as reliability or economies. The key question then becomes: *What is the most appropriate weighting scheme?* In the context of this analysis, this is not an easy question to answer; the subjective nature of these criteria does not lend itself easily to a defensible quantitative weighting scheme.

Figure 7-2: Overview of Feasibility Assessment



The next best alternative was to categorize the criteria into *primary* and *secondary* criteria. *Primary* criteria are those most important to a successful efficiency tracking method in California, and *secondary* are those desirable, but not necessary or critical. RER prioritized the evaluation criteria detailed above in Subsection 8.1 in this manner. Viability, reliability, cost, economies, barriers to implementation, and timeliness are considered *primary* criteria, while leverage, versatility, and context are considered *secondary* criteria. Primary criteria were implicitly weighted more heavily by the assignment of scores with relatively wide ranges. Secondary criteria were weighted less heavily through the assignment of scores with a narrow range.

Assess Viability

The viability criterion was applied first, and all non-viable methods were excluded from further analysis. The viability criterion was actually evaluated during the Methods Assessment. Table 6-1 and Table 6-2 present the results of this process for residential and nonresidential measures, respectively. As shown, all existing data sources, in-store surveys, and market actor interviews are not considered viable methods and were excluded from further consideration. Moreover, some options capable of tracking overall efficiency market shares were eliminated for some measures because they could not provide estimates by decision type.

Evaluate Remaining Primary Criteria

Each viable method was evaluated according to the five *primary* criteria for each of the priority measures by decision type. A preliminary score was calculated as the sum of all *primary* scores. The scoring approach for the *primary* criteria is summarized in Table 7-1 of Subsection 7.3 below.

Evaluate Secondary Criteria

Next, each method was evaluated according to the remaining three *secondary* criteria—leverage, versatility, and context. The scoring approach for the *secondary* criteria is summarized in Table 7-2 of Subsection 7.3 below. As indicated by the narrow (0 to 0.5) scoring range, these criteria were weighted less than the primary criteria in the final score.

Review Analysis Results and Formulate Final Recommendations

The result of the analysis described above was a final score for each viable method for each measure and applicable decision type. The final score was computed as the sum of the preliminary score and the scores assigned to the three *secondary* criteria.

The review of analysis results and the development of recommendations was a complex, often iterative process, required the consideration of not only the scoring of specific methods for each individual method, but factors that were common across measures. Throughout the evaluation process, RER recognized the importance of several issues, including the following:

- To develop a set of market tracking initiatives that provide the broadest market coverage yet maintain an acceptable level of data accuracy,
- To avoid recommending a single method for each measure based solely on the final evaluation scores without analyzing the impact of economies across priority measures,
- That a single method for collecting data from any one market actor might not provide the optimal solution to tracking efficiency market shares in California, and
- There are advantages to collecting data at multiple market nodes, particularly if different methods have different strengths and weaknesses. The result would be an integrated method that provides more reliable results than any one single method.

Given the above rationale, RER's recommended initiatives are comprised of the strengths of multiple methods and represent logical solutions for efficiency market share tracking.

7.3 Scoring Scheme

Table 7-1 and Table 7-2 summarize the approach used to score methods according to the *primary* and *secondary* criteria, respectively. Each table provides an abbreviated definition of each criterion, scoring key, and rationale or other supplementary comments. Several points are worth noting regarding this scoring scheme. First, it is important to recognize the difficulties in evaluating multiple, somewhat overlapping subjective attributes. While it is important to evaluate methods in a consistent manner, much of the scoring necessarily involved a considerable amount of subjective judgment.

Second, RER's analysis of tracking alternatives implicitly assumes an acceptable level of precision, which in turn assumes a sample size needed to achieve this level of precision. This assumption was necessary to derive cost estimates, as the two are directly related. If this assumption were not made, the number of reliability/cost combinations to evaluate would have unmanageable.

Third, this analysis assumes that the highest level of economies will be utilized. For instance, the relatively high scoring of some of the methods is a direct result of available economies. These economies and the associated lower per-measure costs are applicable only insofar as <u>all</u> of the applicable measures are actually included in the tracking initiative.

Finally, to compute the per-measure cost for each method and to assign scores for this criterion, the number of priority measures that could be covered by each method was determined. The total estimated first-year cost was then divided by this number to compute the per-measure costs. In the evaluation scoring, the per-measure cost score is therefore the same for all measures covered by the method.

Table 7-1: Summary of Feasibility Evaluation Scoring Approach: Primary Evaluation Criteria

Criteria	Definition	Scoring Range	Comments/Rationale
I. Viability	The method can yield data that fulfill data requirements for tracking (unit sales/shipments data for CA by efficiency level and decision type).	Not applicable.	Table 6-1 and Table 6-2 identified all viable tracking methods (e.g., those indicated by an **X**). Non-viable methods are excluded from further consideration.
II. Reliability	a) *Accuracy* accounts for a number of issues relating to sampling, if data represent actual or planned installations, etc.—all of which relate to how accurately the data will represent true market trends. This criterion is also a function of the data collection method (on-site vs. telephone survey, for example).	0 – None 1 – Somewhat 2 – Very	-
	b) *Consistency* pertains to whether or not the method can produce the same data on a regular, long-term basis.	0 – None 1 – Somewhat 2 – Very	
III. Cost	Estimated per-measure, first-year cost of developing and operating the tracking initiative.	1 - > $100K 2 - $50 – $100K 3 - $25 - $50K 4 - $0 - $25K	-
IV. Economies	a) Method can be used to collect data for other priority measures.	0 – No 1 – Yes	Because the per-measure cost estimate already accounts for the number of priority measures covered by the method, this element (a) of the economies criterion is <u>not</u> included in the scoring to rank methods. The analysis assumes highest level of efficiency will be utilized.
	b) Method can be used to collect data for non-priority measures, such as competing or substitute measures, or both.	0 – No 1 – Yes	
V. Timeliness	This criterion indicates whether or not the method can be developed and operation in a "timely" manner (e.g., within 6 to 9 months).	0 – No 0.5 – Somewhat 1 – Yes	-
VI. Barriers to Implementation	How likely the method can be implemented as designed.	1 – Not likely to succeed 3 – Somewhat likely to succeed 5 – Highly likely to succeed	Primary factor is cooperation of key data suppliers on a long-term basis.

Table 7-2: Summary of Feasibility Evaluation Scoring Approach: Secondary Evaluation Criteria

Criteria	Definition	Scoring Range	Comments/Rationale
VII. Leverage	Existing CBEE relationships with market actors and other organizations can help to facilitate data collection.	0 – No 0.5 – Yes	-
VIII. Versatility	The method can also produce data pertaining to other market-effects indicators.	0 – No 0.5 – Yes	-
IX. Context	The method can yield comparable tracking data for other regions.	0 – No 0.5 – Yes	-

8

Analysis

This section presents the analysis results for evaluating each viable method for each priority measure. Using the scoring scheme described in Section 7, each method was evaluated according to the eight criteria for each applicable measure and decision type.[1] The results of these analyses are included in each subsection below; there is a separate table of results for each measure and applicable decision type.

RER offers the following general observations:

- ***Reliability.*** Reliability scores have two components: 1) accuracy, and 2) consistency. Overall, the methods that produce data on actual installations (on-site surveys and some building department data sources) are judged to produce more accurate data than the other methods. Also, those methods that can produce data that cover a majority of the market received higher accuracy scores than those that could not. Most methods were judged able to provide data on a consistent basis, though data collection from midstream or upstream market actors is dependent upon their continued willingness to participate.
- ***Costs.*** As noted in Section 7, costs are partly dependent upon the economies that can be achieved from tracking multiple priority measures with the same method. In general, the per-measure, first-year cost estimates are lower for new construction because of the available economies in tracking other priority measures. On-site surveys are typically high in cost relative to mail and telephone surveys, and the costs for collecting data from midstream or upstream market actors are relatively high due to the time and resources required to recruit and maintain relationships with data suppliers.[2]
- ***Economies.*** Economies scores have two components: 1) economies by tracking additional priority measures, and 2) economies through tracking other non-priority measures, which includes both competing and substitute measures. In some instances, the latter is not applicable, as some measures are defined in such a way that no competing measures exist (e.g., windows). Most methods offer economies in tracking new construction installations, while very few can offer economies in tracking retrofit/replace-on-burnout installations. (Note that because economies in

[1] There are actually nine evaluation criteria, but the viability of each method has already been determined at this point. Thus, the analyses presented in this section pertain only to viable methods.

[2] Recall that the per-measure costs are estimated assuming data would be collected on a quarterly basis.

tracking other priority measures is accounted for in the per-measure cost estimate, this score is not included in the preliminary score.)

- ***Timeliness*** score trends are as follows: 1) mail or telephone surveys can be implemented relatively quickly, 2) on-site surveys would require a longer start-up time due to questionnaire development and amount of time required for actual data collection, and 3) developing and maintaining relationships with midstream or upstream market actors could take a considerable amount of time, as evidenced from the Wisconsin tracking initiatives.
- ***Barriers to Implementation.*** Mail, telephone, and on-site surveys have no barriers to implementation, in the sense that these standard data collection methods are available to maintain response rates. In general, data collection from midstream and upstream market actors is expected to be less successful, as their willingness or ability to supply useful data on a long-term basis is uncertain. This criterion is also a function of whether or not opportunities exist that can facilitate the data collection process. For example, because data are already being collected from retailers under the ENERGY STAR® program, data collection from retailers for some measures is expected to be very successful should tracking efforts in California incorporate the ENERGY STAR® initiatives.
- ***Leverage.*** Leverage is not available for most methods. Leverage exists with nonresidential new construction on-site surveys and with residential retrofit or replace-on-burnout on-site surveys because these efforts can be incorporated into the CEC's customer survey efforts. Leverage is also possible in efforts to obtain building department data, and with data collection efforts from some upstream market actors who may benefit from energy efficiency programs.
- ***Versatility.*** Versatility scores are essentially a function of the market node at which data are collected, as well as the data collection method itself. With the exception of building department data, warranty cards, and data collection from some contractors, most methods offer some means for obtaining information about other market effects indicators.
- ***Context.*** The only methods that can provide tracking data for other regions (with out corresponding increases in estimated costs) are warranty cards and data collection from manufacturers. While all other methods can be employed in regions outside of California, the cost of doing so would increase proportionally. Issues associated with collecting comparable tracking data from other regions are presented in Section 11.

Note that the analysis presented here assumes quarterly data collection. Unlike the "old world," in which measurement and evaluation entailed distinct projects conducted on an annual or biannual cycle driven primarily by regulatory factors, market transformation assessment will need to be an ongoing process accommodated by the availability of data generated by a comprehensive tracking system. Collecting data on a semiannual or annual basis would yield an inadequate number of data points to assess the extent of market transformation. This is a critical issue, particularly when one considers the time required to develop a tracking system and the number of data points available to assess market transformation through the end of the transition period. For example, if the first estimates of efficiency market shares are not available until, say, the first quarter of 2000, collecting data on a semiannual basis would only produce four data points through the end of the transition period.

8.1 Residential Duct Sealing

As indicated in Table 6-1, the viable methods for collecting data useful for tracking duct sealing include the following:

- Obtain information regarding duct sealing practices and materials from building department data (new construction only),
- Implement on-site surveys to record duct sealing practices and materials,
- Collect information from residential HVAC contractors regarding their duct sealing practices and materials,
- Collect information from residential builders regarding duct sealing practices and materials (new construction only), and
- Conduct diagnostic tests on a sample of homes to determine duct leakage rates.

All of these methods are applicable to both decision types except collecting data from builders and building departments, which is applicable only to new construction installations. The remaining methods reviewed in Section 5 were judged non-viable because they could not produce data that meet the primary requirements for tracking efficiency market shares in California.

Table 8-1 and Table 8-2 include RER's preliminary analysis of viable methods for tracking residential duct sealing for new construction and duct retrofits in existing homes, respectively. The specific efficiency parameters to be monitored through tracking is the primary issue with tracking duct sealing. Several alternative indicators were introduced in Section 4, including duct sealing practices, duct sealing materials, and tracking duct leakage rates. All of these options are included in Table 8-1 and Table 8-2.

As shown, on-site surveys were awarded the highest preliminary scores for both decision types, which ranked higher than collecting information from contractors and builders primarily because the resulting data are highly accurate and these methods offer economies in tracking other priority measures, which reduces per-measure costs. Additional observations about the analysis results are presented below.

Reliability. As shown, on-site surveys, field inspections by building departments, and diagnostic testing were rated highest in terms of accuracy, as these methods involve data collection at the site level, represent actual installations, and do not rely on customer reporting. All methods were deemed to be able to produce the same data on a consistent basis. However, builders and contractors were given slightly lower scores, as RER's prior research experience with these market actors suggests that their willingness to participate on a long-term basis is uncertain. Reliability scores are consistent between decision types.

Cost. Cost estimates varied across methods, with building department on-site field inspections being the least expensive and diagnostic testing being the most expensive. Because costs are a function of economies, or the number of priority measures covered by the method, on-site surveys, field inspections, and data collection from builders received relatively favorable cost scores for new construction. Because economies cannot be gained in tracking duct retrofits, the per-measure first-year costs for collecting data on retrofits increases significantly.

Economies. As shown in Table 8-1, economies can be realized with all viable methods for tracking new construction duct sealing practices and materials except diagnostic tests used to calculate duct leakage rates.[3] There are no economies possible through any of the viable methods for tracking duct retrofits.

Timeliness. As shown, none of the methods are expected to be developed and implemented in a timely manner. On-site surveys would require a longer start-up time due to questionnaire development and the increased time required for actual data collection. Developing relationships with builders and contractors could also take a considerable amount of time, as evidenced from the Wisconsin tracking initiatives.

Barriers to Implementation. On-site surveys and diagnostic testing scored the highest for both decision types, as these methods can provide a reliable source of high quality, accurate data with no major barriers to implementation. RER's past research experience, as well as the Wisconsin tracking efforts, indicates that collecting data from builders and HVAC contractors across decision types could have mixed success. This is due primarily to their differing and uncertain record keeping practices and their time availability and/or willingness to devote time to meet data request obligations. Recruiting contractors and builders to be data suppliers could require a substantial amount of time and resources with no guarantee of success. Building department field inspections scored particularly low for this criterion. While this method has much to commend it, obtaining the cooperation of building departments in implementing this approach would be extremely difficult.

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[3] Of course, data on other measures could be collected at the sites for which testing is conducted. However, the expense of duct testing would keep samples too small to yield sufficient data on other measures.

Secondary Indicators. Leverage only exists with the building department on-site field inspection method, because over time the CEC could require building departments to collect the forms necessary for efficiency market share tracking, and could suggest revisions in forms that may provide data for additional measures in the future. only methods involving some form of contact with a market actor can be used to collect information about other market effects. With respect to duct sealing, these methods include on-site surveys and collecting data from builders and contractors. None of the viable methods can be used to collect efficiency market share tracking data for other regions without increasing estimated costs. The scores for secondary indicators are consistent across decision types.

Table 8-1: Residential Duct Sealing, New Construction

	Bldg. Dept[2]			Duct Sealing Practices/Materials			Duct Leakage
				Downstream	*Midstream*		*Downstream*
Criteria	**Compliance**	**Verification**	**Field Insp.**	**On-Site Survey**	**Contract.**	**Builder**	**Blower Door/ Duct Blaster Diagnostic Tests**
Reliability (Accuracy)	-	-	2	2	1.5	1.5	2
Reliability (Consistency)	-	-	1	1	0.5	0.5	1
Cost	-	-	4	3	2	3	1
Economies (Priorities)[1]	-	-	1	1	1	1	0
Economies (Non-priorities)	-	-	n/a	n/a	n/a	n/a	n/a
Timeliness	-	-	0	0.5	0	0	0
Barriers to Implementation	-	-	1	5	3	2	5
Preliminary Score	-	-	**8**	**11.5**	**7**	**7**	**9**
Leverage	-	-	0.5	0	0	0	0
Versatility	-	-	0	0.5	0.5	0.5	0
Context	-	-	0	0	0	0	0
Final Score	-	-	**8.5**	**12**	**7.5**	**7.5**	**9**

1 Scores are not included in preliminary score.
2 Compliance and verification forms do not record information about duct sealing methods.

Table 8-2: Residential Duct Sealing, Retrofit

	Duct Sealing Practices/Materials		Duct Leakage
	Downstream	*Midstream*	*Downstream*
Criteria	**On-Site Surveys**	**Contractors**	**Blower Door/ Duct Blaster Test**
Reliability (Accuracy)	2	1.5	2
Reliability (Consistency)	1	0.5	1
Cost	1	2	1
Economies (Priorities)[1]	0	0	0
Economies (Non-priorities)	n/a	1	n/a
Timeliness	1	0	0
Barriers to Implementation	5	3	5
Preliminary Score	**10**	**8**	**9**
Leverage	0.5	0	0
Versatility	0.5	0.5	0
Context	0	0	0
Final Score	**11**	**8.5**	**9**

1 Scores are not included in preliminary score.

8.2 Residential HVAC: Central Air Conditioners and Gas Furnaces

As indicated in Table 6-1, the viable methods for collecting data useful for tracking efficiency market shares of central air conditioners and gas furnace include the following:

- Collect compliance, verification, or field inspection data from building departments (new construction only),
- Include a response card in the product information packet (warranty card method) that is returned by either the installation contractor or final consumer,
- Implement on-site surveys to obtain the manufacturer and model number of installed equipment,
- Collect equipment installation information from residential builders, which should also necessarily include equipment manufacturer and model number (new construction only),
- Collect sales data from residential HVAC contractors, which would necessarily include equipment manufacturer and model numbers of all units sold, and
- Obtain relevant sales data from HVAC equipment distributors in California.

All of these methods are applicable to both decision types except collecting data from building departments and builders, which is only applicable to new construction installations. The remaining methods reviewed in Section 5 were judged non-viable because they could not produce data meeting the primary requirements for tracking efficiency market shares in California. Note that even though data from distributors cannot distinguish between decision types, data collection from HVAC equipment distributors remained a viable option because 1) some HVAC distributors can identify decision type by sales to specific customers, 2) there is potential in the future to encourage distributors to record the type of installation at the point-of-sale, and 3) market share tracking of HVAC equipment through distributors has been successful in Wisconsin.

Table 8-3 and Table 8-4 include RER's preliminary analysis of viable methods for tracking residential HVAC equipment for new construction and replace-on-burnout purchases, respectively. As shown in Table 8-3, on-site surveys and building department verification data received the highest scores for tracking new construction HVAC equipment, primarily due to their relatively low costs per measure (and high economies) and relatively high likelihood of success. On-site surveys and data collection from HVAC equipment distributors faired the best for tracking market shares of replace-on-burnout installations.

Reliability. As mentioned above, on-site surveys are viewed as more reliable methods than others that do not collect data at the site level. Building department verification and field inspection data are highly reliable for collecting efficiency data of new construction installations, as these data represent actual, rather than planned, installations. Warranty card data are not expected to be very accurate, as this method suffers from potentially severe response bias.[4] Data collected from distributors were assigned a lower score for accuracy only because distributors do not currently record the installation type at the point-of sale. It is important to note, however, that should a tracking system be developed with distributors, there is the potential to encourage them to record decision type. Furthermore, some distributors can already identify sales by decision type based upon the customer (e.g., some customers/HVAC contractors only work in the new construction market). All methods for both decision types are expected to produce data with some degree of consistency.

Cost. As shown in Table 8-3, costs for collecting new construction efficiency data from building departments, on-site surveys, and builders are fairly low due to economies. The per-measure costs of these methods increase for replace-on-burnout installations because economies are no longer achievable, as reflected in Table 8-4.

Economies. All viable methods, except warranty cards offer economies in tracking new construction installations of other priority measures, while only distributor data can offer economies in tracking retrofit/replace-on-burnout installations of other priority measures. Economies through tracking non-priority measures are available through all viable methods for both decision types, except the warranty card method.

Timeliness. As evidenced by assigned timeliness scores in Table 8-3 and Table 8-4, no viable method is expected to produce data in a timely manner, though on-site surveys and obtaining building department data are slightly more attractive in this respect. Warranty cards and collecting data from midstream and upstream market actors are expected to involve a fairly time-intensive development process. In the case of warranty cards, manufacturers need to agree to include a response card in their product literature packets. Furthermore, the time between the production and actual installation of the equipment could be as long as one year.

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[4] D&R attempted to collect sales data through a warranty card method. The method proved to be unsuccessful, with a response rate of roughly 3% to 4%, regardless of incentive payments. Apparently, Consumer Reports encourages consumers to not complete and return warranty information cards, since this is a typical method used to collect names and addresses that are then sold to companies that compile commercially available mailing lists.

Barriers to Implementation. As shown in Table 8-3 and Table 8-4, there are few barriers to conducting on-site surveys or collecting data from HVAC equipment distributors.[5] Obtaining building department verification forms is also expected to be fairly successful for new construction installations. The other two sources of building department data (compliance forms and field inspections) have logistical barriers that would need to be overcome to develop these methods. RER does not expect warranty cards to be successful, as the success of this method depends completely upon cooperation from equipment manufacturers in addition to consumers' willingness to complete and return warranty materials.

Secondary Indicators. Leverage is present only through building departments for new construction data collection and with on-site surveys for replace-on-burnout installations (CEC customer surveys can be used to pre-screen for recent HVAC equipment replacement). All methods except warranty cards and building department data can also collect at least some information about other market effects indicators. The extent to which this can be accomplished and the exact nature of such data will vary across methods. None of the methods, except warranty cards, can produce data for tracking HVAC efficiency market shares in other regions.

[5] RER informally interviewed several HVAC distributors in California to assess the likelihood of participation. In particular, seven HVAC distributors representing 92 individual locations were asked about their record keeping practices (e.g., type of sales information they tracked and how this information was stored) and their willingness to participate in a statewide tracking program. First, all of the distributors showed some degree of willingness to participate in a statewide tracking program. Second, all distributors record model numbers of all units sold and, at the very least, store all the sales data in an electronic database. The biggest barriers to participation pertain to timing and staffing issues. These results and the success of the tracking efforts in Wisconsin lead RER to conclude that HVAC distributors could be successfully recruited as data suppliers.

Table 8-3: Residential Gas Furnace and Central Air Conditioning, New Construction

	Bldg. Dept.				*Down-stream*	*Mid-stream*		*Up-stream*
Criteria	**Compliance**	**Verification**	**Field Insp.**	**Warranty Card**	**On-Site Surveys**	**Builder**	**Contractor**	**Distributor**
Reliability (Accuracy)	1	2	2	0.5	2	1.5	1.5	1
Reliability (Consistency)	1	1	1	1	1	0.5	0.5	1
Cost	3	4	4	2	3	3	2	3
Economies (Priorities)[1]	1	1	1	0	1	1	1	1
Economies (Non-priorities)	1	1	1	0	1	1	1	1
Timeliness	0.5	1	0	0	0.5	0	0	0
Barriers to Implementation	3	4	1	2	5	2	3	4
Preliminary Score	**9.5**	**13**	**9**	**5.5**	**12.5**	**8**	**9**	**10**
Leverage	0.5	0.5	0.5	0	0	0	0	0
Versatility	0	0	0	0	0.5	0.5	0.5	0.5
Context	0	0	0	0.5	0	0	0	0
Final Score	**10**	**14**	**9.5**	**6**	**13**	**8.5**	**9.5**	**10.5**

1 Scores are not included in preliminary score.

Table 8-4: Residential Gas Furnace and Central Air Conditioning, Replace-on-burnout

		Downstream	*Midstream*	*Upstream*
Criteria	**Warranty Card**	**On-Site Surveys**	**Contractor**	**Distributor**
Reliability (Accuracy)	0.5	2	1.5	1
Reliability (Consistency)	1	1	0.5	1
Cost	2	1	2	3
Economies (Priorities)[1]	0	0	0	1
Economies (Non-priorities)	0	1	1	1
Timeliness	0	0.5	0	0
Barriers to Implementation	2	5	3	4
Preliminary Score	**5.5**	**10.5**	**8**	**10**
Leverage	0	0.5	0	0
Versatility	0	0.5	0.5	0.5
Context	0.5	0	0	0
Final Score	**6**	**11.5**	**8.5**	**10.5**

1 Scores are not included in preliminary score.

8.3 Residential Lighting

As indicated in Table 6-1, the viable methods for collecting data useful for tracking market shares of compact fluorescent lighting fixtures and lamps include the following:

- Administer a mail or telephone survey to collect the total number and type of compact fluorescent fixtures and lamps, as well as the total number of possible applications for compact fluorescent fixtures in the home,
- Conduct on-site surveys to record the total number and type of compact fluorescent fixtures and lamps, as well as the total number of possible applications for compact fluorescent fixtures in the home,
- Collect sales/installation data of all lighting fixtures and lamps by type from residential builders (new construction only),
- Collect sales data of all lighting fixtures and lamps by type from residential lighting contractors, and
- Collect data from retailers pertaining to all fixture and lamp sales (retrofit or replace-on-burnout only).

Table 8-5 and Table 8-6 include RER's preliminary analysis of viable methods for tracking residential lighting equipment for new construction (compact fluorescent fixtures) and replace-on-burnout (compact fluorescent lamps) purchases, respectively. As shown, on-site, mail, and telephone surveys received the highest preliminary scores for tracking fixtures in new construction. These results are primarily due to the relatively low per-measure costs and high-success rates attributed to these methods for collecting data useful for tracking.

As shown in Table 8-6, collecting data from retailers received the highest score for tracking compact fluorescent lamp replacements. This result is directly attributable to the opportunities available from obtaining data collected under the ENERGY STAR® program.

Reliability. On-site surveys are most reliable in terms of accuracy, as is the case with most other measures installed in new construction. While data collected from builders and lighting contractors could be fairly accurate, it is uncertain whether or not these midstream market actors would be consistent data suppliers on a long-term basis.

For tracking retrofit or replace-on-burnout installations, on-site surveys, and retailer data are deemed to be very accurate. The former represent actual installations, and the latter includes data obtained at the point-of-sale. Information obtained from consumer mail and telephone surveys are not likely to be as accurate, as consumers may or may not be able to identify each type of lighting fixture/lamp in their home.

Cost. The cost for collecting data on lighting fixtures and lamps installed in new construction is relatively low, primarily because the realizable economies drive the per-measure cost downward. This is true for all methods, except contractor sales data collection, since lighting contractors only can provide data on lighting equipment sales.

The cost estimates for collecting data on compact fluorescent fixture and lamp retrofit or replace-on-burnout purchases vary across methods. As shown in Table 8-6, mail and telephone surveys are the least expensive method, followed by collecting data from retailers. This low cost is attributable to the relatively low cost of tracking fixtures and lamps primarily with ENERGY STAR® data. On-site surveys are relatively costly, as there are no achievable economies.

Economies. All methods except lighting contractor data collection offer economies in tracking other priority measures in new construction. Note that only data for residential appliances are also obtainable from mail and telephone surveys, so the economies with these methods are not quite as significant as with the on-site surveys or data from builders. All methods offer economies in tracking non-priority measures (e.g., other lighting fixture and lamp types) for both decision types.

Timeliness. The timeliness scores in Table 8-5 and Table 8-6 reflect the general trends across all measures and methods. In particular, mail and telephone surveys can be developed and administered relatively quickly, while on-site surveys require more development and administration time. Developing data collection systems with midstream market actors can be time consuming because of the time required to recruit data suppliers. Because of the opportunities through the ENERGY STAR® data collection effort, tracking lamp replacements at the retail level could be implemented fairly quickly.

Barriers to Implementation. On-site and mail/telephone surveys were awarded the highest possible score for both decision types. They are considered a reliable source of high quality tracking data with no major barriers to implementation. Collecting data from retailers for tracking fluorescent fixture retrofits also received one of the highest scores. This is due to the anticipated success of obtaining compact fluorescent fixture and lamp sales data already collected under the ENERGY STAR® program.

The scores of the other methods are lower for several reasons. RER’s past experience with builders and contractors gives the impression that collecting data from these market actors for any decision type could have only marginal success, primarily because of differing record keeping practices among contractors and builders, and their time availability and/or willingness to meet data request obligations.

Secondary Indicators. The secondary indicator scores are nearly identical between decision types. None of the viable methods for tracking either compact fluorescent fixtures or lamps can be used to collect data to make inferences about trends in other regions. All methods, however, can be used to collect information about other market effects indicators. The extent to which this can be accomplished and the exact nature of such data will vary across methods. On-site surveys and data collection from retailers are the only methods that received a positive score for leverage, as the planned CEC residential customer survey could be used to identify recent purchasers. Retailers participating in the residential lighting program (or those that are ENERGY STAR® partners) could be required to provide data for tracking in order to participate.

Table 8-5: Compact Fluorescent Fixtures and Lamps, New Construction

	Downstream		*Midstream*	
Criteria	**Mail/Phone**	**On-Site Surveys**	**Builder**	**Contractor**
Reliability (Accuracy)	0.5	2	1.5	1.5
Reliability (Consistency)	1	1	0.5	0.5
Cost	4	3	3	2
Economies (Priorities)[1]	1	1	1	0
Economies (Non-priorities)	1	1	1	1
Timeliness	1	0.5	0	0
Barriers to Implementation	5	5	2	3
Preliminary Score	**12.5**	**12.5**	**8**	**8**
Leverage	0	0	0	0
Versatility	0.5	0.5	0.5	0.5
Context	0	0	0	0
Final Score	**13**	**13**	**8.5**	**8.5**

1 Scores are not included in preliminary score.

Table 8-6: Compact Fluorescent Fixtures and Lamps, Retrofit/Replace-on-Burnout

Criteria	***Downstream***		***Upstream***
	Mail/Phone Survey	**On-Site Survey**	**Retailer[2]**
Reliability (Accuracy)	0.5	2	2
Reliability (Consistency)	1	1	1
Cost	4	1	3
Economies (Priorities)[1]	0	0	0
Economies (Non-priorities)	1	1	1
Timeliness	1	0.5	1
Barriers to Implementation	5	5	5
Preliminary Score	**12.5**	**10.5**	**13**
Leverage	0	0.5	0.5
Versatility	0.5	0.5	0.5
Context	0	0	0
Final Score	**13**	**11.5**	**14**

1 Scores are not included in preliminary score.

2 Scores for collecting sales data from retailers reflect opportunities available through the ENERGY STAR® data collection efforts. This opportunity substantially influenced cost, leverage, and barriers to implementation scores.

8.4 Residential Appliances: Refrigerators, Dishwashers, and Clothes Washers

As indicated in Table 6-1, the following are viable methods for collecting data useful for tracking efficiency market shares of refrigerators, clothes washers, and dishwasher replace-on-burnout and net acquisitions:

- Include a response card in the product information packet (warranty card method) that is returned by either the installation contractor or final consumer,
- Conduct an on-site survey to collect manufacturer and model numbers of installed equipment,
- Conduct a telephone or mail survey to obtain manufacturers and model number of installed equipment, and
- Collect sales data from home appliance retailers, which would necessarily include manufacturers and model numbers of all appliances.[6]

The viable methods for tracking efficiency market shares of dishwashers installed in new construction include the following:

- Include a response card in the product information packet (warranty card method) that is returned by either the installation contractor or final consumer,
- Conduct an on-site survey to collect manufacturer and model number of installed equipment,
- Conduct a telephone or mail survey to obtain manufacturers and model numbers of installed equipment, and
- Collect efficiency data of installed equipment from builders, which would necessarily include manufacturers and model numbers of dishwashers.

The remaining methods reviewed in Section 4 were judged to be non-viable because they could not produce data that meet the primary requirements for tracking efficiency market shares in California.

Table 8-7 presents RER's preliminary analysis of viable methods for tracking residential appliance replace-on-burnout or net acquisition sales. As shown, data collection at the retail level received the highest overall score, followed by on-site surveys and mail/telephone surveys. The high score awarded to data collection from retailers is primarily attributable to the relatively low per-measure cost and high likelihood of success in obtaining data already collected under the ENERGY STAR® program.

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6 Note that these methods pertain to sales of <u>all</u> refrigerator and clothes washer sales, since these appliances are not standard in new construction.

Table 8-8 includes the analysis of viable methods for tracking efficiency market shares of dishwashers installed in new construction. As shown, on-site surveys received the highest overall score. On-site surveys are favored over other methods because they produce accurate data, have low estimated per-measure costs, and have no barriers to implementation.

Reliability. Transactions data for replace-on-burnout or net acquisition purchases obtained from retailers are considered to be very accurate, because these data contain all information recorded at the point-of-sale, including key characteristics required for tracking. On-site surveys also receive the highest score for accuracy, as these data represent actual installations. As with other measures, warranty card data are not expected to be very accurate due to potentially high self-selection bias and low response rates. All methods except data collection from builders are expected to be consistent data sources for appliance purchases of all decision types.

Cost. Costs vary across methods, though per-measure costs for replace-on-burnout and net acquisitions are generally higher than new construction because of the lack of economies. As shown in Table 8-7, estimated per-measure costs are lowest for retailer transaction data because this method can utilize data currently collected under the ENERGY STAR® program. Note that ENERGY STAR® data cover only participating retailers. As a result, it would be necessary to augment these data with data collected from a sample of nonparticipating stores. Costs for downstream surveys are relatively high due to the lack of any economies. That is, when collecting data at the consumer node, it is highly unlikely that a particular residence has replaced or acquired more than one priority measure within a three-month period. The higher costs for a warranty card system are due to anticipated development costs.

Economies. As stated above, implementation of downstream surveys to track clothes washer and refrigerator sales and replacement or net acquisition dishwasher sales does not offer economies in tracking other priority measures. An upstream data collection approach does offer economies, though, because these appliances are distributed and sold to final consumers through the same retail establishments. As evidenced in Table 8-8, economies of non-priority measures are not applicable, as there are no competing or substitute measures for dishwashers.

Timeliness. The timeliness scores presented in both Table 8-7 and Table 8-8 are consistent with scores for the same methods used to track other priority measures. First, mail or telephone surveys could be implemented relatively quickly. On-site surveys would require a longer start-up time due to questionnaire development and the amount of time required for actual data collection. Developing a warranty card tracking system and developing relationships with builders are both expected to be quite lengthy processes. Establishing a tracking system with retailers can be accomplished fairly quickly, since this initiative would be developed under the current ENERGY STAR® data collection efforts.

Barriers to Implementation. On-site surveys were awarded the highest scores possible for all appliance decision types, since they can provide a reliable source of high quality tracking data with no major barriers to implementation. Collecting data for clothes washers, refrigerators, and dishwashers (replace-on-burnout/net-acquisition only) at the retail level also received the highest possible score due to the opportunities available through the ENERGY STAR® program tracking efforts. Mail and telephone consumer surveys are also expected to be very successful, as there are no barriers to implementations and consumers tend to be relatively willing and able to provide the required data.

The scores of the other methods were lower for the several reasons. RER's past research experience indicates that collecting data from builders has mixed success. This is due primarily to uncertain record keeping practices, availability of time, and/or willingness to devote time to meet data request obligations. The warranty card method, which can be used across decision types, is an undeveloped approach that also has many related uncertainties, such as the willingness of manufacturers and/or distributors to assist in the development of this method.

Secondary Indicators. As shown below in Table 8-7, both on-site surveys and retail-level tracking have some associated leverage. The planned CEC residential customer survey can be used to produce a pre-screened sample of consumers that have recently purchased one or more of the relevant appliances. Leverage exists with the retailers in the sense that ENERGY STAR® Retail Partners and/or retailers participating in utility (statewide) appliance programs can be required to provide data useful for tracking appliance sales.

Table 8-7: Residential Appliances, Replace-on-Burnout/Net Acquisitions

Criteria	Warranty Card	*Downstream* On-Site Survey	*Downstream* Mail/Phone Survey	*Upstream* Retailer[2]
Reliability (Accuracy)	0.5	2	1	2
Reliability (Consistency)	1	1	1	1
Cost	2	1	2	3
Economies (Priorities)[1]	0	0	0	1
Economies (Non-priorities)	0	0	0	1
Timeliness	0	0.5	1	1
Barriers to Implementation	2	5	5	5
Preliminary Score	**5.5**	**9.5**	**10**	**13**
Leverage	0	0.5	0	0.5
Versatility	0	0.5	0.5	0.5
Context	0.5	0	0	0
Final Score	**6**	**10.5**	**10.5**	**14**

1 Scores are not included in preliminary score.

2 Scores for collecting sales data from retailers reflect opportunities available through the ENERGY STAR® data collection efforts. This opportunity substantially influenced cost, leverage, and likelihood of success scores.

Table 8-8: Residential Appliances – Dishwashers Only, New Construction

Criteria	Warranty Card	*Downstream* On-Site Survey	*Downstream* Mail/Phone Survey	*Midstream* Builder
Reliability (Accuracy)	0.5	2	1	1.5
Reliability (Consistency)	1	1	1	0.5
Cost	2	3	4	3
Economies (Priorities)[1]	0	1	1	1
Economies (Non-priorities)	n/a	n/a	n/a	n/a
Timeliness	0	0.5	1	0
Barriers to Implementation	2	5	5	2
Preliminary Score	**5.5**	**11.5**	**12**	**7**
Leverage	0	0	0	0
Versatility	0	0.5	0.5	0.5
Context	0.5	0	0	0
Final Score	**6**	**12.5**	**12.5**	**7.5**

1 Scores are not included in preliminary score.

8.5 Residential Gas Water Heating

As indicated in Table 6-1, the following are viable methods for collecting data useful for tracking efficiency market shares of gas water heaters:

- Collect compliance, verification, or field inspection data from building departments (new construction only),
- Include a response card in the product information packet (warranty card method) that is returned by either the installation contractor or final consumer,
- Implement on-site surveys to obtain the manufacturer and model number of installed equipment,
- Collect sales data from residential plumbing contractors, which would necessarily include equipment manufacturers and model numbers of all units sold,
- Collect sales data, including manufacturer and model number from water heater distributors in California,
- Collect sales data, including manufacturer and model number of all gas water heater sold by retailers (replace-on-burnout only) and
- Collect equipment installation information from residential builders, which should also necessarily include equipment manufacturer and model number (new construction only).

Four of these methods apply to both decision types. Collecting data from building departments and builders applies only to new construction installations, and data collection from retailers applies only to replace-on-burnout units.

Table 8-9 and Table 8-10 include RER's analysis of viable methods for tracking residential gas water heating equipment for new construction and replace-on-burnout purchases, respectively. As shown, on-site surveys and building department verification forms were awarded the highest overall scores for tracking new construction installations. On-site surveys also received the highest overall score for tracking replace-on-burnout and net acquisition purchases. These results are attributable to relatively low per-measure costs, accuracy of the data, and anticipated high likelihood of success.

Reliability. Several factors influenced the reliability scores of each method for both decision types. First, as with other measures, on-site surveys provide a reliable method for collecting accurate data on gas water heater characteristics. Second, data collected through building department data verification and field inspections will represent actual installations rather than planned installations. Building department compliance data tends to lag actual dates of installation and can contain data that is different from what was actually installed. Third, collecting detailed data from builders and plumbing contractors is marginally less accurate due to the uncertain and inconsistent record keeping practices of each of these market actors. Furthermore, these market actors are not viewed as long-term consistent data suppliers, as their time availability and willingness to supply data are presently uncertain. Fourth, plumbing contractors and retailers do not have full coverage for replace-on-burnout and net-acquisition decision types. In particular, consumers can purchase gas water heaters for replacements either from a retailer or directly from a plumbing contractor. Distributors cannot distinguish sales by decision types, and only a portion of water heaters are sold through distributors. Thus, even though data from distributors can be quite accurate and useful, it will not meet all data requirements for tracking. Finally, as mentioned above, self-selection bias and low response rates can be a major issue relating to the reliability of warranty card data.

Cost. The costs for obtaining building department data, conducting on-site surveys, and collecting data from builder surveys for new construction installations are relatively low, reflecting the economies for tracking other priority measures with these approaches. Because economies are not achievable with warranty cards or collecting data from plumbing contractors or distributors, the per-measure costs for tracking replace-on-burnout and net acquisitions are relatively high. For the same reasons, the costs for conducting on-site surveys for replace-on-burnout and net-acquisition installations also increase considerably.

Economies. As mentioned above, economies are achievable by collecting data for new construction with either on-site surveys, building department data, or builder surveys. For example, building department data contain data on at least three other priority measures and their respective non-priority measures, and on-site surveys can produce data on almost all priority measures and their competing technologies. Data available from warranty cards, water heater distributors, and plumbing contractors would be water heater specific, and therefore offer no economies.[7] All methods for both decision types would provide data on non-priority measures.

Only data collection from retailers for replace-on-burnout and net acquisitions offers economies. That is, tracking at the retailer node presents some economies with the ability to track priority measures other than gas water heaters at a single node. When tracking at the consumer node, it is highly unlikely that a particular residence has replaced or acquired more than one priority measure within a three-month period.

Timeliness. None of the methods scored favorably for timeliness, with the exception of collecting building department verification data. The major factors influencing the development and implementation time of these methods include length of the data collection

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[7] However, some HVAC distributors also carry water heating equipment, in which case economies could exist.

period and the time needed to develop working relationships with market actors who can provide tracking data.

Barriers to Implementation. On-site surveys scored the highest across decision types since they can provide a reliable source of high quality tracking data with no major barriers to implementation. The scores of the other methods were lower for the several reasons. The success of collecting building department data for tracking new construction installations relies on some intangibles, including the willingness of building department staff to voluntarily provide tracking data and the effort needed to foster good working relationships with building departments with no guarantee of success. RER's past research experience, as well as the Wisconsin tracking efforts, indicates that collecting data from builders and plumbing contractors across decision types could have mixed success. This is due primarily to the differing and uncertain record keeping practices of contractors and builders and their availability of time or willingness to devote time to meet data request obligations. The warranty card method, which can be used across decision types, is an undeveloped approach that also has many related uncertainties, such as the willingness of manufacturers and/or distributors to assist in developing this method. Informal discussions with a sample of water heater distributors throughout the state indicate that a data collection effort with wholesale distributors could be developed rather successfully. However, cooperation with retail distributors is uncertain.

Secondary Indicators. As indicated in Table 8-9 and Table 8-10, the only methods for which existing relationships might be useful in facilitating data collection are obtaining new construction installations through building department data and replace-on-burnout installations via on-site surveys. The CEC can encourage participation and eventually recommend mandatory participation through the Title 24 revision process scheduled for 2001. Also, the CEC's planned residential customer surveys can pre-screen customers for recent gas water heater purchases, which will be used as a sample for on-site surveys. Some methods, such as on-site surveys and data collection from builders and plumbing contractors, can also be used to obtain information about other market effects indicators. Only the warranty card method can provide efficiencies of gas water heater sales in other regions.

Table 8-9: Gas Water Heaters, New Construction

Criteria	Warranty Card	Bldg. Dept. Compliance	Bldg. Dept. Verification	Bldg. Dept. Field Insp.	*Down-stream* On-Site Survey	*Mid-stream* Builder	*Mid-stream* Contractor	*Up-stream* Distributor
Reliability (Accuracy)	0.5	1	2	2	2	1.5	1.5	1
Reliability (Consistency)	1	1	1	1	1	0.5	0.5	1
Cost	2	3	4	4	3	2	2	2
Economies (Priorities)[1]	0	1	1	1	1	1	0	1
Economies (Non-priorities)	1	1	1	1	1	1	1	1
Timeliness	0	0.5	1	0	0.5	0	0	0
Barriers to Implementation	2	3	4	1	5	2	3	4
Preliminary Score	**6.5**	**9.5**	**13**	**9**	**12.5**	**7**	**8**	**9**
Leverage	0	0.5	0.5	0.5	0	0	0	0
Versatility	0	0	0	0	0.5	0.5	0.5	0.5
Context	0.5	0	0	0	0	0	0	0
Final Score	**7**	**10**	**13.5**	**9.5**	**13**	**7.5**	**8.5**	**9.5**

1 Scores are not included in preliminary score.

Table 8-10: Gas Water Heaters, Replace-on-Burnout

Criteria	Warranty Card	*Downstream* On-Site Surveys	*Midstream* Contractor	*Upstream* Distrib.	*Upstream* Retail
Reliability (Accuracy)	0.5	2	1.5	1	1
Reliability (Consistency)	1	1	0.5	1	1
Cost	2	1	2	2	2
Economies (Priorities)[1]	0	0	0	1	1
Economies (Non-priorities)	1	1	1	1	1
Timeliness	0	0.5	0	0	0
Barriers to Implementation	2	5	3	4	3
Preliminary Score	**6.5**	**10.5**	**8**	**9**	**8**
Leverage	0	0.5	0	0	0
Versatility	0	0.5	0.5	0.5	0.5
Context	0.5	0	0	0	0
Final Score	**7**	**11.5**	**8.5**	**9.5**	**8.5**

1 Scores are not included in preliminary score.

8.6 Residential Windows

As indicated in Table 6-1, the viable methods for collecting data useful for tracking efficiency market shares of residential windows include the following:

- Obtain U-values, number of panes, and glazing area from building department data (for new construction only),
- Conduct an on-site survey to collect number of panes, frame type, and glazing size,
- Collect all available window efficiency data from residential builders (for new construction only),
- Collect all available sales or installation data from residential window contractors, and
- Obtain window sales data from retailers (retrofits only).

On-site surveys and collecting data from window contractors are applicable to both decision types. Building department data and data collected from builders are only applicable to new construction installations, and data collection from retailers is only applicable to window retrofits. The remaining methods reviewed in Section 5 were judged non-viable because they could not produce data that meet the primary requirements for tracking efficiency market shares in California.

Table 8-11 and Table 8-12 present RER's analysis of viable methods for tracking residential windows in new construction and window retrofits, respectively. As shown, data obtained from building department verification forms received the highest overall score for tracking window efficiency parameters in new construction. This is due mainly to the low per-measure cost, reliability of the data, and the anticipated high likelihood of success of this method. Data collection from window contractors rated the highest for tracking efficiencies of window retrofits. Although, none of the viable methods was highly favored, on-site surveys and window contractor data collection faired best primarily because of the reliability of the data and lower per-measure costs.

Reliability. The reliability scores for accuracy of all methods for both decision types indicate that building department verification forms are the most accurate source of efficiency data for residential windows. Once windows are installed (e.g., window labels are removed), U-values and solar heat gain coefficients (SHGCs) are no longer observable. However, other parameters, including the number of panes and the frame type can be recorded. Therefore, unlike the other measures, on-site surveys and building department field inspections are not the best source for the most accurate data. Builders and contractors are likely to provide all desired window efficiency parameters, but it is uncertain if these market actors would be willing to be long-term consistent data suppliers.

Windows installed in existing homes are purchased at retail establishments by both final consumers and contractors. Retailers can provide sales invoice information that should include window characteristics, which would be very accurate. However, because contractors also purchase windows from manufacturers and distributors, collecting data at the retail level would exclude a portion of the market. Hence, retailers scored marginally lower in terms of accuracy than did contractors for providing retrofit efficiency data.

Cost. As with the other measures, per-measure costs for tracking new construction measures are lower than those in existing homes because of the economies available by tracking multiple priority measures with one method—with building department data or on-site surveys, in particular. Obtaining data from window contractors, builders, and retailers is expected to be relatively high because of the time and resources required to recruit and maintain relationships with these market actors.

Economies. As indicated in Table 8-11, all methods offer economies, except data collection from window contractors, who would not be able to supply data for any other priority measures. None of the viable methods for tracking window retrofits offers economies. Although some retail establishments that sell residential windows also sell appliances (i.e., Home Depot), the economies did not seem extensive enough to warrant a positive score. Note that economies gained by tracking non-priority measures are not applicable here, as there are no competing or substitute measures for windows.

Timeliness. The timeliness scores presented in Table 8-11 and Table 8-12 are consistent with timeliness scores for other measures. That is, for new construction data, some sources of building department data and on-site surveys can be implemented more quickly than other measures.

Barriers to Implementation. As indicated, the likelihood of success varies by method. As with the other measures, on-site surveys received the highest possible scores. Obtaining new construction verification data from building departments is expected to be fairly successful, as evidenced by RER's informal survey of building departments throughout California. However, these results do not pertain to field inspections, as they are not currently normal practice. RER anticipates that collecting data from midstream and upstream market actors will be only marginally successful because of uncertain cooperation from market actors.

Secondary Indicators. As shown, leverage can be used for obtaining building department data and conducting on-site surveys, for new construction and retrofits, respectively. The planned CEC residential customer survey can be used to produce a pre-screened sample of consumers that have recently retrofitted windows in their home. Some information about other market effects indicators can be obtained from on-site surveys and data collection from midstream and upstream market actors for both decision types, though the nature and extent to which this can be accomplished will vary across methods. None of the methods can be employed to obtain efficiency data for installations in other regions without corresponding cost increases.

Table 8-11: Residential Windows, New Construction

	Bldg. Dept.			*Downstream*	*Midstream*	
Criteria	**Compliance**	**Verification**	**Field Insp.**	**On-Site Survey**	**Builder**	**Contractor**
Reliability (Accuracy)	1	2	0.5	0.5	1.5	1.5
Reliability (Consistency)	1	1	1	1	0.5	0.5
Cost	3	4	4	3	2	2
Economies (Priorities)[1]	1	1	1	1	1	0
Economies (Non-priorities)	n/a	n/a	n/a	n/a	n/a	n/a
Timeliness	0.5	1	0	0.5	0	0
Barriers to Implementation	3	4	1	5	2	3
Preliminary Score	**8.5**	**12**	**6.5**	**10**	**6**	**7**
Leverage	0.5	0.5	0.5	0	0	0
Versatility	0	0	0	0.5	0.5	0.5
Context	0	0	0	0	0	0
Final Score	**9**	**12.5**	**7**	**10.5**	**6.5**	**7.5**

1 Scores are not included in preliminary score.

Table 8-12: Residential Windows, Retrofit

Criteria	*Downstream* On-Site Survey	*Midstream* Contractor	*Upstream* Retailer
Reliability (Accuracy)	0.5	1.5	1
Reliability (Consistency)	1	0.5	1
Cost	1	2	1
Economies (Priorities)[1]	0	0	0
Economies (Non-priorities)	n/a	n/a	n/a
Timeliness	0.5	0	0
Barriers to Implementation	5	3	2
Preliminary Score	**8**	**7**	**6**
Leverage	0.5	0	0
Versatility	0.5	0.5	0.5
Context	0	0	0
Final Score	**9**	**7.5**	**5.5**

1 Scores are not included in preliminary score.

8.7 Nonresidential Windows

As indicated in Table 6-2, the viable methods for collecting data useful for tracking efficiency market shares of nonresidential windows include the following:

- Obtain number of panes, U-values, frame type, glazing type (tinted or clear), and glazing area from building department compliance forms or field inspections,
- Conduct on-site surveys of nonresidential sites to collect information on number of panes, frame type, and glazing type (tinted or clear), and glazing area,
- Obtain relevant efficiency parameters from nonresidential builders, and
- Collect all available sales or installation data from nonresidential window contractors.

Note that methods for tracking nonresidential window retrofits were not evaluated and all of the above methods apply only to new construction installations. The nonresidential window retrofits measure was dropped as a priority measure primarily because it is difficult to concretely define what constitutes a window retrofit in the nonresidential sector. In particular, as discussed in Section 4, window retrofits in nonresidential buildings typically involve film application, and do not necessarily imply glazing or window assembly replacement.

Table 8-13 includes RER's analysis of viable methods for tracking efficiency market shares of windows installed in nonresidential new construction. Note that there are two columns for on-site surveys. The scoring in the first column assumes that the planned CEC commercial customer on-site surveys will be used to collect data for tracking purposes. The second column of scores for on-site surveys reflect a "ground zero" approach – one which the costs would not be subsidized by funds already earmarked for CEC data collection (e.g., assume that the CEC would not conduct commercial on-site surveys). The scores for the CEC and non-CEC on-sites are identical except for cost estimates and leverage scores.

As shown, on-site surveys conducted through the CEC and compliance forms submitted to building departments rated highest overall for collecting data on window efficiency parameters for tracking. As with residential on-site surveys, there are no barriers to implementing this method. However, data on window efficiency parameters available from an on-site is limited, as solar heat gain coefficients (SHGC) and other information, such as glazing type, are not observable after construction is completed.

Reliability. As mentioned above, on-site surveys received a low accuracy score because some window efficiency parameters cannot be observed. More accurate, but not perfect, data sources include building department compliance forms, builders, and window contractors. While builders are required to record all relevant efficiency parameters on the envelope compliance forms (ENVs), these data represent planned, not actual, installations.[8] Nonresidential contractors and builders are likely to be able to provide all desired efficiency parameters, but it is uncertain if these market actors would be willing to be long-term consistent data suppliers.

Cost. Cost scores vary across viable tracking methods. As shown in Table 8-13, assuming that the planned CEC commercial on-site surveys will be designed to collect data useful for tracking, RER estimates that the additional MA&E funds needed to support this effort will be fairly low. In contrast, on-site surveys that cannot be subsidized are very expensive and are given a cost score of “1.” The costs of obtaining data from other market actors, including building departments, window contractors, builders, and distributors, is expected to be relatively high because of the time and resources required to recruit and maintain relationships with these market actors.

Economies. All methods offer some economies for tracking multiple priority and non-priority measures, except data collection from window contractors.

Timeliness. The timeliness scores presented in Table 8-13 are consistent with the scoring of other measures. As shown, none of the viable methods for tracking nonresidential window efficiency market shares can be implemented and operational relatively quickly. Obtaining information from building department—either compliance forms or conducting field inspections—will require time to receive cooperation from building departments and to establish data collection protocols. As explained with the other measures, developing working relationships with builders and contractors and establishing and maintaining the system could be time intensive.

Barriers to Implementation. On-site surveys received the highest possible score, as there are no barriers for implementing this method. The scores of the other methods are lower because the methods rely on cooperation of either building departments or other market actors to supply data. Building department field inspections scored low because conducting field inspections is not a normal business practice and it is unlikely that building departments would be willing to change these practices in the near future. RER anticipates that data collection from midstream market actors would be only marginally successful because of uncertain cooperation from these market actors.

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8 Recall that in the residential sector, differences between the compliance forms and installation verifications forms (CF-6R) are not uncommon. However, informal discussions with building departments in California indicate that differences between planned and actual installations in the nonresidential sector are less common.

Secondary Indicators. As shown, leverage exists with both building departments and the CEC on-site surveys. First, the CEC could encourage building department cooperation. Second, the CEC could incorporate efficiency market share tracking needs into its planned commercial on-site survey effort. The methods through which there is direct contact with a market participant (downstream or upstream) offer some versatility. For example, carefully designed questions pertaining to awareness and decision-making practices of end users could be incorporated into an on-site survey, and questions regarding efficiency specification and other business practices could be asked as a part of the data collection protocol from midstream market actors.

Table 8-13: Nonresidential Windows, New Construction

	Bldg. Department		***Downstream***		***Midstream***	
Criteria	**Compliance**	**Field Insp.**	**On-Site (CEC)[2]**	**On-Site**	**Builder**	**Contractor**
Reliability (Accuracy)	1.5	0.5	0.5	0.5	1.5	1.5
Reliability (Consistency)	1	1	1	1	0.5	0.5
Cost	3	2	4	1	3	2
Economies (Priority Measures)[1]	1	1	1	1	1	0
Economies (Non-Priority Measures)	1	1	1	1	1	0
Timeliness	0.5	0	0.5	0.5	0	0
Barriers to Implementation	3	1	5	5	2	2
Preliminary Score	**10**	**5.5**	**12**	**9**	**8**	**6**
Leverage	0.5	0.5	0.5	0	0	0
Versatility	0	0	0.5	0.5	0.5	0.5
Context	0	0	0	0	0	0
Final Score	**10.5**	**6**	**13**	**9.5**	**8.5**	**6.5**

1 Scores are not included in preliminary score.
2 Scores assume on-site surveys would be conducted as part of the planned CEC commercial customer surveys.

8.8 Nonresidential HVAC: Packaged Air Conditioning

As indicated in Table 6-2, the viable methods for tracking packaged air conditioners include the following:

- Collect equipment manufacturer and model number from building departments, either from required compliance forms or field inspections (new construction only),
- Include a response card in the product information packet (warranty card method) that is returned by either the installation contractor or final consumer,
- Implement on-site surveys to obtain the manufacturer and model number of installed equipment,
- Collect equipment installation information from nonresidential builders, which should also necessarily include equipment manufacturer and model number (new construction only),
- Collect sales data from HVAC contractors, which would necessarily include equipment manufacturer and model numbers of all units sold in California, and
- Obtain manufacturer, model numbers, and other relevant characteristics of packaged air conditioning equipment sold by HVAC equipment distributors.

All of these methods are applicable to both decision types except collecting data from building departments and builders, which are only applicable to new construction installations. The remaining methods reviewed in Section 5 were judged non-viable because they could not produce data meeting the primary requirements for tracking efficiency market shares in California. As explained in the residential HVAC section above, even though data from distributors cannot distinguish between decision types, data collection from HVAC equipment distributors remained a viable option because 1) some HVAC distributors can identify decision type by sales to specific customers, 2) there is potential in the future to encourage distributors to record the type of installation at the point-of-sale, and 3) market share tracking of HVAC equipment through distributors has been successful in Wisconsin.

Table 8-14 and Table 8-15 include RER's preliminary analysis of viable methods for tracking commercial packaged air conditioning equipment for new construction and replace-on-burnout installations, respectively. There are two columns for on-site surveys in both tables. The scoring in the first column assumes that the CEC will conduct on-site surveys in the commercial customer that will be used to collect data for tracking purposes. The second column of scores for on-site surveys assumes that the CEC would not conduct commercial on-site surveys. The scores for the CEC and non-CEC on-sites are identical except for cost estimates (in Table 8-14 only) and leverage scores (in both tables).

As shown in Table 8-14, on-site surveys (both CEC and non-CEC), building department compliance form data, and distributor data collection received the highest scores for tracking new construction installations, primarily because the data can be very accurate, there are few or no barriers to implementing these methods, and/or there are low development and operation costs.

On-site and telephone surveys and distributor data collection received the highest overall scores for tracking replace-on-burnout installations of commercial packaged air conditioning equipment. These results are attributable to the high degree of data accuracy, relatively low cost, and the absence of barriers associated with implementing these methods.

Reliability. Most of the viable methods for tracking packaged air conditioning equipment installed in new construction received favorable scores for accuracy and consistency; those that involved on-site verification of installations were awarded the highest scores for accuracy (field inspections through building departments and on-site surveys). As with some of the residential measures, warranty card data are not expected to be accurate due to potentially serious response bias. Sales data obtained from HVAC distributors were awarded a lower score only because the distributors interviewed by RER staff indicated that they do not maintain records on decision type. However, some distributors can infer decision type through tracking sales to specific contractors. All methods except collecting data from builders and contractors were deemed to be consistent data sources.

Reliability scores of methods for tracking replace-on-burnout installations are similar to those for new construction. While customer telephone surveys are not appropriate for some measures, RER's past experience reveals that data pertaining to small commercial HVAC equipment obtained via telephone surveys can be fairly accurate.

Cost. Evaluation scores for the cost criterion varied from being relatively low to being fairly high. On-site surveys conducted by the CEC scored most favorably for new construction installations. Note that both CEC and non-CEC on-site survey and telephone survey costs are significantly higher for collecting data on replace-on-burnout installations. These higher costs are attributable to the fact that, because the anticipated CEC on-site samples would not be sufficient to produce reliable estimates of efficiency market shares of replace-on-burnout installations, the CEC's on-site survey must be augmented with additional data collection activities.

The remaining methods involve considerable effort since they require the recruitment of market actors and the development of data reporting protocols. As with the other measures, the ability to recruit data suppliers varies depending on the market actors involved and can be relatively costly. The fewer market actors that need to be recruited to cover the same percentage of the market as other methods, the more minimal the costs.

Economies. As shown in Table 8-14 and Table 8-15, all of the viable methods can be used to track additional priority and non-priority measures for both new construction and replace-on-burnout installations except the warranty card method. HVAC contractors would only be able to provide data for HVAC-related equipment.

Timeliness. Timeliness scores are consistent with those awarded for other measures. In particular, those methods that require recruiting participation from market actors—warranty card data and data collection from builders and contractors—are not expected to be developed and operational in a timely manner. Obtaining compliance forms from building departments and conducting on-site surveys require less development time, but still involve time and resources for development of questionnaires and data collection protocols. A telephone survey for collecting efficiency data of equipment replacements can be developed fairly quickly.

Barriers to Implementation. As shown by Table 8-14 and Table 8-15, on-site and telephone surveys and data collection from HVAC equipment distributors received the highest scores, indicating few or no barriers to implementing these methods. Because HVAC equipment distributors typically sell both residential and small commercial HVAC equipment, the results for residential central air conditioning and gas furnaces apply to packaged air conditioning. The seven distributors informally interviewed by RER indicated at least a willingness to explore participating in an efficiency market share tracking initiative.

As with other measures, the barriers to implementing the remaining methods are primarily related to gaining the cooperation of market actors to serve as data suppliers. Building department field inspections were awarded the lowest possible score because it is unlikely that building departments would be willing to dedicate scarce resources to conduct field inspections in the near future. Furthermore, RER anticipates that data collection from midstream market actors would be only marginally successful because of uncertain cooperation from market actors.

Secondary Indicators. The scoring of the secondary criteria are consistent across measures. As shown, data sources available through building departments and on-site surveys conducted by the CEC offer leverage. Some methods, mainly those that involve direct contact with one or more market actors, can be used to collect information on other market effects indicators. only the warranty card data method can produce data pertaining to sales of packaged air conditioning equipment outside of California.

Table 8-14: Packaged Air Conditioning, New Construction

Criteria	Warranty Card	Bldg. Dept.		*Down-stream*		*Midstream*		*Up-stream*
		Compliance	Field Insp.	On-Site (CEC)[2]	On-Site	Builder	Contractor	Distributor[3]
Reliability (Accuracy)	0.5	1.5	2	2	2	1.5	1.5	1
Reliability (Consistency)	1	1	1	1	1	0.5	0.5	1
Cost	2	3	2	4	1	3	2	3
Economies (Priority Measures)[1]	0	1	1	1	1	1	1	1
Economies (Non-Priority Measures)	1	1	1	1	1	1	1	1
Timeliness	0	0.5	0	0.5	0.5	0	0	0
Barriers to Implementation	2	3	1	5	5	2	2	4
Preliminary Score	**6.5**	**10**	**7**	**13.5**	**10.5**	**8**	**7**	**10**
Leverage	0	0.5	0.5	0.5	0	0	0	0
Versatility	0	0	0	0.5	0.5	0.5	0.5	0.5
Context	0.5	0	0	0	0	0	0	0
Final Score	**7**	**10.5**	**7.5**	**14.5**	**11**	**8.5**	**7.5**	**10.5**

1 Scores are not included in preliminary score.
2 Scores assume on-site surveys would be conducted as part of the planned CEC commercial customer surveys.
3 Recall from Section 4 that distributors of residential HVAC equipment typically sell small commercial equipment as well.

Table 8-15: Packaged Air Conditioning, Replace-on-Burnout

Criteria	Warranty Card	*Downstream*			*Midstream*	*Upstream*
		On-Site (CEC)[2]	On-Site	Phone Survey	Contractor	Distributor[3]
Reliability (Accuracy)	0.5	2	2	1.5	1.5	1
Reliability (Consistency)	1	1	1	1	0.5	2
Cost	2	1	1	2	2	3
Economies (Priority Measures)[1]	0	0	0	0	0	1
Economies (Non-Priority Measures)	0	0	0	0	1	1
Timeliness	0	0.5	0.5	1	0	0
Barriers to Implementation	1	5	5	5	2	3.5
Preliminary Score	**4.5**	**9.5**	**9.5**	**10.5**	**7**	**10.5**
Leverage	0	0.5	0	0	0	0
Versatility	0	0.5	0.5	0.5	0.5	0.5
Context	0.5	0	0	0	0	0
Final Score	**5**	**10.5**	**10**	**11**	**7.5**	**11**

1 Scores are not included in preliminary score.
2 Scores assume on-site surveys would be conducted as part of the planned CEC commercial customer surveys.
3 Recall from Section 4 that distributors of residential HVAC equipment typically sell small commercial equipment as well.

8.9 Nonresidential HVAC: Chillers

As indicated in Table 6-2, the viable methods for collecting data useful for tracking efficiency market shares of chillers include the following:

- Collect data from building departments, either from required compliance forms or field inspections (new construction only),
- Collect efficiency parameters by chiller type and size of installed equipment via a customer mail or telephone survey,
- Conduct on-site surveys to collect efficiency parameters by type and size of installed equipment,
- Obtain sales data from major chiller manufacturers, which would necessarily be segmented by type and size, and
- Collect efficiency parameters by chiller type and size of installed equipment from HVAC contractors.

All of these methods are applicable to both decision types except collecting data from building departments, which is applicable only to new construction installations.

Table 8-16 and Table 8-17 include RER's preliminary analysis of viable methods for tracking efficiency market shares of new construction and replace-on-burnout installations of chillers, respectively. As with the other measures, RER differentiated between on-site surveys subsidized by funds earmarked for CEC data collection and those that are not. The scores for the CEC and non-CEC on-sites are identical except for cost estimates of new construction installations and leverage scores.

As indicated in the tables below, CEC on-site surveys received the highest overall score, followed by telephone surveys and data collection from chiller manufacturers for installations in newly constructed buildings/facilities. Data collection from chiller manufacturers and a customer telephone survey were awarded the highest overall scores for replace-on-burnout installations.

Reliability. As shown below, accuracy scores varied only slightly across viable tracking methods. Building department field inspections and data collection from manufacturers received the highest possible scores for new construction and replace-on-burnout installations, respectively. Data from building department compliance forms are accurate, but represent planned, not actual, installation data. There tends to be less divergence between planned and actual installations in the nonresidential sector than in the residential sector. Data collection from midstream market actors is expected to be fairly accurate, though this fact is uncertain at this time.

Note that on-site surveys were not awarded a perfect accuracy score, as with most other measures. Because the analysis of on-site surveys assumed that they would be conducted as part of the CEC's planned commercial on-site survey effort, any chiller installations in the industrial sector (roughly 20% of all chiller sales) would be omitted from the sample. Thus, the data obtained via the CEC commercial on-site surveys might not be perfectly representative of the entire chiller market for either decision type, insofar as there are differences in decision making between installations in the commercial and industrial sectors.

Cost. Cost estimates vary across methods, with non-CEC on-site surveys, building department field inspections, and data collection from midstream market actors being the most costly for collecting data in the new construction market. Because costs are partly a function of the number of priority measures covered by the method, and the assumption that tracking efforts would be incorporated into the CEC's planned commercial survey effort, on-site surveys are estimated to be the least expensive method for tracking chiller installations.

Note in Table 8-17 that the on-site survey costs are significantly higher for collecting data on replacement installations. These higher costs are attributable to the fact that, because the anticipated CEC on-site samples would not be sufficient to produce reliable estimates of efficiency market shares of replace-on-burnout installations, the on-site survey must be augmented with additional data collection activities.

Economies. As shown in Table 8-16 and Table 8-17, economies can be achieved primarily through data collection from building departments and through telephone or on-site surveys. Economies might be possible through contractors and facility engineers or designers, but the extent is uncertain and would depend upon the specialization of these market actors. Note that data collection from manufacturers does not offer any economies. Even though a few of the major chiller manufacturers also produce residential and small commercial HVAC equipment, chiller sales are typically conducted through a separate division or sales office. The ability to obtain data pertaining to chiller sales as well as other HVAC equipment through the same channels is uncertain.

Timeliness. As shown, a few of the viable methods cannot be developed and operational in a timely manner, mainly building department field inspections and data collection from midstream market actors. As with the other measures, these methods could involve considerable development time and resources. Other methods, including obtaining compliance data from building departments and chiller manufacturers and conducting on-site surveys could be developed in a fairly reasonable amount of time, though not as quickly as administering a telephone survey.

Barriers to Implementation. RER anticipates strong barriers to implementing field inspections through building departments, and relatively strong barriers to collecting data from midstream market actors. As with other measures, these scores are primarily based upon low or uncertain long-term cooperation of key market actors to supply data. Because a sample can be designed to achieve any response rate, there are essentially no barriers to implementing on-site or telephone surveys.

Secondary Indicators. As shown, leverage (through the CEC) can be used to develop and implement data collection efforts with building departments as well as by incorporating tracking needs into the planned commercial customer on-site survey effort. All methods, except building department data sources, can be used to collect information on other market effects indicators. Data collection from chiller manufacturers is the only method through which data can be collected on chiller sales in regions outside of California.

Table 8-16: Chillers, New Construction

	Building Department		*Downstream*			*Midstream*		*Upstream*
Criteria	**Compliance**	**Field Insp.**	**Phone Survey**	**On-Site (CEC)[2]**	**On-Site**	**Contractor**	**Engineer/ Designer**	**Manufacturer**
Reliability (Accuracy)	1.5	2	1.5	1.5	1.5	1.5	1.5	1.5
Reliability (Consistency)	1	1	1	1	1	0.5	0.5	0.5
Cost	3	2	2	4	1	2	2	3
Economies (Priority Measures)[1]	1	1	1	1	1	0	0	0
Economies (Non-Priority Measures)	1	1	1	1	1	0	0	0
Timeliness	0.5	0	1	0.5	0.5	0	0	0.5
Barriers to Implementation	2	1	5	5	5	2	2	4
Preliminary Score	**9**	**7**	**12.5**	**13**	**10**	**6**	**6**	**10.5**
Leverage	0.5	0.5	0	0.5	0	0	0	0
Versatility	0	0	0.5	0.5	0.5	0.5	0.5	0.5
Context	0	0	0	0	0	0	0	0.5
Final Score	**9.5**	**7.5**	**13**	**14**	**10.5**	**6.5**	**6.5**	**11**

1 Scores are not included in preliminary score.
2 Scores assume on-site surveys would be conducted as part of the planned CEC commercial customer surveys.

Table 8-17: Chillers, Replace-on-Burnout

Criteria	*Downstream*			*Midstream*		*Upstream*
	Phone Survey	On-Site (CEC)[2]	On-Site	Contractor	Engineer/ Designer	Manufacturer
Reliability (Accuracy)	1.5	1.5	1.5	1.5	1.5	2
Reliability (Consistency)	1	1	1	0.5	0.5	1
Cost	2	1	1	2	2	3
Economies (Priority Measures)[1]	0	0	0	0	0	0
Economies (Non-Priority Measures)	0	0	0	0	0	0
Timeliness	1	0.5	0.5	0	0	0.5
Barriers to Implementation	5	5	5	2	2	4
Preliminary Score	**10.5**	**9**	**9**	**6**	**6**	**10.5**
Leverage	0	0.5	0	0	0	0
Versatility	0.5	0.5	0.5	0.5	0.5	0.5
Context	0	0	0	0	0	0.5
Final Score	**11**	**10**	**9.5**	**6.5**	**6.5**	**11.5**

1 Scores are not included in preliminary score.

2 Scores assume on-site surveys would be conducted as part of the planned CEC commercial customer surveys.

8.10 Non-HVAC Motors

As indicated in Table 6-2, the viable methods for collecting data useful for tracking efficiency market shares of non-HVAC motors include the following:

- Conduct on-site surveys to obtain motor efficiency data by horsepower (HP) levels,
- Collect motor efficiency levels by HP of units sold by California motor distributors and/or purchased by OEMs, and
- Collect efficiency level and HP of motors specified and/or purchased by engineers.

Note that there is no distinction between decision types for this measure.

Table 8-18 includes RER's preliminary analysis of viable methods for tracking efficiency market shares of motors purchased for non-HVAC applications. As indicated, on-site surveys received the highest overall score. Despite the higher costs, on-site surveys can produce more accurate data and essentially have no associated barriers to implementation compared to the other alternatives.

Reliability. As indicated below, only on-site surveys can produce accurate data on motor efficiencies. Accuracy scores for the other methods are lower primarily because data collected from any one upstream market actor will not represent the entire motor market. Recall from Section 4 that there are two distinct channels of motor distribution: to OEMs and through motor distributors. Motors shipped to OEMs are assembled with other components in the production of a variety of types of equipment and products. Motors sold through motor distributors are eventually sold to final end users for motor replacements. Though motors sold through distributors as stand-alone products are more relevant to market transformation efforts in California, collecting data from only one of these market nodes would exclude the remainder of the market. All viable tracking alternatives are expected to be consistent sources of data on a long-term basis.

Cost. Cost is one of the factors that distinguishes on-site surveys from the other tracking alternatives. Because non-HVAC motors are primarily installed in the industrial sector (e.g., assembly, process, compressed air applications), the CEC commercial on-site surveys cannot cover this measure. This, and the fact that industrial on-site surveys are considerably more expensive than commercial on-site surveys, results in very high on-site cost estimates. Cost estimates for other tracking alternatives are also fairly high, due to the time and resources required to recruit data suppliers and develop data collection protocols.

Economies. As shown in Table 8-18, scores for the economies criterion vary across methods. On-site surveys can be used to collect data on other priority and non-priority measures, though the extent to which this is possible is limited to other measures installed in the industrial sector. Compressed air optimization and adjustable speed drives are the only priority measures that can also be covered by on-site surveys in the industrial sector. Aside from on-site surveys, data collection from engineers is the only other tracking alternative that offers notable economies through tracking other measures. Some motor distributors carry related equipment components, including ASDs. This, however, did not warrant a positive score for this criterion.

Timeliness. Scores for the timeliness criterion reveal that data collected with any of the viable methods will not be available in a relatively timely fashion. This result is primarily a function of either the field time required for on-site surveys or the time required to develop relationships and data collection protocols with other key market actors.

Barriers to Implementation. As indicated below, with the exception of on-site surveys, all of the viable methods have significant barriers to being successful efficiency market share tracking methods.

To assess the feasibility of collecting sales data from motor distributors, RER conducted an informal survey with a sample of motor distributors in California.[9] Six motor distributors, representing less than 5% of the California market, were surveyed for their record keeping practices (e.g., the type of sales information they tracked, how this information is stored) and their willingness to participate in a statewide tracking program. None of the distributors were interested in participating in any sort of tracking program. Moreover, the information the distributors record is incomplete and would not meet the data requirements for tracking efficiency market shares. For example, sales model numbers are not necessarily stored in an electronic database. One company, however, indicated that they might participate with an incentive offering.[10]

Secondary Indicators. As shown, none of the alternative tracking methods received positive scores for the leverage criterion, though all methods can be used to track other market effects indicators because they involve some sort of direct contact with key market actors. Data collection from OEMs or OEM distributors is the only alternative that can collect data on sales in other regions.

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[9] A sample of hundreds of motor wholesaler/distributors in California was compiled from various sources, including lists from manufacturers. There are a large number of small independent distributors in addition to larger distributors having multiple branches throughout the state.

[10] Although 5% is a small sample of market actually surveyed, many other calls were placed with no response. This lack of response is most likely indicative of their interest and that additional completed surveys would result in the same conclusion.

Table 8-18: Non-HVAC Motors

	Downstream	*Upstream*		*Midstream*
Criteria	**On-Site Survey**	**OEMs, Distributors**	**Motor Distributors**	**Engineer**
Reliability (Accuracy)	2	1	1	1
Reliability (Consistency)	1	1	1	1
Cost	1	2	2	2
Economies (Priority Measures)[1]	1	0	0	1
Economies (Non-Priority Measures)	1	0	0	1
Timeliness	0.5	0	0	0
Barriers to Implementation	5	1	1	2
Preliminary Score	**11.5**	**5**	**5**	**7**
Leverage	0	0	0	0
Versatility	0.5	0.5	0.5	0.5
Context	0	0.5	0	0
Final Score	**12**	**6**	**5.5**	**7.5**

1 Scores are not included in preliminary score.

8.11 Adjustable Speed Drive Pumps and Fans

As indicated in Table 6-2, the viable methods for collecting data useful for tracking efficiency market shares of adjustable speed drive (ASD) pumps and fans include the following:

- Collect data on pump and fan controls for all applicable variable load motors from building department compliance forms or field inspections (new construction only),
- Collect data on pump and fan controls for all applicable variable load motors from a telephone survey,
- Conduct an on-site survey to collect data on pump and fan controls for all applicable variable load motors,
- Collect data on pump and fan controls for all applicable variable load motors from engineers, and
- Collect sales data from distributors regarding sales of ASDs in California.

Note that there is no distinction between decision types for this measure.

Table 8-19 includes RER's preliminary analysis of viable methods for tracking efficiency market shares of ASD installations. As with most of the priority nonresidential measures, RER has provided two columns for on-site surveys. The scoring in the first column assumes that the tracking needs will be incorporated into the planned CEC commercial customer on-site surveys. The second column of scores assumes that the CEC would not conduct commercial on-site surveys with funds earmarked for data collection. The scores for the CEC and non-CEC on-sites are identical except for cost estimates and leverage scores.

As indicated in Table 8-19, CEC on-site surveys and telephone surveys received the highest overall score, primarily because of the relatively low estimated costs and absence of barriers to implementation. Building department compliance records and unsubsidized on-site surveys also received relatively high overall scores.

Reliability. As shown below, building department field inspections and telephone surveys received the highest possible scores for accuracy. Data collected through on-site surveys will be very accurate, as they represent actual installations. However, the accuracy score for on-site surveys is low because of the assumption that tracking needs will be incorporated into the planned CEC commercial survey. As such, ASD applications in the industrial sector will not be accounted for, and the resulting data would not be representative of the entire ASD market. All methods are expected to produce data on a consistent basis.

Cost. Cost estimates vary across methods, with building department field inspections and data collection from midstream and upstream market actors being the most costly for collecting data on ASD installations. Because costs are partly a function of the number of priority measures covered by the method, and the assumption that tracking efforts would be incorporated into the CEC's planned commercial survey effort, on-site surveys are estimated to be the least expensive method for tracking the extent of ASD applications. Unsubsidized on-site surveys have the highest per-measure estimated cost.

Economies. As indicated in Table 8-19, economies are achievable with all alternative methods for tracking ASDs except through data collection from distributors. As explained above, the same distributors might carry both motors and ASDs, but no other priority measures would apply. This was deemed to not warrant a positive score for this criterion.

Timeliness. Timeliness scores are consistent with the those awarded for other measures. With the exception of a telephone survey, data collected with any of the viable methods will not be available in a relatively timely fashion. This result is primarily a function of either the field time required for on-site surveys or the time required to develop relationships and data collection protocols with other key market actors.

Barriers to Implementation. As with the other measures, telephone and on-site surveys can be successful tracking methods because samples can be designed to achieve the necessary response rate for producing reliable estimates of efficiency market shares. Barriers to implementation exist with the remaining methods, primarily because they rely on the cooperation of key market actors to supply data. Cooperation from these market actors is either uncertain or is expected to be very low. For example, results of RER's information survey of motor distributors, described in the preceding subsection, might apply to ASD distributors, since some distributors carry both motors and ASDs. Thus, the barriers to developing a data collection agreement are expected to be very high.

Secondary Indicators. As shown, scores for the three secondary criteria vary across methods. Leverage exists with building departments and CEC on-site surveys for reasons explained in the above subsections. Only methods that involve direct contact with key market actors, including data collection at the site level and from midstream and upstream market actors, can be used to collect information on other market effects indicators, such as consumer awareness, availability of information, and decision making and stocking practices. None of the viable methods for tracking ASDs can be used to collect data outside of California without increasing cost estimates accordingly.

Table 8-19: ASD Pumps and Fans

	Bldg. Dept.		Downstream			Midstream	Upstream
Criteria	**Compliance**	**Field Insp.**	**Phone Survey**	**On-Site (CEC)[2]**	**On-Site**	**Engineers**	**Distributors**
Reliability (Accuracy)	1	2	2	1	1	1	1
Reliability (Consistency)	1	1	1	1	1	1	1
Cost	3	2	3	4	1	2	2
Economies (Priority Measures)[1]	1	1	1	1	1	1	0
Economies (Non-priority Measures)	1	1	1	1	1	1	0
Timeliness	0.5	0	1	0.5	0.5	0	0
Barriers to Implementation	3	1	5	5	5	2	3
Preliminary Score	**9.5**	**7**	**13**	**13.5**	**10.5**	**7**	**7**
Leverage	0.5	0.5	0	0.5	0	0	0
Versatility	0	0	0.5	0.5	0.5	0.5	0.5
Context	0	0	0	0	0	0	0
Final Scores	**10**	**7.5**	**13.5**	**14.5**	**11**	**7.5**	**7.5**

1 Scores are not included in preliminary score.
2 Scores assume on-site surveys would be conducted as part of the planned CEC commercial customer surveys.

8.12 Nonresidential Lighting: 32W T8s w/Electronic Ballasts

As indicated in Table 6-2, the viable methods for collecting data useful for tracking efficiency market shares of nonresidential lighting equipment – 32 watt T8 lamps with electronic ballasts, in particular - include the following:

- Obtain installed lighting information, including luminaire type, lamp type and number, ballast type and number, and watts per square foot from building department compliance forms or field inspections (new construction only),
- Implement on-site surveys to obtain the lighting efficiency parameters, luminaire type, lamp type and number, and number of ballasts by type of installed equipment,
- Collect necessary data of installed lighting equipment from nonresidential builders, (new construction only), and
- Collect sales data from nonresidential lighting contractors, which would necessarily include efficiency parameters, lamp and ballast type, and number of units sold.

All of these methods are applicable to both decision types except collecting data from building departments and builders, which are only applicable to new construction installations.

Table 8-20 and Table 8-21 include RER’s evaluation of viable methods for tracking efficiency market shares of lighting equipment installed in the nonresidential new construction sector and retrofits, respectively. Note that there are two columns for on-site surveys. The scoring in the first column assumes that the planned CEC commercial customer on-site surveys will be used to collect data for tracking purposes. The second column of scores reflect that the costs would not be subsidized by funds already earmarked for CEC data collection. The scores for the CEC and non-CEC on-sites are identical except for cost estimates and leverage scores.

As shown in Table 8-20, both CEC and non-CEC on-site surveys and obtaining data from compliance forms submitted to building departments received the highest overall scores. The main differences among scoring across methods are mostly due to differences in estimated costs and expected barriers to implementation. Table 8-21 reveals that on-site surveys and mail/telephone surveys scored more favorably than data collection from lighting contractors because the data are expected to be more accurate, estimated costs are lower, and significant barriers to implementation are absent.

Reliability. As shown by Table 8-20 and Table 8-21, the viable methods for tracking nonresidential lighting equipment can produce accurate data for both decision types.

Obtaining data from building department compliance forms was not awarded a perfect score for accuracy because data represent planned, not actual, installations. Similar to other measures, the uncertain record keeping practices of and cooperation from builders and contractors resulted in lower reliability scores – for both data accuracy and consistency – for data collection from these market actors.

Cost. As evidenced by the scoring, on-site surveys for collecting new construction installations can be implemented at a fairly low marginal cost if tracking needs were to be incorporated into the CEC commercial survey effort. However, on-site survey costs are very high for tracking retrofits with and without CEC involvement. Obtaining building department compliance forms (for new construction installations) and developing a telephone or mail survey (for retrofits) are also expected to be less expensive than collecting data from midstream market actors, such as builders and contractors. Similar to other measures, developing tracking systems that involve recruiting market actors as data suppliers could be costly and time intensive because of the effort required to recruit and maintain their cooperation.

Economies. As shown in Table 8-20, data collection from lighting contractors is the only method that cannot collect data for tracking other priority measures. All other methods can track multiple priority measures and other non-priority measures. None of the viable methods for tracking lighting retrofits can be used to track other priority or non-priority measures.

Timeliness. The timeliness scores are consistent with those awarded for other measures. The methods that require recruiting participation from market participants, including data collection from builder and lighting contractors, are not expected to be developed and operational in a timely manner. Obtaining compliance forms from building departments and conducting on-site surveys require less development time, but still involve time and resources for questionnaire development and data collection protocols. A telephone survey for collecting efficiency data of lighting retrofits can be developed fairly quickly.

Barriers to Implementation. The anticipated barriers to successfully implementing the viable methods for tracking nonresidential lighting vary considerably. Building department field inspections, and data collection from contractors and builders were awarded very low scores. As mentioned previously, RER anticipates little willingness on the part of building departments to conduct on-site field inspections to verify installations. Likewise, cooperation from builders and contractors is not expected to be high. At the other end of the spectrum, have not been identified barriers to successfully implementing on-site and mail or telephone surveys.

Secondary Indicators. As shown, only CEC on-site surveys and building department data sources received positive scores for leverage. With respect to versatility, questions to obtain information about other market effects indicators can be incorporated into the on-site survey or the data collection protocol with lighting contractors and builders. None of the viable methods for tracking nonresidential lighting for either decision type can produce data for tracking efficiency market shares in other regions.

Table 8-20: Nonresidential Lighting (32W T8s w/Electronic Ballasts), New Construction

	Bldg. Department		*Downstream*		*Midstream*	
Criteria	**Compliance**	**Field Insp.**	**On-Site (CEC)[2]**	**On-Site**	**Contractor**	**Builder**
Reliability (Accuracy)	1.5	2	2	2	1.5	1.5
Reliability (Consistency)	1	1	1	1	0.5	0.5
Cost	3	2	4	1	2	2
Economies (Priority Measures)[1]	1	1	1	1	0	1
Economies (Non-Priority Measures)	1	1	1	1	1	1
Timeliness	0.5	0	0.5	0.5	0	0
Barriers to Implementation	3	1	5	5	2	2
Preliminary Score	**10**	**7**	**13.5**	**10.5**	**7**	**7**
Leverage	0.5	0.5	0.5	0	0	0
Versatility	0	0	0.5	0.5	0.5	0.5
Context	0	0	0	0	0	0
Final Score	**10.5**	**7.5**	**14.5**	**11**	**7.5**	**7.5**

1 Scores are not included in preliminary score.
2 Scores assume on-site surveys would be conducted as part of the planned CEC commercial customer surveys.

Table 8-21: Nonresidential Lighting (32W T8s w/Electronic Ballasts), Retrofit

	Downstream			***Midstream***
Criteria	**On-Site (CEC)[2]**	**On-Site**	**Phone/Mail Survey**	**Contractor**
Reliability (Accuracy)	2	2	1	1.5
Reliability (Consistency)	1	1	1	0.5
Cost	1	1	3	2
Economies (Priority Measures)[1]	0	0	0	0
Economies (Non-Priority Measures)	0	0	0	0
Timeliness	0.5	0.5	1	0
Barriers to Implementation	5	5	5	2
Preliminary Score	**9.5**	**9.5**	**11**	**6**
Leverage	0.5	0	0	0
Versatility	0.5	0.5	0.5	0.5
Context	0	0	0	0
Final Score	**10.5**	**10**	**11.5**	**6.5**

1 Scores are not included in preliminary score.
2 Scores assume on-site surveys would be conducted as part of the planned CEC commercial customer surveys.

8.13 Nonresidential HVAC: Energy Management Systems

As indicated in Table 6-2, the viable methods for collecting data useful for tracking efficiency market shares of energy management systems include the following:

- Collect data about the HVAC system control features from building departments, either from required compliance forms or through field inspections (new construction only),
- Administer a mail or telephone survey to collect data on the type and use of installed HVAC controls from end users,
- Implement on-site surveys to collect data on the type and use of installed HVAC controls from end users,
- Collect sales data from HVAC contractors, which would necessarily include information about HVAC system control types sold and installed in nonresidential buildings in California.

All of these methods are applicable to both decision types, except collecting data from building departments.

Table 8-22 and Table 8-23 include RER's analysis of viable methods for tracking efficiency market shares of HVAC energy management systems (EMSs). Again, scoring for on-site surveys distinguished between CEC and non-CEC involvement. The scores for the CEC and non-CEC on-sites are identical except for cost estimates in Table 8-22 and leverage scores.

As shown, on-site and mail or telephone surveys received the highest overall scores for tracking new construction installations. CEC on-sites and mail or telephone surveys scored most favorably for tracking EMS retrofits. These results are attributable to high data accuracy, low estimated costs, and/or absence of barriers to successfully implement these methods.

Reliability. As discussed in Section 4, tracking efficiency market shares of EMS could be difficult because there are no efficiency levels of EMS systems *per se*. Thus, data requirements for tracking include 1) type of space conditioning control system (centralized infers an EMS system), and/or 2) use of specific control types. The former reflects the relative mixes of the sophistication of HVAC controls in nonresidential buildings and might be too correlated with building size and/or type to make any inferences about energy efficiency. Furthermore, it does not necessarily infer effective use of available controls, which would provide more information about HVAC control usage patterns over time. Thus, while system type data collecting would be useful, tracking the use of controls over time would be more valuable for assessing overall building energy efficiency and market transformation efforts.

These issues are related to the scores of accuracy presented in Table 8-22 and Table 8-23. Those methods that can produce data on both HVAC system control type and the use of specific controls were awarded higher scores than those that could not. In particular, only on-site and mail/telephone surveys received the highest possible score for accuracy because information can be obtained directly from end users about the type and use of HVAC controls. Other methods, including building department data sources and data collection from HVAC contractors, can only provide data on type of systems and controls installed, not usage practices. These methods received lower accuracy scores.

All methods were deemed consistent long-term data sources except data collection from HVAC contractors.

Cost. Scores for the cost criterion are consistent with those assigned to other measures. In particular, data collection from contractors and building department field inspections are expected to be more costly due to time and resources needed develop data collection protocols. The estimated cost for CEC on-site surveys is fairly low for tracking new construction and retrofit installations of EMS; the cost is significantly higher if on-sites are not subsidized with funds already earmarked for CEC data collection.

Economies. All of the viable methods for tracking EMS can also be used to collect data on other priority and non-priority measures installed in nonresidential new construction. However, only HVAC contractors would be able to supply data on multiple measures installed as replacements. Data collection from HVAC contractors, however, has a more limited scope, as contractors could only supply data on HVAC-related equipment and services.

Timeliness. As indicated in Table 8-22 and Table 8-23, mail and telephone surveys can be developed and administered fairly quickly, while the development of on-site surveys and obtaining data from building departments require more time and resources. Setting up a tracking initiative that would involve obtaining data from HVAC contractors is not expected to be timely, as recruiting data suppliers and setting up a data collection protocol could be very time intensive.

Barriers to Implementation. The evaluation of barriers to implement these methods is consistent with the scoring for other measures. There are no barriers to successfully implement on-site or mail and telephone surveys, thus these measures were assigned the highest possible score. Other methods, particularly building department field inspections, are not expected to be highly successful, as they depend upon the cooperation of market actors, which would involve supplying data or changing their normal business practices.

Secondary Indicators. Again, scores assigned to leverage, versatility, and context are consistent with scoring of other measures. Leverage exists with on-site surveys because the planned CEC customer surveys can incorporate market share tracking needs. In the case of building departments, the CEC can encourage building department cooperation and recommend that builders be required to submit compliance and installation forms for future Title 24 revisions.

As indicated by the scoring, all viable methods except the building department data sources can also be used to collect information about other market effects indicators. None of the methods for either decision type can produce efficiency market share data for other regions without significant increases in cost.

Table 8-22: Energy Management Systems, New Construction

	Bldg. Department		***Downstream***			***Midstream***
Criteria	**Compliance**	**Field Insp.**	**On-Site (CEC)[2]**	**On-Site**	**Mail/Phone Survey**	**Contractor**
Reliability (Accuracy)	1	1	2	2	2	1
Reliability (Consistency)	1	1	1	1	1	0.5
Cost	3	2	4	1	3	2
Economies (Priority Measures)[1]	1	1	1	1	1	1
Economies (Non-Priority Measures)	1	1	1	1	1	1
Timeliness	0.5	0	0.5	0.5	1	0
Barriers to Implementation	3	1	5	5	5	2
Preliminary Score	**9.5**	**6**	**13.5**	**10.5**	**13**	**6.5**
Leverage	0.5	0.5	0.5	0	0	0
Versatility	0	0	0.5	0.5	0.5	0.5
Context	0	0	0	0	0	0
Final Score	**10**	**6.5**	**14.5**	**11**	**13.5**	**7**

1 Scores are not included in preliminary score.
2 Scores assume on-site surveys would be conducted as part of the planned CEC commercial customer surveys.

Table 8-23: Energy Management Systems, Retrofit

Criteria	*Downstream*			*Midstream*
	On-Site (CEC)[2]	**On-Site**	**Mail/Phone Survey**	**Contractor**
Reliability (Accuracy)	2	2	2	1
Reliability (Consistency)	1	1	1	0.5
Cost	4	1	3	2
Economies (Priority Measures)[1]	0	0	0	1
Economies (Non-Priority Measures)	0	0	0	1
Timeliness	0.5	0.5	1	0
Barriers to Implementation	5	5	5	2
Preliminary Score	**12.5**	**9.5**	**12**	**6.5**
Leverage	0.5	0	0	0
Versatility	0.5	0.5	0.5	0.5
Context	0	0	0	0
Final Score	**13.5**	**10**	**12.5**	**7**

1 Scores are not included in preliminary score.
2 Scores assume on-site surveys would be conducted as part of the planned CEC commercial customer surveys.

8.14 Packaged Refrigeration Equipment

Table 6-2 reveals that none of the tracking alternatives can produce the data required for tracking efficiency market shares of packaged refrigeration equipment. Note that methods for tracking nonresidential window retrofits were not evaluated. As explained in Section 9, this measure was dropped as a priority measure.

8.15 Compressed Air System Optimization

Because this measure specifically pertains to end-user practices and does not represent a piece of equipment with associated efficiency levels, the only viable methods for tracking involve data collection at the customer level. As indicated in Table 6-2, viable methods for collecting data useful for tracking efficiency market shares of compressed air system optimization include the following:

- Conduct on-site surveys of industrial sites to obtain information about air compressor efficiency levels and compressed air system leak maintenance and management practices, and
- Administer a mail or telephone survey of industrial sites to obtain information about air compressor efficiency levels and compressed air system leak maintenance and management practices.

Note that distinguishing between decision types is not applicable to this efficiency measure. The point should also be made that the on-site survey would involve minimal equipment inspection; the majority of the information required for tracking would need to be obtained via facility manager or engineer interviews.[11] As indicated in Table 8-24, telephone/mail surveys are favored over on-site surveys, primarily due to the lower estimated costs.

Reliability. The data obtained via on-site or telephone/mail surveys can be very accurate, provided the appropriate respondent is identified, such as the facility manager or engineer. Because the required data includes information on leak maintenance and management practices, in addition to compressor efficiency levels, a portion of the on-site survey should necessarily include questions to obtain such information.

Both methods were awarded the highest possible score for consistency.

Cost. As indicated in Table 8-24, costs for implementing on-site surveys are substantially higher than a mail or telephone survey. Because compressed air systems are dominant in the industrial rather than in the commercial sector, this measure must be covered by the planned

[11] Section 4 reviewed the elements of compressed air optimization and the data that would be required for tracking purposes.

CEC commercial on-site survey effort. Regardless, implementing on-site surveys of industrial sites is considerably more costly than doing so in the commercial sector.

Economies. Both on-site and mail or telephone surveys can be used to collect information on multiple priority and other non-priority measures. Because compressed air optimization is an industrial measure, economies achievable with these methods are limited to other industrial measures.

Timeliness. As with the other measures, telephone and mail surveys can be developed and administered in a relatively timely manner, while on-site surveys typically require more time to implement, particularly in industrial sites.

Barriers to Implementation. As indicated, there are no barriers to implementing either of the viable methods for tracking compressed air optimization practices.

Table 8-24: Compressed Air System Optimization

	Downstream	
Criteria	**On-Site Survey**	**Phone/Mail Survey**
Reliability (Accuracy)	2	2
Reliability (Consistency)	1	1
Cost	1	3
Economies (Priority Measures)[1]	1	1
Economies (Non-Priority Measures)	1	1
Timeliness	0.5	1
Barriers to Implementation	5	5
Preliminary Score	**10.5**	**13**
Leverage	0.5	0
Versatility	0.5	0.5
Context	0	0
Final Score	**11.5**	**13.5**

1 Scores are not included in preliminary score.

9

Recommendations for Tracking Residential Measures

9.1 Overview

This section presents RER's recommended initiatives for tracking market shares of the residential priority measures. Section 8 detailed the scoring of each viable method for each priority measure by applicable decision type. The final step of the Feasibility Assessment is to develop a set of market tracking initiatives that provide the broadest market coverage yet maintain an acceptable level of data accuracy. Adopting a myopic view and recommending a single method for each measure based purely on the final scores of the methods without analyzing the impact of economies across priority measures would disservice the intent of this research. Further, it is clear that no single method for collecting data from any one market actor can provide the optimal solution to tracking efficiency market shares in California.

RER's recommended initiatives are integrated methods that borrow from the strengths of the highest scored methods to produce workable tracking solutions. For instance, the relatively high scores of some of the methods are a direct result of available economies. These economies and the associated lower per-measure costs are applicable only insofar as all measures covered by the economies are actually included in the method. In order to take full advantage of this factor, RER considered initiatives that grouped measures by methods exhibiting such economies.

RER also considered the advantages of integrating two methods where one method provides considerable secondary data and helps fill in some of the weaknesses of another method. The result is an integrated method that provides more reliable results than the two component methods. An example of this approach is the use of on-site data to calibrate building department verification and installation data.

The tracking initiatives presented here recommend data collection on a quarterly basis. Unlike the "old world," in which measurement and evaluation entailed distinct projects conducted on an annual or biannual cycle driven primarily by regulatory factors, market transformation assessment will need to be an ongoing process accommodated by the availability of data generated by a comprehensive tracking system. Collecting data on a semiannual or annual basis would yield an inadequate number of data points to assess the extent of market transformation. This is a critical issue, particularly when one considers the time required to develop a tracking system and the number of data points available to assess market transformation through the end of the transition period. For example, if the first estimates of efficiency market shares are not available until, say, the first quarter of 2000, collecting data on a semiannual basis would only produce four data points through the end of the transition period.

Subsection 9.2 below provides a summary of the recommended tracking initiatives for residential measures, and Subsections 9.3 through 9.6 detail each recommendation.

9.2 Summary of Recommended Tracking Initiatives for Residential Measures

Table 9-1 summarizes RER's recommendations for tracking the priority residential measures.[1] As indicated, RER recommends that the market shares of the residential measures be tracked with the following four initiatives:

- ***Initiative I: Integrating On-Site Surveys and Building Department Data.*** This initiative integrates building department data and installation data collected with on-site surveys in the residential new construction sector. This initiative is the recommended primary data source for new construction installations of the following priority measures:
    - Duct sealing (practices),
    - Central air conditioning equipment,
    - Compact fluorescent fixtures,
    - Windows,
    - Gas furnaces,
    - Gas water heating equipment, and
    - Dishwashers.

  This initiative would also be a secondary data source for new construction installations of the following measures:
    - Clothes washers,
    - Compact fluorescent lamps, and
    - Refrigerators.

[1] Note that the recommendations appearing in Table 9-1 represent the primary tracking initiative for each measure. In some cases, RER recommends that the primary data be supported or augmented with secondary data to cross-check data obtained from other sources. Secondary methods are discussed when appropriate.

- ***Initiative II: On-Site Surveys of Prescreened Residential Sites.*** This initiative recommends that on-site surveys be conducted for a prescreened sample of residential sites that have replaced windows or that have retrofitted air distribution ducts. This recommended initiative would be the primary data source for retrofits of the following priority measures:
  - Duct sealing (practices), and
  - Windows.

  This initiative can also be used as a primary data source for replace-on-burnout, or net acquisition installations of air conditioning and water heating priority measures, including central air conditioning equipment, gas water heating equipment, and gas furnaces.

  However, insofar as there are unlikely to be homes that retrofit or add more than one of the high priority measures per quarter, there are no economies to using this method. each additional measure included in this initiative will add considerable costs due to the costs of performing on-site inspections. Therefore, RER recommends Initiative III for tracking replace-on-burnout, or net acquisition purchases of residential HVAC and gas water heating measures.

- ***Initiative III. Collecting Distributor Sales Data.*** This initiative recommends that quarterly sales data be collected from HVAC and water heating distributors. These data will not provide tracking data by decision type.[2] However, if Initiative I is also implemented, tracking data will be available for new construction. These estimates together with the distributor data could be used to infer replace-on-burnout and net acquisition shares.

  Assuming that Initiative I is also adopted, this initiative can be the primary data source for replace-on-burnout, or net acquisition installations of HVAC and water heating priority measures. In particular,
  - Central air conditioning equipment,
  - Gas furnaces,
  - Gas water heating equipment, and
  - Packaged air conditioning equipment.

- ***Initiative IV: Energy Star® /EGIA Retail Tracking.*** This recommended initiative is an integrated approach involving current ENERGY STAR® data collection efforts and the Electric and Gas Industries Association for tracking of replace-on-burnout and net acquisition purchases. This initiative would be the primary data source for replace-on-burnout and net acquisition purchases of the following priority measures:

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[2] Tracking by decision type has been a primary objective of the tracking system. In particular, methods that are unable to provide tracking data by decision type were assumed not to be viable options for tracking. However, data collection from distributors for some measures was retained as a viable option for reasons explained in Section 8.

- Compact fluorescent fixtures and lamps,
- Clothes washers,
- Refrigerators, and
- Dishwashers.

This tracking method would be a secondary data source for replace-on-burnout and net acquisition purchases of the following:

- Central air conditioning equipment,
- Residential windows, and
- Gas furnaces.

Table 9-1: Summary of Recommended Tracking Initiatives for Priority Residential Measures

Priority Measure	Recommended Tracking Initiative
Duct Sealing [NC]	I Bldg. Dept./On-site Survey Data
Duct Sealing [Retro.]	II On-Site Survey of Prescreened Sample
Central Air Conditioners [NC]	I Bldg. Dept./On-Site Survey Data
Central Air Conditioners [Net Acquis./ROB]	III Distributor Sales Data
Compact Fluorescent Fixtures [NC]	I Bldg. Dept./On-Site Survey Data
Compact Fluorescent Fixtures [ROB]	IV ENERGY STAR®/EGIA Retail Initiative
Horizontal Axis Clothes Washers [Net Acquis/ROB.]	IV ENERGY STAR®/EGIA Retail Initiative
Windows [NC]	I Bldg. Dept./On-Site Survey Data
Windows [Retro]	II On-Site Survey of Prescreened Sample
Compact Fluorescent Lamps [NC]	I Bldg. Dept./On-Site Survey Data
Compact Fluorescent Lamps [ROB]	IV ENERGY STAR®/EGIA Alliance Retail Initiative
Gas Furnaces [NC]	I Bldg. Dept./On-site Survey Data
Gas Furnaces [ROB]	III Distributor Sales Data
Refrigerators [Net Acquis./ROB]	IV ENERGY STAR®/EGIA Retail Initiative
Dishwashers [NC]	I Bldg. Dept./On-Site Survey Data
Dishwashers [ROB]	IV ENERGY STAR®/EGIA Alliance Retail Initiative
Gas Water Heaters [NC]	I Bldg. Dept./On-Site Survey Data
Gas Water Heaters [ROB]	III Distributor Sales Data *(See table footnote)*

[NC] [Retro.] [ROB] and [Net Acquis.] denote new construction, retrofit, replace-on-burnout, and net acquisition decision types, respectively.
Note that distributor sales data of sales of water heater replacements excludes roughly 50% of the water heaters sold through retailers who purchase directly from the manufacturer. This issue is discussed in Section 9.5.

When combined, these four initiatives recommend approaches for tracking all of the priority residential measures for all decision types. These initiatives recommend collecting data at the end-user level using on-site surveys, from building departments for new construction, from retailer records, and from distributors. Where possible, these initiatives utilize the significant economies from collecting information about numerous priority measures at one market node using a single customized approach. Alternative approaches that require data collection from market nodes other than from consumers require either a multi-node tracking initiative or the omission of a significant portion of the market.

Timing

The four recommended initiatives are designed to collect data on a quarterly basis and could be developed and implemented by the end of the third quarter of 1999, thereby producing tracking data by the first quarter of 2000. Table 9-2 summarizes the timing of the planning and implementation of each initiative. Note that these estimates rely on reasonable and timely cooperation from the major players in each of the initiatives. For example, Initiative II on the timely development of data conduits with HVAC and water heater distributors.

Table 9-2: Summary of the Timing of the Planning and Implementation the Recommended Residential Tracking Initiatives

Initiative	Planning	Implementation
I Integrating On-Site Survey and Building Department Data	6 – 10 weeks beginning 2nd Quarter 1999	3rd Quarter 1999
II On-Site Surveys of Prescreened Residential Sites	6 – 10 weeks beginning 2nd Quarter 1999	4th Quarter 1999
III Collection of Distributor Sales Data	12 – 16 weeks beginning 2nd Quarter 1999	3rd Quarter 1999
IV ENERGY STAR®/EGIA Retail Tracking	4 – 6 weeks beginning 2nd Quarter 1999	2nd Quarter 1999

Costs

Table 9-3 presents a summary of the costs by initiative for the first and subsequent years. The estimated annual budget to develop and implement the four recommended tracking initiatives is in the range of $1,054,000 to $1,405,000 for the first year. Development costs are not incurred in subsequent years, which reduces the annual costs to roughly $920,000 to $1,202,000.

As will be detailed in subsequent sections of this report, these costs can be lowered, but at the cost of data quality and/or measure coverage. The main methods to lower costs include collecting data semi-annually instead of quarterly, decreasing the on-site sample sizes, or eliminating a data source from the integrated data collection method.

Table 9-3: Summary of the Annual Costs for First and Subsequent Years for Planning and Implementing the Recommended Residential Tracking Initiatives

Initiative	First Year	Second Year
I Integrating On-Site Survey and Building Department Data	$442,000 - $560,000	$420,000 - $512,000
II On-Site Surveys of Prescreened Residential Sites	$356,000 - $445,000	$332,000 - $410,000
III Collect Distributor Sales Data	$96,000 - $170,000	$68,000 - $140,000
IV ENERGY STAR®/EGIA Retail Tracking	$160,000 - $230,000	$100,000 - $140,000
Total Cost	$1,054,000 - $1,405,000	$920,000 - $1,202,000

9.3 Initiative I: Integrating On-Site Survey and Building Department Data

As indicated in Table 9-1, RER recommends tracking new construction installations of several residential measures at the end user level—through data collected via on-site surveys and through building department compliance forms, in particular. Surveying the end user and collecting data from installation records is more favorable than collecting data at other market nodes for several reasons. First, as explained in Section 4, upstream market actors, such as distributors and manufacturers, do not typically track product sales beyond the first invoice and/or are unable to distinguish sales by decision type. Second, end user-level data are preferred over obtaining data from midstream market actors, such as builders and contractors. RER anticipates that these sources would not be reliable, long-term sources of data useful for efficiency tracking. Furthermore, RER's experience in past studies suggests that these market actors would be very reluctant to commit time or resources to such research efforts.

The initiative proposed here integrates data from quarterly on-site surveys in the residential new construction sector with data from building department verification records. This tracking initiative would be the primary source of market tracking for seven priority measures in the residential new construction sector including:

- Duct sealing (practices),
- Central air conditioning equipment,
- Compact fluorescent fixtures,
- Windows,
- Gas furnaces,
- Gas water heating equipment, and
- Dishwashers.

This initiative will also serve as a secondary source for three other priority measures installed in newly constructed homes including:

- Clothes washers,
- Compact fluorescent lamps, and
- Refrigerators.

Figure 9-1 provides an overview of this tracking initiative. As shown, there are seven key elements to the tracking approach:

- Survey design,
- On-site surveys,
- Building department verification data,
- Building department and on-site survey data overlap,
- On-site and building department data calibration and verification,
- Market share tracking analyses, and
- New construction measure efficiency tracking database updates.

Briefly, this initiative entails data collection from three samples of newly constructed residential sites. A quarterly sample of 400 on-site surveys will be conducted using a stratified sample of newly constructed homes. This data will be augmented with the collection of data from at least 1,100 Installation Certificates (CF-6R Form) from a sample of building departments throughout California. In addition, for 50 of the 400 on-site surveys, both building department data and on-site survey data will be collected each quarter. Data from these three samples will verify the accuracy of the building department data, calibrate the timing of the installation of energy using equipment in newly purchased homes, generate useful tracking parameters, collect data on other market effects indicators, and ultimately populate a measure efficiency tracking database.

RER estimates that this initiative could be developed and operational within six months of its inception.

The remainder of this recommendation details the data and measure coverage, procedure for developing the initiative, provides timing and cost estimates, and discusses other issues.

Measure and Data Coverage

On-Site Surveys. Table 9-4 includes measures covered by the on-site survey, whether this is the primary or secondary data tracking source, the characteristics of measures that can be collected during the on-site visit, and corresponding data that would ultimately be used for tracking market shares.[3] The distinction between the data collected on-site and the data used for market share tracking is important. In most cases, the equipment type and model number are the only observable data that can be collected during the on-site visit. These data can ultimately be translated to useful efficiency and equipment characteristics by using product directories or manufacturer-specific publications.

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[3] A designation of a primary source indicates that the on-sites will provide the primary data used to track market shares. A secondary designation indicates that this data will be either supplemental to other initiatives or used to cross-check data from other sources.

Table 9-4: Measures and Measure Characteristics Covered by On-Site Surveys

Measure	Source Type	Data Collected On-Site	Tracking Data
Dishwashers	Primary	Manufacturer and model number	EF, presence of energy saving features
Compact Fluorescent Fixtures	Primary	Number of fixtures by type	Number of fixtures by type
Duct Sealing Practices	Primary	Tape type, presence of mechanical fastening and plenum	Tape type, presence of mechanical fastening and plenum
Central Air Conditioners	Secondary	Type, manufacturer, model number	Type, SEER, capacity
Gas Furnaces	Secondary	Type, manufacturer, model number	Type, AFUE, capacity
Gas Water Heaters	Secondary	Manufacturer and model number	EF, tank size
Compact Fluorescent Lamps	Secondary	Number of lamps by wattage	Number of lamps by wattage
Windows	Secondary	Number of panes, frame type (wood, vinyl), size	Number of panes, frame type (wood, vinyl), Size
Clothes Washers	Secondary	Manufacturer and model number	EF, capacity (lbs.)
Refrigerators	Secondary	Manufacturer and model number	EF, type (top mount, bottom mount, side-by-side, single door), size (cubic feet)

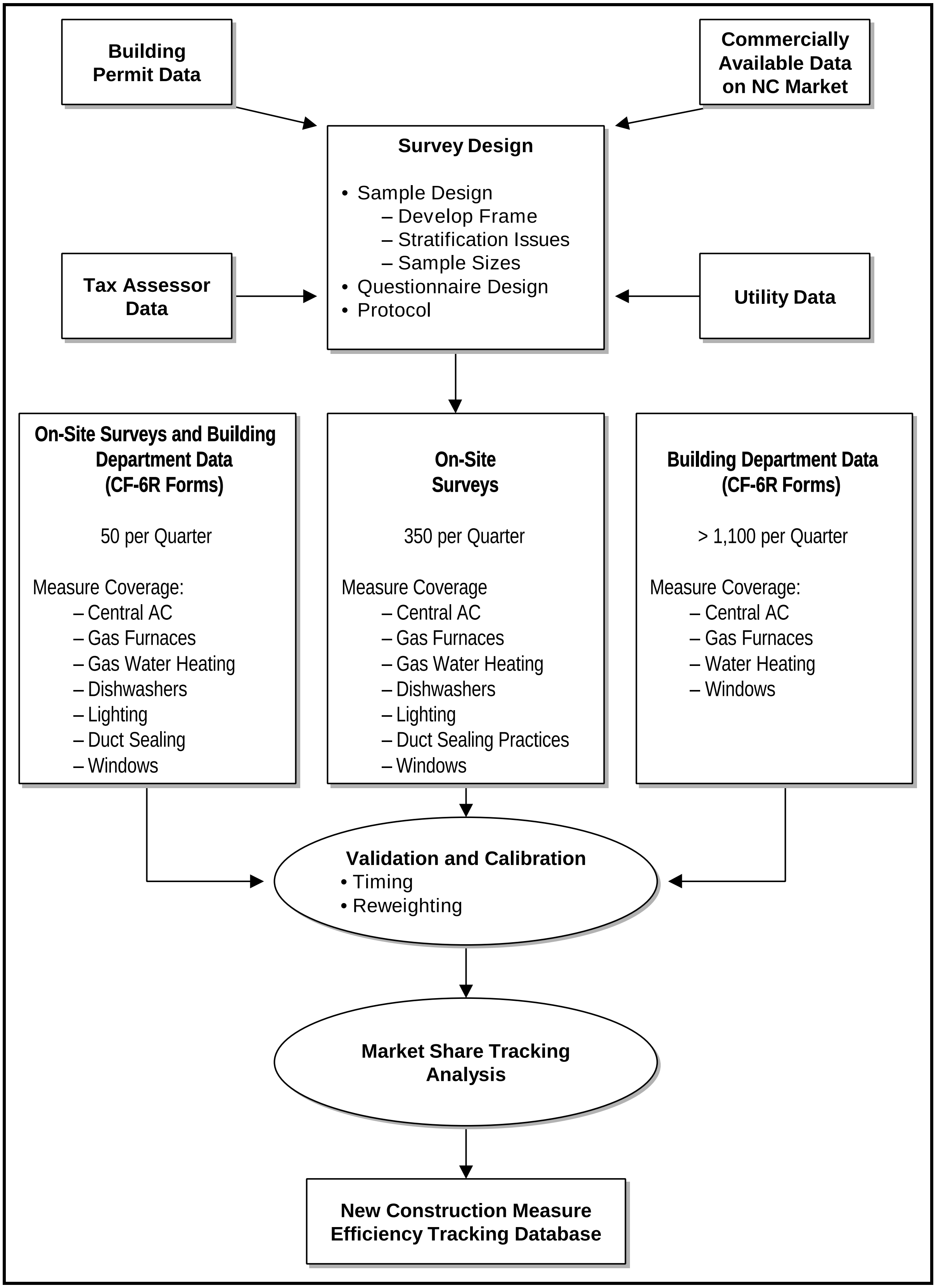
Building Department Data. The CF-6R forms used to verify the installation of energy using equipment in residential new construction are the source of the building department data. Table 9-5 includes the priority measures covered by these forms, whether this is the primary or secondary source for tracking data, and the characteristics of the measures that can be used for tracking market shares. Note that, unlike the on-site survey data, the data collected from the CF-6R forms are already in a form useful for efficiency tracking.

In addition to the specific data for the high priority measures presented above, data on purchasing and decision-making practices relating to energy-using equipment, detailed data on competing measures such as electric and solar water heaters, and demographic characteristics can also be collected during the on-site surveys and/or from building department data.

Table 9-5: Measures and Measure Characteristics Covered by Building Department Data

Measure	Source Type	Data Available from Building Department CF-6R Forms
Central Air Conditioners	Primary	Manufacturer, model number, Type, SEER, capacity
Gas Furnaces	Primary	Manufacturer, model number, Type, AFUE, capacity
Gas Water Heaters	Primary	Manufacturer, model number, EF, tank size
Windows	Primary	U-value, number of panes

Figure 9-1: Residential New Construction – Market Tracking Initiative



Development

Development of this method entails 1) the design and implementation of a residential new construction on-site survey, 2) formulation of a protocol for collecting building department data, and 3) construction of a new construction measure efficiency tracking database. Development of each of these components is discussed below.

Design and Implementation of Residential New Construction On-Site Survey

The following are four major elements of the on-site survey:

- Sample design,
- Questionnaire design,
- On-site survey protocol,
- Data collection.

Sample Design. The initial step of the survey design is to identify the population of new construction activity in California and to develop a sample frame. The information needed to develop the population and sample frame could be collected from the following sources:

- Tax assessor records,
- Commercial market research firms,
- CEC customer survey sample frame/data, and
- Utility data.

It should be noted here that collecting data from the latter two alternatives is problematic. The CEC survey database will rely heavily on sample frame data received from individual utilities. RER's past experience reveals that it is difficult for the utilities to identify new construction customers, as this data is not typically included on their billing frame. Further, the CEC's biggest concern and obstacle to developing their customer survey effort is obtaining sample frame and billing data from utilities, which are necessary for implementation of the CEC's customer surveys.[4] Having noted these issues, data from commercial companies, trade associations, and tax assessor records can provide sufficient data to develop a population and sampling frame.

[4] Utilities are hesitant to supply billing frame data to a state public agency, but might be more amenable if the surveys are used for market share tracking.

Sample stratification and size are also important sample design considerations.

- ***Sample Stratification.*** Stratification of the sample by residence type and climate zone would allow for the examination of market share trends by these stratification variables. This would be particularly important for weather sensitive measures.
- ***Sample Size.*** The sample size needs to support the estimation of tracking parameters for the primary priority measures. RER recommends a completed sample size of 400 on-site surveys of newly constructed homes per quarter. The recommended sample size would support the estimation of 1) the proportion of homes with compact fluorescent fixtures (assumed to be 40%), within ±10%, with 90% confidence; and 2) the average energy factor above some base level (presumably the standard) for dishwashers with the same precision.[5,6] Further, assuming a central air conditioning saturation of 60%, a sample of 240 homes would be available to make inferences on duct sealing practices per quarter.

Questionnaire Design. The on-site questionnaire design will be critical for the success of the tracking effort. The survey should involve two phases: a resident interview and a thorough walk-through inspection of the relevant measures. RER recommends that the survey be tailored to collect the data required to develop the market tracking database (e.g., the equipment characteristics outlined in Table 9-4). Further, the questionnaire should include questions on self-reported attitudes and resident demographics.

Survey Protocol and Data Collection. A standard protocol, involving an introductory letter and a not-to-exceed telephone callback method to set on-site appointments, should be adopted. Data collection should be completed by professionals experienced in energy auditing of residential homes and conducting in-person interviews.

Collecting Building Department Data

Over 500 individual building departments in California issued more than 110,000 building permits in 1997 (Construction Industry Research Board, 1998). This recommended tracking initiative requires that at least 1,100 CF-6R forms be collected from a sample of these building departments every quarter.[7] Obtaining this information from building departments

[5] This assumes a coefficient variation of one and that 85% of new homes have dishwashers already installed.

[6] The completed sample would need to be considerably larger if the on-sites were the primary tracking method for low saturation priority measures, such as central air conditioners. These priority measures are accounted for in the relatively large sample sizes obtainable from the building departments.

[7] Requiring at least 1,100 forms would support the estimation of the percentage of covered priority measures that are considered to be high efficient. For example, if it assumed that 20% of newly constructed homes install high efficiency air conditioners, a sample size of roughly 1,100 would be required to support an estimate of ±10% with 90% confidence. One could also consider estimating the average efficiency level above the standard. Using a coefficient variation of one, this would require a sample size of about 280.

will require the cooperation of a significant sample of building departments to collect and send the data to a central clearinghouse.

In order to gauge the feasibility of this task, RER conducted an informal survey of 23 building departments throughout California. These 23 building departments represent roughly 17% of the total number of building permits issued in 1997. Key findings include the following:

- Six building departments were willing to collect and send the required data. These six building departments represent roughly 35% of building permits issued in 1997 by the surveyed building departments.
- Four building departments indicated that they would seriously consider submitting the data. These four building departments represent roughly 24% of the building permits issued in 1997 by the surveyed building departments.
- Thirteen of the building departments indicated that they would not be willing to submit the data. The major reason given by these building departments was lack of staffing and/or time.

These findings were very encouraging. The indication is that roughly 59% of the surveyed building departments would, with some encouragement, be willing to collect the CF-6R forms and submit them for market share tracking. Given that financial incentives could be offered to pay for internal building department staff time to fulfill requests, it is anticipated that a statistically significant sample of CF-6R forms can be collected for the purposes of market share tracking.

As mentioned above, data from both an on-site survey and from building department data will be collected for 50 sites. Information from building departments will be gathered and used to develop contacts for the on-site surveys.

The protocol for the on-site survey and the collection of the building department data will follow the methods described above.

Construction of the Efficiency Market Share Tracking Database

Data collected through on-site surveys and from building department verification forms must be recoded to construct an efficiency market share tracking database. Several important issues regarding the development of the tracking database include data entry, recoding data into useful tracking parameters, sample weighting, calibrating timing between purchases and actual installations, and estimating window efficiency parameters.

Data Entry Database Format. Data entry will be a major portion of the work effort every quarter. Data from the on-site surveys and building departments will be collected in hard copy format that will need to be entered into an electronic database. RER recommends a conventional database format, such as Excel or Access.

Recoding Collected On-Site Data into Useful Market Share Tracking Parameters. An efficient methodology must be developed to translate the data collected on-site into useful tracking data. In general, the on-site survey will be used to record equipment types and model numbers, which then must be translated into efficiency and size data. Typically, this can be accomplished by using manufacturer product literature and product availability databases and should be done during the post processing of the data.[8]

Translating Building Department Data into Useful Market Tracking Parameters. The CF-6R forms exist in hard-copy format only. With the exception of windows, the measure characteristics data reported on the installation certificate can be directly used for tracking. That is, actual equipment size and efficiency data are recorded on these certificates. The window data are by individual window and will have to be size-weighted to get average U-values for each residence.

Weighting the Samples. Considerable care will need to be taken to correctly post-weight the on-site and building department data to reflect the population of residential new construction in California.

Calibrating Timing of Installation. The data collected in the tracking database will be used to infer the extent of market transformation attributable to programs targeting the priority measures. A critical part of this effort is to ensure the comparison of tracking parameters for equipment purchased in the same period. This is an issue in the new construction sector, where there can be considerable time lags between the time equipment is purchased and when the home is first occupied.[9] Both on-site and building department data will be collected from 50 residences. These sites will be used to reconcile installation dates across samples.

Leveraging Window Data. Detailed data on window U-values can be obtained from building department data. The on-site data are less likely to have detailed data on window U-values, as these data are not observable after installation. However, both sources can

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8 ODC spent considerable time and effort in recoding collected data into data useful for efficiency tracking in Wisconsin. Learning their recoding approach would be useful for tracking in California.

9 This was particularly evident in RER's market effects study of residential new construction programs in Southern California (RER, 1998). There can be lag times of up to a year between the time air conditioning equipment is installed and the first homeowner occupies the home.

provide frame type and number of panes. RER recommends exploring the possibility of leveraging the U-value data from the building department data to on-site data using the frame type and number of panes.

Timing and Schedule

There are a number of issues relating to the timing and scheduling of this initiative. These include the time needed to develop the survey design, implementing the initial on-site surveys, fostering a relationship with the building departments to facilitate collection of CF-6R forms, development of the tracking databases, and the on-going operation of the tracking system. Table 9-6 presents a summary of the timing and a recommended schedule for implementing this tracking initiative.

As shown, once the tracking system is operational, the scheduling of quarterly updates will need to be closely monitored. RER anticipates that sample design updates will need to be done during the on-site data collection of the prior quarter. On the other hand, once relationships with the building departments are established, most data could be forwarded in a timely manner, requiring relatively little field work from the tracking system operator.

Table 9-6: Summary of Timing and Scheduling of Initiative I

Task	**Timing**	**Scheduling**
Survey Design	6-8 Weeks	2nd Quarter 1999
Initial On-Site Surveys	8-10 Weeks	3rd Quarter 1999
Initial Building Department Contacts	6-8 Weeks	2nd Quarter 1999
Initial Building Department Data Collection	3-6 Weeks	3rd Quarter 1999
Initial Tracking Database Development	3-5 Weeks	3rd Quarter 1999
On-Going Sample Design Update	2-3 Weeks	Quarterly from 3rd Quarter 1999
Quarterly On-Site Surveys	8-10 Weeks	Quarterly from 4th Quarter 1999
Quarterly Building Department Data Collection	3-4 Weeks	Quarterly from 4th Quarter 1999
Update Tracking Database	3-5 Weeks	Quarterly from 4th Quarter 1999

Cost Estimates

Table 9-7 presents a summary of the estimated costs by task to develop and operate this tracking initiative.[10] Ranges of costs are provided as a guideline; the final budgets would depend on the features adopted for the final tracking system and cooperation from involved parties.

Table 9-7: Summary of Costs of Initiative I, by Major Task

Task	Estimated Cost
Development and First Quarter:	
Survey Design	$10,000 - $25,000
Initial On-Site Surveys (400)	$86,000 - $96,000
Building Department Contacts	$8,000 - $15,000
Quarterly Building Department Data Collection	$8,000 - $15,000
Tracking Database Development	$15,000 - $25,000
Subsequent Quarters:	
Quarterly Sample Design Update	$3,000 - $7,000
Quarterly On-Site Surveys	$86,000 -$96,000
Quarterly Building Department Data Collection	$8,000 - $15,000
Quarterly Tracking Database Update	$8,000-$10,000
First Year Cost	**$442,000 - $560,000**
Subsequent Year Cost	**$420,000 - $512,000**
Fixed Costs	**$22,000 - $48,000**

On-site survey costs based upon $215 to $240 per site.

As shown in Table 9-7, RER estimates the cost to implement Initiative I in the first year to be $442,000 to $560,000. These costs could be lowered, but at the cost of data quality and/or measure coverage. Some suggestions for decreasing the budget include the following:

- ***Decreasing the On-Site Sample Sizes.*** Decreasing the sample size would lower the cost by roughly $215 to $240 per site. For example, if the sample size was lowered to 250 per quarter the annual reduction in cost would be $11,000 to $12,000 per year. The trade off would be lowered precision level in the estimates of equipment efficiencies.

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[10] The cost estimates presented here were derived after the analysis presented in Section 8 was conducted. The cost scores included in Section 8 represent RER's fist estimate of costs that were derived for the purposes of comparing alternative tracking methods. Detailed budgets were not formulated until the recommended tracking methods were identified. In retrospect, these detailed cost estimates may differ slightly from the scores for the cost criteria presented in Section 8.

- ***Collecting Only On-Site Data.*** This would lower the cost by an estimated $50,000 to $80,000 per year. The trade off is a lack of coverage in window U-values, and a considerable decrease in sample sizes for high-efficiency central air conditioners and gas water heaters. The decrease in sample sizes could cause precision problems with estimated tracking parameters. Further, insofar as this is an integrated system, the ability to calibrate the timing of equipment installations and the option of leveraging the window U-value data from the building department data to the on-site sample would be lost.
- ***Collecting Only Building Department Data.*** This would be a streamlined approach covering only three priority measures. The cost of a system relying purely on building department installation certificate data would be in the $50,000 to $80,000 range annually.[11] This is not a recommended approach.
- ***Collect Data Semi-Annually.*** Collecting data semi-annually would lower the annual cost by $200,000 to $250,000 per year. Less frequent data collection could result in a market tracking database that that is not definitive enough to be useful for the assessment of market transformation.

Other Issues

Timely versus Retrospective View of Data. The timing of purchases in the new construction market is an issue when implementing this initiative. As explained earlier, some measures might have been purchased by the builder up to a year in advance of the first occupant moving into the home. These timing issues are accounted for during the calibration portion of the tracking analyses. However, the result is that data collected in any quarter may not reflect purchases of equipment in that quarter. The result could be adjustments to prior quarters' shares, thereby resulting in a tracking method will provide accurate data when viewed retrospectively, but may be less representative of the most recent quarter.

Expanding the Role of Building Departments. RER's informal survey of building departments indicated their willingness to support tracking efforts. RER recommends that this relationship be explored to encourage as many building departments as possible to participate in data collection for efficiency market share tracking efforts. Future recommendations by the CEC for Title 24 revisions are not due until the year 2001. At that time, the mandatory collection of the CF-6R forms and implement a statewide system to collect these data should be recommended.

[11] A detailed description of the use of other building department data is provided in the Section 5. Approaches that rely on compliance and customized building inspector field surveys are not recommended.

9.4 Initiative II: On-Site Surveys of Prescreened Residential Sites

Overview

As indicated in Table 9-1, RER recommends tracking the retrofits of two residential measures – windows and duct sealing - at the customer level.[12] Alternatives to collecting these data at the customer level include doing so at the retail level (for windows) or through contractors (for windows and duct sealing). However, collecting windows sales data only at the retail level would be omitting a significant portion of the market from the tracking efforts. Further, as discussed earlier, implementing tracking at the contractor level is problematic and appears to have significant reliability issues.

Figure 9-2 provides an overview of the four essential elements to this tracking initiative:

- Prescreen residential consumers for recent retrofit activities,
- Design and conduct the on-site surveys,
- Conduct market share tracking analyses, and
- Update measure efficiency tracking database.

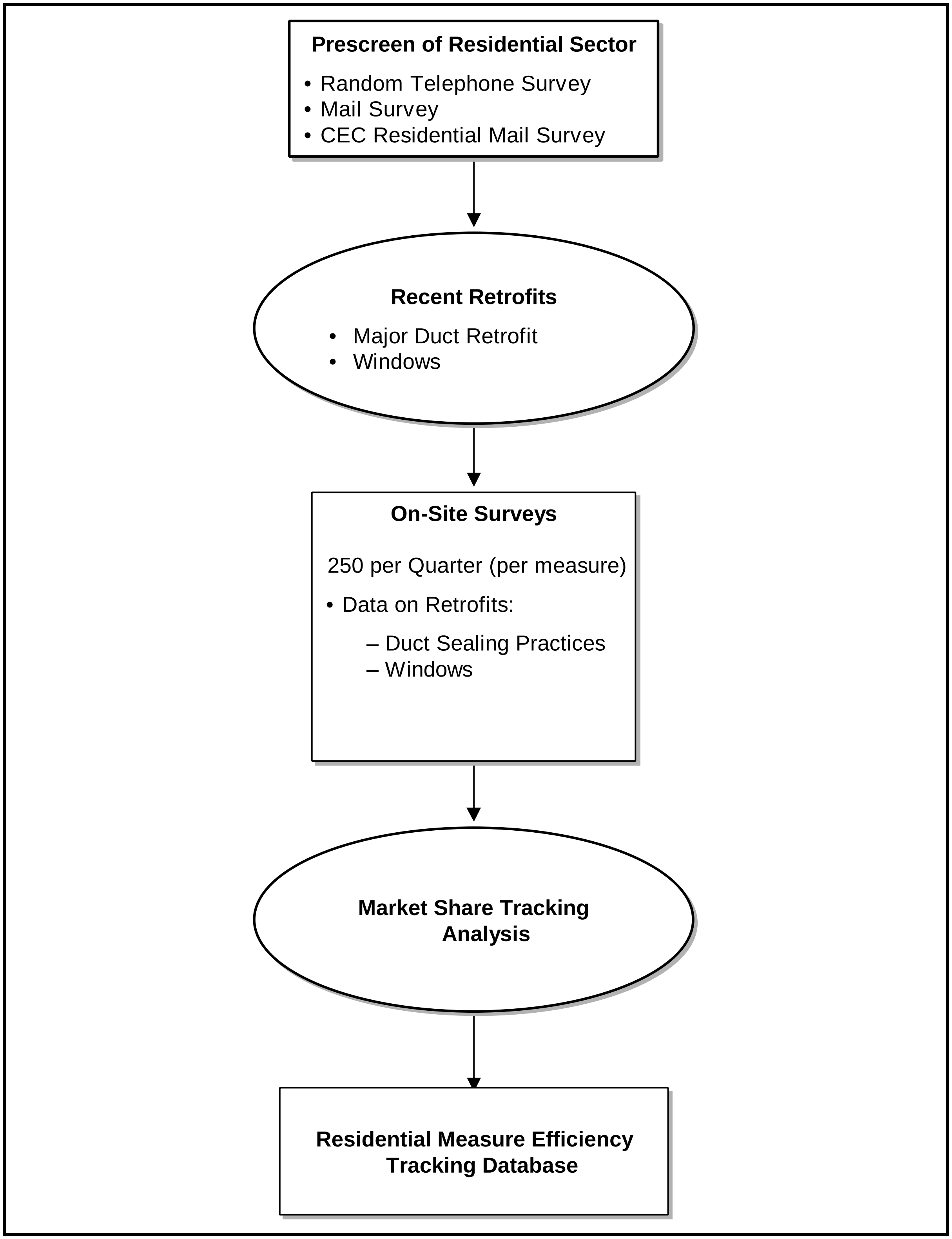
A random telephone or mail survey can be administered to develop a sample of prescreened homes that have recently retrofitted any of the measures covered by this initiative. An on-site survey will then be conducted on the identified sites to collect data required for efficiency market share tracking. RER estimates that this method could be developed and operational within six months of the onset of development.

The following features of this recommended initiative are discussed below.

- Measure and data coverage,
- Initiative development,
- Timing and schedule,
- Cost estimates,
- Including HVAC and water heating equipment in the initiative, and
- Integrating screening questions in a CEC residential customer survey.

[12] This could also be a primary source for gas water heaters, central air conditioners, and gas furnaces. Insofar as these are replace-on-burnout or net acquisitions, a purely random sample of homes is unlikely to yield a sufficient number of transactions for the covered measures. Consequently, this approach recommends on-site surveys of a prescreened sample of residential sites that have only recently purchased or replaced windows or upgraded their air distribution system.

Figure 9-2: Overview of Prescreened On-Site Survey – Window and Duct Retrofits



Measure and Data Coverage

Table 9-8 includes the measures covered by this initiative, whether this is the primary or secondary source for tracking data, the characteristics of the measures that can be collected during the on-site visit, and the characteristics of the measures that would ultimately be used for tracking market shares.[13]

Table 9-8: Measures and Measure Characteristics Covered by On-Site Surveys

Measure	Source Type	Data Collected On-Site	Tracking Data
Windows	Primary	Manufacturer, U-value, number of panes, frame type (wood, vinyl), size	U-value, number of panes, frame type (wood, vinyl), size
Duct Sealing (Practices)	Primary	Tape type, mechanical fastening (y/n) and plenum	Tape type, mechanical fastening (Y/N) and plenum

In addition to the specific data for the high priority measures presented above, data on purchasing and decision-making practices relating to energy-using equipment, and demographic characteristics can also be collected during the on-site visits.[14] The collection of data for other competing measures depends on the scope of questions about new purchases during the screening survey. Further, other priority measures could also be included in this system, although the data collected for these measures would be secondary information.

Development

Development of this method entails 1) the design and implementation of a method to identify homes with recent window or duct system retrofits , 2) the design and implementation of the residential on-site survey with the prescreened residences, and 3) development of an efficiency market share tracking database for duct sealing and window retrofits.

Development of each of these components is discussed below.

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[13] A designation of primary source indicates that the data source will provide the primary data used to track market shares. A secondary designation indicates that this data will be either supplemental to other initiatives or used to cross-check data from other sources.

[14] If this method were used to collect data for central air conditioners, gas furnaces, or gas water heaters the on-site survey could also collect detailed data on competing measures, such as electric and solar water heaters.

Design and Implementation of a Screening Method to Identify Homes with Recent Window or Duct Retrofits

Two alternative approaches for identifying homes that have recently purchased new or retrofitted windows or that have recently upgraded their home's air distribution system include

- A random dial telephone survey, or
- A mail survey.[15]

In addition to identifying the appropriate sites, the prescreening survey can help to recruit and schedule on-site visits. Each of the above alternatives is discussed below.

Conduct a Random Dial Telephone Survey. A random dial telephone survey is a standard surveying technique that involves calling residences at random within the area of interest and conducting a telephone survey with those who agree to participate. Telephone numbers can be gathered from telephone books, purchased from commercial marketing firms, or randomly generated with computer software. The relatively short survey should include questions about recent purchasing activity pertaining to the relevant measures. If the resident has recently purchased any of the priority measures (or competing measures), information relating to self-reported purchase decision attitudes and resident demographics should be obtained. The final survey task is to recruit the customer for the on-site survey.

Conduct a Mail Survey. A mail survey could be used to screen a sample of residences. The major feature of this approach is to design a short postcard type survey that collects the needed information on recent purchases. Homes reporting purchases will then be contacted to schedule the on-site survey.

The main issues affecting this initiative are the required random sample sizes needed to obtain a statistically significant screened sample and the relative costs of the screening alternatives.

Random Prescreening Sample Sizes. In order to provide reliability and precision in estimates, it is anticipated that a completed sample of 250 on-sites per priority measure will be required.[16] Assuming a response rate of 50% and given that there is no overlap between measures, this implies a screened sample of roughly 500 homes that have recently retrofitted

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[15] Another alternative for screening homes is to incorporate screening questions into the residential customer survey that the CEC might implement in the future. This alternative is discussed at the end of this subsection.

[16] This is based on sampling to predict the average efficiency above a predetermined base value and assumes a coefficient of variation of one, a 90% confidence level, and a relative error of ±10%.

at least one of the measures per quarter.[17] Using some simplifying assumptions about measure lifetimes, saturation, and retrofit rates, the prescreened sample sizes per quarter can be estimated.

- ***Windows.*** Assuming a saturation of 100% and a lifetime of 50 years, this implies a sample size of roughly 100,000 per quarter.
- ***Duct Sealing (Practices).*** Assuming a saturation of 70% and a lifetime of 30 years, this implies a sample size of roughly 86,000 per quarter.

These required sample sizes are large and present a major obstacle for the success of this method. However, oversampling by climate zone and housing type, and including an assumption about the percentage of retrofits can substantially reduce the required sample sizes. Note also that these sample sizes are not mutually exclusive. That is, randomly calling 100,000 homes could to produce 500 homes with window purchases, but would also be expected to identify 580 homes that have retrofitted their duct system.

Relative Costs. The relative costs of each of these methods are a major issue. The cost for random digit dialing services is in the range of 50 to 65 cents per call, depending on long-distance charges. Given the required prescreened sample sizes, this method would cost roughly $50,000 to $65,000 per quarter for all of the measures. The use of a mail survey will cost roughly twice the cost of the random dialing.

As presented above, using a random telephone survey or administering a mail survey for prescreening involves significant costs. The major factor is the required prescreened sample sizes needed to support quarterly tracking. Costs could be mitigated by extending the time interval of the screening questions. For example, the screening questions can be changed to identify households that have retrofitted one of the priority measures within the last *six months* instead of the last *three months*. Doing so would cut the required prescreening sample size in half for any particular quarter, since the expected number of homes purchasing a measure would double. The drawback to this approach is that the responses cover the last six months and not just the quarter in question. Assuming an equal distribution of purchases across quarters, it would take six months before any statistically significant inferences could be estimated for a particular quarter.[18,19]

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[17] This is a fairly aggressive response rate that would require an incentive payment to the equipment owner to encourage their participation.

[18] This lag time problem would be mitigated by for central air conditioners and gas furnaces because the purchase of these items is very seasonal. Therefore, one would expect the distribution of purchases across quarters to be skewed towards spring and summer for central air conditioners and fall and winter for gas furnaces.

[19] There are a number of variations to this screening approach. For instance, one could also implement an approach that keeps the same sample size as the six-month window approach but extend the period to one

Using this moving six-month screening approach, locating the required sample of prescreened residences alone could cost roughly $25,000 per quarter using the cheaper random digit dialing.

Design and Implementation of Residential On-Site Survey with Prescreened Homes

The residential on-site survey will be a streamlined effort. The sample of residences will be developed from the prescreened survey, and the actual on-site survey time will be minimal, given the relatively small number of possible measures that need to be inspected. RER recommends a completed on-site sample size of 250 homes that have retrofitted each priority measure per quarter.[20] This sample size should be sufficient to provide reasonable precision levels in the estimation of market shares.

The on-site questionnaire design will be critical for the success of the tracking effort. The survey should involve two phases: a brief resident interview and inspection of the measures that were recently retrofitted at each site. RER recommends that the survey be tailored to collect the data required to develop the market tracking database (e.g., timing of the purchase, the equipment characteristics outlined in Table 9-4). Further, the questionnaire should include questions on self-reported attitudes and resident demographics.

Development of the Efficiency Market Share Tracking Databases

Development of the measure efficiency market share tracking database involves entry of data collected with the on-site survey, and recoding collected data into useful market share tracking parameters.

Data Entry Database Format. Data entry will be a major portion of the work effort for each quarter. Data from the on-site surveys will be collected in hard copy format that will need to be entered into an electronic database. RER recommends a conventional database format, such as Excel or Access.

Recoding Collected On-Site Data into Useful Market Share Tracking Parameters. An efficient methodology will need to be developed to translate the data collected on-site into useful market tracking data. In general, the on-site survey will be used to obtain equipment types and model numbers, which will need to be translated into efficiency and size data. Typically, this can be accomplished by using product literature or other product databases and should be done during the post processing of the data.

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year. This provides the same acceptable expected precision as the six month window but will results in increased quarterly sample sizes as more surveys are administered.

[20] This is based on sampling to predict the average efficiency above a predetermined base value. Assuming a coefficient of variation of one, a 90% confidence level, and a relative error of ±10%.

Weighting the Samples. Considerable care will need to taken to correctly post-weight the samples of on-sites to reflect the population of retrofits.

Timing and Schedule

The timing and scheduling of this initiative is a function of the time needed to develop the prescreening survey, implementation of the initial on-site surveys, development of the tracking databases, and the ongoing operation of the tracking system. As presented in Table 9-9, once the initial tracking system is operational, the scheduling of quarterly updates will need to be closely monitored. RER anticipates that prescreening surveys will need to be done during the same period as the on-site data collection of the prior quarter.

Table 9-9: Summary of Timing and Scheduling

Task	Timing	Scheduling
Telephone Screening Survey	12-18 Weeks	2nd and 3rd Quarter 1999
Initial On-Site Surveys	8-10 Weeks	4th Quarter 1999
Tracking Database Development	2-3 Weeks	4th Quarter 1999
Quarterly Telephone Screening Surveys	8-12 Weeks	Quarterly from 4th Quarter 1999
Quarterly On-Site Surveys	8-10 Weeks	Quarterly from 1st Quarter 2000
Update Tracking Database	1-2 Weeks	Quarterly from 1st Quarter 2000

Cost Estimates

Table 9-10 presents a summary of the estimated costs to develop and operate this tracking initiative.[21] Ranges of costs are provided only as a guideline; final budgets would depend on the features adopted for the final tracking system.

Table 9-10: Summary of Costs of Initiative II, by Major Task

Task	Estimated Cost
Development and First Quarter:	
Survey Development	$20,000 - $30,000
Initial Telephone Screening Survey	$25,000 - $30,000
Initial On-Site Surveys	$50,000 - $62,500
Tracking Database Development	$12,000 - $15,000
Subsequent Years:	
Quarterly Telephone Screening Surveys	$25,000 - $30,000
Quarterly On-Site Surveys	$50,000 - $62,500
Quarterly Tracking Database Update	$8,000 - $10,000
Estimated First Year Cost	**$356,000 - $445,000**
Estimated Subsequent Year Cost	**$332,000 - $410,000**
Fixed Costs	**$24,000 - $35,000**

On-site survey costs are based upon $100 to $125 per site.

As shown in Table 9-10, RER estimates the cost to develop and implement this initiative in the first year is $356,000 to $445,000.[22] These costs could be lowered, but at the cost of accuracy and/or measure coverage. Some suggested ways for decreasing the budget include:

- ***Decreasing the On-Site Sample Sizes.*** Decreasing the sample size would lower the cost by roughly $100 to $125 per site. For example, if the sample size was lowered by 100 per quarter, the annual reduction in cost would be roughly

[21] The cost estimates presented here were derived after the analysis presented in Section 8 was conducted. The cost scores included in Section 8 represent RER's fist estimate of costs that were derived for the purposes of comparing alternative tracking methods. Detailed budgets were not formulated until the recommended tracking methods were identified. In retrospect, these detailed cost estimates may differ slightly from the scores for the cost criteria presented in Section 8.

[22] The assumed cost for the on-sites are considerably lower than the on-sites in the new construction sector (Initiative I). This is attributable the fact that the on-sites for retrofits/replace-on-burnouts only need to focus on a couple of measures, at most, and that the on-site surveyor will know in advance which measures to inspect.

$40,000 to $50,000 per year. The trade off would be a lowered precision level in the estimates of equipment efficiencies.

- ***Expanding the Role of the Screening Survey***. Typically, on-site surveys are implemented in the residential sector to obtain detailed information relating to energy-using equipment. This is due primarily to the homeowner being unfamiliar with the equipment and/or reluctant to gather the needed data. However, in the case where there are only a handful of recently purchased appliances, the homeowner might be more aware of the needed data and be willing to supply the data. Given the cost of the on-site surveys, every effort should be made to gather the data during the postcard screening survey or on-site visit appointment setting process. Using this approach and assuming we could collect 25% of the needed sample through self-reported data, the overall cost of the initiative would decrease by $50,000 to $64,000, annually. Some of this decrease could be offset by the offer of an incentive to provide the data.
- ***Conducting Semi-Annual Surveys.*** The survey frequency could be semi-annually as opposed to quarterly. This would reduce the cost by about $130,000 to $165,000 per year. Again, the trade off is that this less frequent approach to data collection could result in a market tracking database that that is not definitive enough to be useful for the assessment of market transformation. Further, due to the moving window approach to the prescreening survey, semi-annual surveys could cause further delays in the final market share tracking estimates.

Including HVAC and Water Heating Equipment in Initiative II

As discussed above in the Overview of this Section, this method can also be used to collect data for replacements and net acquisitions of central air conditioners, gas furnaces, and gas water heaters. This is not the recommended approach for developing tracking data for these measures. However, the data coverage and cost impacts are provided here for comparison with the recommended approach, Initiative III.

Measure and Data Coverage. Table 9-11 presents the HVAC and water heating measures and the measure characteristics covered by the on-site surveys. The distinction between the data collected on-site and the data used for market tracking is important. In most cases, the equipment type and model numbers are the only observable data that can be collected during the on-site visit. These data will ultimately be translated into useful efficiency and equipment characteristics by using product directories or other manufacturer-specific publications, or databases of available products.

Table 9-11: HVAC and Water Heating Measures and Measure Characteristics Covered by On-Site Surveys

Measure	Source Type	Data Collected On-Site	Tracking Data
Central Air Conditioners	Primary	Type, manufacturer, and model number	Type, SEER, capacity
Gas Furnaces	Primary	Type, manufacturer and model number	Type, AFUE, capacity
Gas Water Heaters	Primary	Manufacturer and model number	EF, tank size

Timing, Scheduling, and Cost Estimates. Insofar as the on-site surveys to collect data for the HVAC and water heating could be done concurrently with the other on-site surveys, including HVAC and water heating to this initiative would not change the estimated timing and scheduling. The estimated cost to included HVAC and water heating measures are significant. There would be no need to increase in the sample sizes from what is required to prescreen window retrofits (100,000). However, the on-site sample sizes would increase substantially from 500 to 1,250 per quarter. This would increase the annual budget for this initiative by roughly $300,000 to $375,000.

Integrate Screening Questions in CEC Residential Customer Mail Survey

On September 25, 1998, the CEC's Demand Analysis Office presented a proposal to the California Board for Energy Efficiency (CBEE) for co-funding the CEC's data collection efforts. Until this year, customer surveys were funded by the utilities through DSM funds. Because this funding source is no longer available, the CEC sought funding from the CBEE to supplement funds requested by the CEC in its budget change proposal (BCP). The proposal submitted to the CBEE provided background of the CEC data collection efforts and summarized the budget requirements for continuing the survey implementation through 2002.

The CEC's proposal to the CBEE identified two surveys that show some promise as elements of a tracking system: a commercial survey and a residential survey. (The commercial survey proposal is discussed in more detail in Section 10.) RER has met in person twice and has conducted numerous telephone conversations with CEC staff to discuss the feasibility of using the CEC's customer surveys as an element of an overall tracking system. Using the residential survey to identify homes for recent purchases or retrofits is the primary benefit of incorporating tracking needs into the residential survey.

The objective here is not to suggest funding the CEC for the residential survey effort or to suggest how any such funds should be allocated. The discussion that follows is included only to suggest that, should the CBEE fund such a data collection effort in the residential sector, that opportunities to incorporate tracking needs should be recognized. Furthermore, the following is based upon the information presented in the CEC's September 25 proposal to the CBEE.

The CEC's plan for the residential customer survey in its September 25 proposal entails conducting roughly 100,000 mail surveys and 2,000 on-site follow-up surveys. The surveys would be conducted biannually. Because the residential survey was just conducted in 1998, it would not scheduled to be conducted again until the year 2000. The CEC's estimated cost for the residential surveys was $4 million.[23]

While using a CEC survey to prescreen homes would cost less than a random dial survey, there are, of course, a number of issues associated with this alternative. Timing and sampling issues, survey design, and cost impacts are discussed below.

Timing Issues. Should a residential customer survey be administered by the CEC, it would need to be implemented *statewide* on a quarterly basis to be successful as a screening tool to accommodate market share tracking needs.

Sampling Issues. The CEC residential survey could potentially involve a completed sample of 100,000 homes. Assuming this sample size and that the CEC would be willing to field the survey quarterly, would result in quarterly samples of 12,500. In order to obtain the 12,500 completed survey responses per quarter and assuming a response rate of 33%, the CEC would need to initially mail out at least 37,500 surveys.

The total number of completed CEC surveys will need to be increased to meet the required prescreened sample size requirements for this initiative. Based the above information, the completed sample size would need to be increased from 37,500 to 50,000 per quarter. This increase in sample presents a considerable obstacle – increases in cost. To mitigate cost increases, RER would recommend a postcard-type mailer be included in the initial survey mailing that could be used to identify purchasers of priority measures. The response card could be designed to obtain information directly from the homeowner or identify homes willing to participate in the tracking effort. The idea here is that response rates might be higher than without the postcard insert.

Survey Design. The residential mail survey questionnaire would not need substantial revisions to accommodate the CBEE's tracking needs, primarily because it would be used only to identify sites with recent equipment purchases, replace-on-burnouts, or retrofits. Questions on recent acquisitions and replacements traditionally have been included in utility

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[23] This estimate does not include funding for the average equipment energy use follow-up study or the load-metered sites customer characteristics analysis.

appliance saturation surveys, and would presumably be included in the CEC questionnaire one way or the other. These questions would be used to identify candidates for the on-site survey. The candidates would then be contacted by telephone to schedule the on-site survey.

Cost Impacts. The cost impacts of adopting this approach for prescreening would decrease the cost of implementing the initiative by roughly $50,000 to $75,000 per year. These impacts are attributable to decreases in costs of prescreening, though some budget should be reserved for developing or reviewing the survey and sample design, and ongoing coordination with the CEC.

The cost impacts to the CEC of incorporating tracking into a residential survey are unclear, given the fact that the CBEE has not yet considered reserving funds for the residential survey effort. As explained in Section 10, updating the DEER database and the commercial survey were considered priorities for funding in 1999. Should funding for the CEC residential customer survey become available, RER recommends incorporating market share tracking needs into the data collection effort. The resulting added costs to the CEC survey would be attributable to expanding the quarterly sample to accommodate the required sample sizes for screening.

9.5 Initiative III: Collecting Distributor Sales Data

Overview

As indicated in Table 9-1, RER recommends tracking the replace-on-burnout and net acquisition purchases of residential HVAC and water heating measures at the distributor level. As explained in Section 4, collecting data at the distributor level does not allow for the tracking measures at the decision type level. However, if Initiative I is implemented, detailed data on HVAC and water heating equipment will be known for new construction installations. Because distributor data would represent both new construction and replace-on-burnout/net acquisition purchases, replace-on-burnout and net acquisition shares can be inferred by subtracting new construction shares from the distributor sales data.[24] The major benefit of using the distributor survey as opposed to a pre-screened on-site survey is cost. As will be highlighted below, the development and operation of data collection from distributors is considerably cheaper than conducting quarterly on-site surveys. Furthermore, collecting data at the distributor level will provide an accurate representation of the size and efficiency mixes of the California HVAC and water heating markets overall.

RER recommends that a tracking initiative be developed and operated through a cooperative effort with HVAC and water heating equipment distributors in California. This initiative involves the collection of quarterly equipment sales data, which would necessarily need to include manufacturer, model number, and quantity sold. These data will then be used to develop a database containing detailed information on relevant measure characteristics useful for tracking.

Tracking initiatives that use distributor data are presently being used in Wisconsin with some success. However, other reviews of this method have not been as encouraging.[25] In general, these reviews identify lack of manpower and proprietary information as the main reasons for distributor unwillingness to participate. To explore the feasibility of this method for tracking in California, RER conducted an informal survey of California HVAC and water heating distributors to discern their willingness to participate in a statewide tracking effort. Results are summarized below.

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[24] As explained in Section 8, at least some distributors can identify sales by decision type according to the customer, even though this information is not typically recorded at the point-of-sale. Should this tracking initiative be adopted, there is potential to encourage distributors to record this information in the future.

[25] See for example EPRI, 1997.

- ***HVAC Distributors.*** A list of HVAC wholesaler/distributors in California was obtained from the North American Heating, Refrigeration & Air Conditioning Wholesalers.[26] This list was supplemented with other miscellaneous sources for a final group of 22 different distributors. Most of the distributors carry both the heating and cooling equipment and many have multiple branches. The number of branches range from a single location too as many as 42 different locations throughout the state. The 22 companies in the sample represent 190 different locations.

  Seven HVAC distributors, represent 92 individual locations, were asked about their record keeping practices (e.g., type of sales information they recorded and how this information was stored) and their willingness to participate in a statewide tracking program. All expressed some degree of willingness to participate in a statewide tracking program. The biggest barriers to their participation in a statewide market share tracking effort relate to timing and staffing requirements in preparing and submitting the required data.

  The distributors surveyed collect model number information at the very least and store all the sales data in an electronic database. Most surveyed would be interested learning their share of the HVAC equipment market, as they currently do not have much of an idea of their current share of the market in California.

- ***Water Heating Distributors.*** RER compiled a list of water heater wholesaler/distributors in California from various sources, including lists from manufacturers. Some of the major distributors have multiple branches and there are many small, independent distributors in the water heater market. The final listing was comprised of 50 to 60 different distribution companies representing 160 different locations.

  Seven plumbing equipment distributors, representing 50 individual locations, were asked about their record keeping practices (e.g., type of sales information they recorded and how this information was stored) and their willingness to participate in a statewide tracking program. All showed some degree of willingness to participate in a statewide tracking program. Most surveyed would be interested in learning their share of the California market, as they currently do not have an idea of what their current market share relative to other distributors. As with the HVAC distributors, the biggest barriers to their participation in a statewide market share tracking effort relate to timing and staffing issues.

  They all collect model number information at the very least and store all the sales data in an electronic database. However, some of the small, independent companies have not made the transition from paper inventories to electronic databases. This introduces some logistical problems, as hard copies of sales data will need to be hand coded into an electronic format.

  As explained in Section 8, roughly 50% of the residential water heaters are not sold through distributors. Rather, large building supply retail chains and “do-it-

[26] See http://www.nhraw.org.

yourself" stores, such as Home Depot, have the ability to buy in large quantities and typically do so directly from the manufacturer. Furthermore, these retailers buy at the national level and have their own channels of distribution. Therefore, it is critical to recognize that only collecting sales data from water heating equipment distributors would be omitting a significant portion of the water heater market.

In light of this shortcoming of this method, RER identified three alternatives for tracking efficiency market shares of gas water heater *replacements/*net acquisitions. The options include: 1) conduct on-site surveys of a prescreened sample of home that have recently purchased a new water heater, 2) collect sales data from major retailers, or 3) collect data from distributors and incorporate ENERGY STAR® data collection efforts into California tracking when water heaters become an ENERGY STAR® product.[27]

RER favors the latter approach for several reasons. First, the first option has already been deemed to be cost prohibitive because of the costs associated with identifying sites that have recently purchased a water heater, and the fact that there are no achievable economies through conducting on-site surveys. Second, collecting sales data from major retailers, such as Home Depot, might not feasible. RER's preliminary research suggests that retailers would not be willing to supply the data required for tracking. Finally, some HVAC equipment distributors also sell water heating equipment, so the marginal cost of collecting water heater data could be relatively low.

The remainder of this section assumes that water heater sales data will be obtained from equipment distributors (option 3 above) and that a dialogue with ENERGY STAR® representatives continues to pursue the option of obtaining water heater sales data collected under the ENERGY STAR® program in the future.

Measure and data coverage, development of the initiative, timing and scheduling, and cost estimates are discussed below.

Measure and Data Coverage

Table 9-12 includes the measures covered by this initiative, whether this is the primary or secondary source for tracking data, the characteristics of the measures that can be collected during the on-site visit, and the characteristics of the measures that would ultimately be used for tracking market shares.

[27] As will be noted in the Initiative IV, water heaters are not yet an ENERGY STAR® product, but are expected to be included in the ENERGY STAR® program sometime in 1999. ENERGY STAR® representatives are still uncertain about when water heater data collection efforts can begin.

Table 9-12: HVAC and Water Heating Measures and Measure Characteristics Covered by Collection of Distributor Sales Data

Measure	Source Type	Data Collected	Tracking Data
Air Conditioners	Primary	Type, manufacturer, and model number	Type, SEER, capacity
Gas Furnaces	Primary	Type, manufacturer and model number	Type, AFUE, capacity
Gas Water Heaters	Primary	Manufacturer and model number	EF, tank size
Packaged Air Conditioning	Primary	Manufacturer, and model number	System type, EER/SEER, HSFP or COP, and size

Development

Development of this method entails 1) the recruitment of California HVAC and water heating distributors to participate in the tracking initiative, 2) the design and implementation of an efficient data collection protocol, and 3) development of a replace-on-burnout/net acquisition efficiency market share tracking database.

Development of each of these components is discussed below.

Recruitment of California HVAC and Water Heating Distributors

The first step of this initiative involves recruiting distributors to serve as data suppliers in the tracking effort. Based upon RER's informal discussions with a sample of HVAC and water heating distributors serving the California market, and the experience in Wisconsin, there are several elements critical to the success of this initiative.

- First, it is essential that the confidentiality of distributor proprietary sales data be guaranteed. In particular, tracking data should be reported only at an aggregated level that ensures the confidentiality of any single distributor.
- Second, the burden on distributor staff and time be minimized and/or distributors should be compensated for their time.
- Third, the distributors will likely need on-site assistance to develop a data reporting protocol. For example, some HVAC distributors in Wisconsin required computer programming assistance in order to provide a "data dump" that included the required data. Furthermore on-site visits will be likely be necessary not only during the development stage, but throughout the operation of this tracking initiative.
- Fourth, the tracking database, or other useful information, should be made available to all participating distributors.

RER also recommends that the recruitment process be an ongoing effort. In particular, attention needs to be given to participating distributors to ensure timely delivery of sales data as well as to retaining current data suppliers and recruiting new participants.[28] Further, to accommodate possible climate zone effects, distributors should be recruited from both southern and northern California and across climate zones.

Data Collection Protocol

Due to the diverse formats used by the distributors to record sales data, the data collection protocol will need to be flexible, and in most cases tailored to individual distributors. We recommend that site visits be undertaken for the larger distributors to ensure a thorough understanding of the available data and to assist the distributor in developing reports useful for market tracking. Again, the Wisconsin experience indicates that on-site visits of distributors resulted in the participation of some distributors who would have otherwise not participated. This was due mainly to assist the distributors in developing methods to download valuable tracking data at a minimal cost to the distributor.

Construction of the Efficiency Market Share Tracking Databases

Construction of the measure efficiency market share tracking database involves entry of the collected distributor sales data, and recoding the data into useful market share tracking parameters.

Database Development. Database development will be a major portion of the work effort. In general, our understanding is that distributors keep equipment sales data in electronic format. The first step will be to develop protocols for the individual distributors to retrieve the data in a usable format. However, it is anticipated that these data will be in various formats that will require translation into a standardized format. For this purpose, RER recommends a conventional database format, such as Excel or Access.

Recoding the Collected Sales Data into Useful Market Share Tracking Parameters. An efficient methodology will need to be developed to translate the data collected from distributors into useful market tracking data. The distributor sales data will be used to obtain equipment types and model numbers, which will need to be translated into efficiency and size data. Typically, this can be accomplished by using product literature or other product databases and should be done during the post processing of the data.

[28] The Wisconsin experience with distributors indicates that a substantial amount of time is spent maintaining relationships with current participants.

Timing and Scheduling

The timing and scheduling of this initiative are a function of the time needed to recruit the initial sample of participant HVAC and water heater distributors, implementation of the initial data collection, and to maintain the system. A summary of the timing and scheduling of this initiative by major task is presented in Table 9-13. The time needed to recruit distributors is the most subject to uncertainty. However, our informal survey of distributors indicates willingness on the part of distributors to participate in the tracking effort. This suggests that a 12 to 16 week window should be sufficient to recruit enough distributors to begin the tracking initiative.

Table 9-13: Summary of Timing and Scheduling – Collection of Distributor Sales Data

Task	Timing	Scheduling
Initial Recruitment of Sample of Distributors	12-16 Weeks	2nd and 3rd Quarter 1999
Initial Collection of Quarterly Distributor Sales Data	6-8 Weeks	2nd and 3rd Quarter 1999
Initial Tracking Database Development	4-6 Weeks	4th Quarter 1999
Quarterly Review of Distributor Sample	1-2 Weeks	Quarterly from 4th Quarter 1999
Quarterly Collection of Distributor Sales Data	6-8 Weeks	Quarterly from 4th Quarter 1999
Update Tracking Database	2-4 Weeks	Quarterly from 1st Quarter 2000

Cost Estimates

Table 9-14 presents a summary of the estimated costs to develop and operate this tracking initiative.[29] Ranges of costs are provided only as a guideline; final budgets would depend on the features adopted for the final tracking system.

Table 9-14: Summary of Costs of Initiative III, by Major Task

Task	Estimated Cost
Development and First Quarter:	
Recruitment of Sample of Distributors	$25,000 - $30,000
Initial Collection of Sales Data	$10,000 - $20,000
Tracking Database Development	$10,000 - $15,000
Subsequent Quarters:	
Quarterly Review of Distributor Sample	$2,000 - $5,000
Quarterly Collection of Sales Data	$10,000 - $20,000
Quarterly Tracking Database Update	$5,000 - $10,000
Estimated First Year Cost	**$96,000 - $170,000**
Estimated Subsequent Year Cost	**$68,000 - $140,000**
Fixed Costs	**$28,000 - $30,000**

[29] The cost estimates presented here were derived after the analysis presented in Section 8 was conducted. The cost scores included in Section 8 represent RER's fist estimate of costs that were derived for the purposes of comparing alternative tracking methods. Detailed budgets were not formulated until the recommended tracking methods were identified. In retrospect, these detailed cost estimates may differ slightly from the scores for the cost criteria presented in Section 8.

9.6 Initiative IV: ENERGY STARâ /EGIA Retail Tracking

Overview

As indicated in Table 9-1, RER recommends tracking the replace-on-burnout and net acquisition purchases of several residential measures at the retail level. Section 4 explained that several of the residential measures covered by this study are purchased by the consumer at retail establishments. Collecting data for tracking market shares of replace-on-burnout and net acquisition purchases at a market node other than the consumer or retail level would be omitting a significant portion of the market from the tracking efforts.

RER recommends that a tracking initiative be developed and operated through a cooperative effort between ENERGY STAR® and the Electric and Gas Industries Association (EGIA). Both organizations offer tremendous opportunities for successful market share tracking. First, market shares of several priority residential measures are already being tracking through the ENERGY STAR® program. Second, the EGIA, a California-based trade organization with a membership comprised of manufacturers, distributors, and contractors, is an ideal candidate for recruiting and maintaining relationships with non-ENERGY STAR® retailers as data suppliers.

RER has met with representatives of both organizations in person and by telephone on several occasions, in addition to conducting a meeting with all involved parties together to discuss the feasibility and development of this tracking initiative. In general, this initiative involves two separate but related elements: 1) obtaining data already collected through the ENERGY STAR® program and 2) collecting sales data from smaller, independent, non-ENERGY STAR® California retailers.

- ***Obtain Data Collected Under ENERGY STARâ Retail Partnership Agreements.*** The primary portion of this tracking initiative involves obtaining data collected under ENERGY STAR® Partnership agreements. D&R International (D&R), a consulting firm retained to provide support services for the ENERGY STAR® program, recruit ENERGY STAR® Retail Partners, negotiate data collection agreements with Partners, and collects and processes all data collected through ENERGY STAR® agreements. The tracking initiative proposed here requires 1) becoming familiar with the ENERGY STAR® database, and 2) determining which data are required for tracking in California. D&R would then provide the desired data on a periodic basis for tracking market shares of identified efficiency measures in California.
- ***Collect Data from Non-ENERGY STARâ and Smaller Regional Retailers.*** Because D&R does not collect data from non-ENERGY STAR® retailers, which are typically small, independent retailers, the existing D&R ENERGY STAR® database is not representative of all retail sales in California. As such, the ENERGY STAR® data will need to be augmented with sales data from nonparticipating and regional

retailers in California. The second element of this proposed initiative involves recruiting non-ENERGY STAR® retailers to supply their sales data on a periodic basis. The EGIA would serve as a liaison between the data collection agent and retailers, helping to recruit and develop this portion of the tracking system.

Summary of ENERGY STAR® and Current Data Collection Efforts

ENERGY STAR® is a joint program of the U.S. Department of Energy (DOE) and the Environmental Protection Agency (EPA). The purpose of this program is to encourage the development of a sustainable consumer market for energy-efficient technologies by educating consumers and creating partnerships with manufacturers, retailers, and utilities. The focus of the ENERGY STAR® program is the ENERGY STAR® label. A product receives the distinctive ENERGY STAR® label if it exceeds the Federal energy efficiency standards by a specified amount. Typically, a product must be 13% to 25% more efficient than the Federal standard to receive the label, though in some cases (e.g., clothes washers) the requirement is 111%.[30] If there are no Federal minimum energy use standards for a specific appliance, the product may earn the ENERGY STAR® label if it has special energy-saving features that enables it to use less energy than similar products. For example, computer monitors with a "sleep" mode earn the ENERGY STAR® label.

The ENERGY STAR® program covers the following products:

- Room air conditioners,
- Clothes washers,
- Dishwashers,
- Windows and doors,
- Refrigerators,
- Lighting fixtures,
- Televisions and VCRs, and
- Various plug-load office equipment, including copiers, fax machines, multifunction devices, printers, scanners, computers, and monitors.

The important aspect of the ENERGY STAR® program relating to market share tracking is the retail partnership arrangement. ENERGY STAR® Retail Partners receive free point-of-purchase and sales training materials, listing on the ENERGY STAR® website and Federal consumer information hotlines, access to utility and manufacturing programs, and leverage from ongoing national brand awareness campaigns. In return, Retail Partners agree to 1) label qualifying products, 2) display the point-of-purchase materials and brochures, 3) advertise and offer promotions on the ENERGY STAR®-labeled product, 4) train retail staff using

[30] Note that Federal standards do not yet apply to front-loading washers.

ENERGY STAR® promotional materials, and 5) provide sales data for tracking and other analytical purposes.

Transactions data are obtained from nearly all Retail Partners for both ENERGY STAR® and non-ENERGY STAR®-qualified products. There are currently 18 Retail Partners representing over 1,100 storefronts nationwide:

- 49er Window & Door
- Alexander's Appliances
- BGE Home Products and Services Inc.
- Circuit City Stores Inc.
- Conser Homes Inc.
- Deranleau's
- G&T Enterprises
- Goldcoast Ltd.
- Home Base
- Howard's TV & Appliance
- Liberty Appliance
- Montgomery Ward
- Mosee Brothers Inc.
- Pacific Sales
- Renwes Appliances
- The Hodges Company
- TOPS Appliance City
- Warehouse Discount Center

These Retail Partners account for nearly 15% of the retail market for the products covered by the ENERGY STAR® program.[31] They are currently under negotiation with Sears to become a Partner, at which point they will cover from 25% to 40% of the retail market, and are also negotiating an agreement with Best Buy. Data are not obtained from non-ENERGY STAR® Retail Partners, which are typically smaller, independent stores, representing about 40% to 50% of the California market.

The measure coverage, data coverage, development and operation, cost summary, advantages and disadvantages, and additional considerations regarding this proposed tracking initiative are detailed below.

Measure and Data Coverage

As indicated in Table 9-1, market shares for most of the residential priority measures can be tracked with the ENERGY STAR®/EGIA initiative. In particular, this initiative will cover replace-on-burnout or net acquisition purchases of the following measures:

- Compact fluorescent fixtures and lamps,
- Horizontal axis clothes washers,
- Refrigerators, and
- Dishwashers.[32,33]

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[31] In addition to the Retail Partners, there are six Retail Buying Group partners, Utility Partners, 91 Manufacturer Partners, four Government Partners, and two Energy Service Partners. California Utility Partners include PG&E, SMUD, SDG&E, and SCE.

[32] Compact fluorescent lamps are not currently an ENERGY STAR® rated product, but is expected to be covered by the program in 1999.

Because data for other appliances (including HVAC equipment and windows) are also collected under the ENERGY STAR® program, data for these measures can be obtained for tracking purposes, even though this initiative is not recommended as the primary tracking method for these measures.

Also note that gas water heaters can also be covered with this method in the future. Even though water heaters are not yet an ENERGY STAR® product, they are expected to be added to the program sometime in 1999. D&R is uncertain at this point when/how water heater sales data would be collected. As explained above for Initiative III, RER emphasizes that gas water heaters be included in this initiative as soon as possible. Doing so would mitigate the shortcomings of only collecting water heater sales data from distributors, as recommended in Initiative III.

The data collected under this initiative can be classified as either *unit sales data* or *market share data*, depending on the negotiated ENERGY STAR® Partnership agreement. Most ENERGY STAR® Retail Partners provide D&R with comprehensive unit sales data. These voluminous data are ideal for tracking purposes, as is point-of-sale data aggregated to the information collected product level. A few Retail Partners have agreed to provide data only in terms of the percentage of ENERGY STAR® unit sales relative to total sales. D&R is currently negotiating with these retailers to obtain more detailed data that would at least be useful for tracking purposes. Currently, ENERGY STAR® retailers submit data to D&R on a somewhat sporadic basis. However, D&R staff explained that they are currently working toward obtaining data on a quarterly basis. Note also that participating retailers also submit one year of historical transactions data upon entering the ENERGY STAR® program.

The unit sales data obtained from ENERGY STAR® retailers includes the following for ENERGY STAR® qualified products:

- Store number,
- Brand,
- Model number, and
- Number sold.

[33] Recall from Section 4 that clothes washers and refrigerators are not commonly installed by the builder in a newly constructed home, thus, tracking sales of these appliances through retailers would not be excluding net acquisitions from the analysis.

This data is also provided by some retailers for non-qualified products. However, one retailer provides data aggregated by product class rather than by individual products.[34]

With respect to efficiency market share tracking, D&R would aggregate the number of units sold across stores located in California for each unique brand and model number. Another option would be to aggregate data into smaller geographic regions, such as Southern California, Central California, and Northern California, if possible. This data would then need to be recoded into efficiency data useful for tracking. In particular, efficiency, size, and equipment type data are associated with each unique model number for each brand. Manufacturer catalogs, product directories, and other databases can be used in this process.

As mentioned above, ENERGY STAR® data would account for roughly 40% to 50% of the California market. Discussions during meetings between D&R and the EGIA revealed that if a few regional retail chains in California can be recruited as data suppliers, market coverage for market share tracking could increase to as high as 60% to 70%.

The data obtained from non-ENERGY STAR® Partners will be negotiated with each retailer and will need to be collected on a quarterly basis. Complete transactions data are not necessary for market share tracking, and prospective data suppliers might be more comfortable supplying as little data as possible. The Wisconsin tracking initiative serves as a good model for collecting data directly from upstream market actors in California. Not only do record keeping systems vary across retailers, but their willingness to provide certain data fields will likely differ. The key is to be as flexible as possible and not burden data suppliers with unnecessary constraints or requirements. Again, the data supplied will need to be negotiated with each individual retailer.

Development

Development Procedure

The development of this initiative will involve the five primary steps described below. The first two steps pertain to obtaining data from D&R's ENERGY STAR® database, and the remaining three steps involve recruiting non-ENERGY STAR® retailers and setting up a data collection and reporting protocol.

[34] It is important to note here that ENERGYSTAR® data collection efforts are an ongoing, evolving process. D&R staff has expressed interest in working to obtain more detailed data from retailers, particularly if such efforts can be mutually beneficial.

1) ***Become familiar with ENERGY STAR® database and identify data needs.*** As mentioned above, D&R developed and maintains data collection for the ENERGY STAR® program. RER has discussed the possibility of obtaining California sales data with D&R staff on several occasions. The first step of this process is to meet with D&R staff, become familiar with the data that would be available from the D&R database, and identify the data fields needed for efficiency market share tracking in California.

   RER has reviewed the data that D&R receives from participating retailers. As mentioned above, data required for backing out equipment efficiencies, type, and size are collected from the retailers' unit sales data.

2) ***Develop protocol for obtaining ENERGY STAR® data.*** After the desired data fields from the D&R database have been identified, a protocol for obtaining the data will be developed. Issues here include frequency of reporting, format of the data, level of data aggregation, and appropriate compensation to D&R.

3) ***Construct sample design of non-ENERGY STAR® retailers.*** To "fill the gaps" of the D&R ENERGY STAR® database, data need to be collected from non-ENERGY STAR® retailers. The first step of this process is to identify eligible retailers and construct a sample design. This sample design should consider the retailers' shares of the California market for each applicable measure and should be representative of the non-ENERGY STAR® retailer market. The EGIA would provide considerable input during this process.

4) ***Recruit non-ENERGY STAR® data suppliers.*** After potential data suppliers are identified and a sample design is constructed, the next, most critical step is to recruit data suppliers. Again, the EGIA would have a very active role during the recruiting process and would serve as a liaison between retailers and the data collection agent. Potential obstacles to successfully recruiting data suppliers and concerns of retailers about releasing their sales data have surfaced during several discussions between RER and the EGIA. However, data collected from distributors in Wisconsin provide useful guidelines for approaching and recruiting data suppliers and proves that this type of data collection can be successful and that mutually beneficial arrangements can be forged.[35,36] A first step in the recruiting process would be to meet with the EGIA's Board of Directors and then with individual potential data suppliers.

5) ***Set up data collection protocol with individual retailers.*** After a data supplier agrees to participate in this tracking initiative, the final step is to arrange a data collection protocol. This might or might not include reviewing each retailer's current record keeping practices and working with them to develop a data reporting process.

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[35] The concerns raised during a recent EGIA Board meeting are very similar as those that ODC encountered when developing the Wisconsin distributor tracking initiative.

[36] Appendix H details the Wisconsin tracking experience.

<u>*Development Time and Costs*</u>

The time and cost requirements for developing this tracking initiative are a function of the time and resources needed to develop data collection from the ENERGY STAR® database and those required to recruit non-ENERGY STAR® retailers.[37] One key advantage to this tracking initiative is that data can be obtained from D&R's ENERGY STAR® database relatively quickly. Because RER has discussed this possibility with D&R on several occasions, they are aware of data needs for tracking in California and are prepared to begin developing this initiative as soon as possible.

RER estimates that once the development process is under way, it would take roughly three months to obtain the first useful tracking data point representing sales by ENERGY STAR® Retail Partners. RER estimates that development of the ENERGY STAR® portion of this initiative will cost roughly $20,000 to $30,000.

However, the ENERGY STAR® data provide insight into only a portion of the California market. Constructing a sample design and recruiting non-ENERGY STAR® retailers will require more time and resources. Using the Wisconsin efforts as a gauge, RER estimates that constructing a sample design and recruiting non-ENERGY STAR® retailers could take at least six to nine months. Thus, the first tracking data point representing non-ENERGY STAR® retailers might not be available for nine months up to one year.

RER estimates that the costs for developing the non-ENERGY STAR® retailer portion of this initiative will range between $40,000 and $60,000. This general estimate is based somewhat upon the costs for developing the Wisconsin distributor tracking system.

Operation

The operation of this tracking initiative pertains to all data collection, processing, reporting, and analysis activities. Once this tracking initiative is developed and data collection protocols are arranged, the operation of the system and reporting would be necessarily involve the following:

- Ongoing communication with D&R staff, the EGIA, and non-ENERGY STAR® retailers supplying data,
- Obtaining data from D&R and non-ENERGY STAR® retailers on a quarterly basis,
- Developing and maintaining a market share tracking database, and
- Summarizing data and reporting on efficiency market trends on a quarterly basis.

[37] Time requirements in this context refers to the time it would take to have the first useful tracking data point once the development process begins.

The final result of this process includes a residential lighting and appliance replace-on-burnout/net acquisition efficiency tracking database updated on a quarterly basis, and a quarterly report summarizing trends in efficiency levels of replace-on-burnout/net acquisition purchases of the measures covered by this initiative.

RER estimates that the operation of this tracking initiative will cost roughly $25,000 to $35,000 per quarter or $100,000 to $140,000 per year. The estimated time and cost requirements for operating this tracking initiative account for 1) time required to retrieve and process data, 2) the time needed to maintain relationships with non-ENERGY STAR® retailers, 3) recruiting additional non-ENERGY STAR® retailers (as needed or if necessary), and 4) maintaining contact with D&R staff regarding collection of ENERGY STAR® data.

Cost Summary

Table 9-15 summarizes the costs for the development and ongoing operation of the ENERGY STAR®/EGIA retail tracking initiative.[38] As shown, RER estimates that this initiative will cost roughly $160,000 to $230,000 in the first year, and about $100,000 to $140,000 in subsequent years. It is evident that collecting data from non-ENERGY STAR® retailers involves more time and resources than obtaining data from the D&R ENERGY STAR® database. However, doing so is necessary in order to accurately estimate efficiency market shares of the covered measures. The estimated budget for this portion of the initiative could vary depending on the number of non-ENERGY STAR® retailers needed to supply data and the time and effort needed to do so.

[38] The cost estimates presented here were derived after the analysis presented in Section 8 was conducted. The cost scores included in Section 8 represent RER's fist estimate of costs that were derived for the purposes of comparing alternative tracking methods. Detailed budgets were not formulated until the recommended tracking methods were identified. In retrospect, these detailed cost estimates may differ slightly from the scores for the cost criteria presented in Section 8.

Table 9-15: Summary of Costs of Initiative IV, by Major Task

Task	Estimated Cost
Development and First Quarter:	
Development: ENERGY STAR® Retailers	$20,000 -$30,000
Development: Non-ENERGY STAR® Retailers	$40,000 -$60,000
Initial Data Collection from ENERGY STAR® Retailers	$10,000 -$15,000
Initial Data Collection from Non-ENERGY STAR® Retailers	$15,000 -$20,000
Subsequent Quarters:	
Quarterly Data Collection from ENERGY STAR® Retailers	$10,000 -$15,000
Quarterly Data Collection from Non-ENERGY STAR® Retailers	$15,000 -$20,000
Estimated First Year Cost	**$160,000 -$230,000**
Estimated Subsequent Year Cost	**$100,000 –$140,000**
Fixed Costs	**$60,000 - $90,000**

Advantages and Disadvantages

The primary advantages of this initiative include the following:

- Tracking at the retail level is one of the most appropriate nodes for collecting data for *replacement* and/or net acquisition purchases made directly by the consumer.
- This method offers tremendous economies because data for several priority measures can be collected with the same initiative.
- This initiative makes it possible to track additional competing measures, in addition to the priority measures identified for this study.
- Both the D&R (representing ENERGY STAR®) and the EGIA have expressed solid interests in pursuing this initiative. Furthermore, these organizations already have an existing working relationship, which strengthens this joint effort.
- The EGIA can provide a valuable link between retailers and the data collection and/or analytical agents. Furthermore, non-ENERGY STAR® retailers would be more willing to release proprietary data if tracking efforts were supported by organizations like the EGIA.
- An infrastructure has already been developed for collecting data from ENERGY STAR® Retail Partners, and the amount of time required for the development of the ENERGY STAR® portion of this initiative is relatively short.
- Historical data are available from the ENERGY STAR® data, though this data would not be necessarily be as complete as the data currently available, as more retailers have been joining the program over time.

The disadvantages include the following:

- Products not covered by the ENERGY STAR® program cannot be cost effectively covered with this tracking initiative.
- This initiative can only collect data representing replace-on-burnout or net acquisition *purchases*.
- Because the ENERGY STAR® program only collects data from participating retailers, the data are not representative of the entire California market. Because of this "gap," non-ENERGY STAR® retailers need to be recruited as data suppliers, which significantly increases data collection costs.

10

Recommendations for Tracking Nonresidential Measures

10.1 Overview

This section presents RER's recommended initiatives for tracking the efficiency market shares of the nonresidential priority measures. Section 8 detailed the scoring of each viable method for each priority measure by applicable decision type. The final step of the Feasibility Assessment is to develop a set of market tracking initiatives that provide the broadest market coverage, yet maintain an acceptable level of data accuracy. The objective of this task was not to rely solely on the final scores of the methods presented in Section 8, but to account for achievable economies across priority measures and across sectors significantly to formulate the recommendations presented here.

As with the residential measures, RER's objective was to formulate tracking initiatives that provided the highest level of economies and an acceptable level of data accuracy. For example, significant portions of two of the recommended tracking initiatives rely on the CEC's planned commercial customer on-site survey for which the CBEE has already approved funding. Incorporating data collection for tracking into the CEC customer survey avoids duplication of efforts and increases the productivity of MA&E funds transferred to the CEC.

Again, the tracking initiatives presented in this section recommend that efficiency market share data be collected on a quarterly basis. The frequency of data collection is a critical issue, particularly when one considers the time required to develop a tracking system and the number of data points available to assess market transformation through the end of the transition period. For example, if the first estimates of efficiency market shares are not available until, say, the first quarter of 2000, collecting data on a semiannual basis would only produce four data points through the end of the transition period.

The remainder of this section is organized as follows:

- Subsection 10.2 provides a summary of recommended tracking initiatives for nonresidential measures,

- Subsection 10.3 summarizes the issues involved with incorporating tracking needs into the CEC's planned commercial on-site survey efforts,
- Subsection 10.4 through 10.8 detail RER's recommendations for tracking nonresidential priority measures, and
- Subsection 10.9 discusses the nonresidential measures for which tracking recommendations were not developed.

10.2 Summary of Recommended Tracking Initiatives for Nonresidential Measures

Table 10-1 summarizes RER's recommendations for tracking the priority nonresidential measures.[1] As indicated, RER recommends that the market shares of the nonresidential measures be tracked with the following three initiatives:

- ***Initiative V: Integrating CEC On-Site Commercial Surveys and Building Department Data.*** This initiative integrates data collected via the CEC commercial on-site surveys and compliance data from participating building departments throughout the state. This initiative is the recommended primary data source for new construction installations of the following priority measures:
  - Nonresidential windows,
  - Packaged air conditioning,
  - Adjustable speed drive pumps and fans (HVAC and water heating applications),
  - 32 watt T8s with electronic ballasts, and
  - Energy management systems.

  Initiative Va: Integrating On-Site Commercial Surveys and Building Department Data. Because of the current uncertainties regarding the CEC data collection efforts, RER offers this initiative as an alternative to Initiative V. This initiative integrates data collected via on-site surveys in the commercial sector and compliance data from participating building departments throughout the state. The measures covered by this initiative are the same as those covered by Initiative V.
- ***Initiative VI: Integrating CEC On-Site Commercial Surveys and a Commercial & Industrial Sector Telephone Surveys.*** This initiative integrates the planned CEC commercial on-sites surveys and a telephone survey of commercial and industrial customers to collect data on retrofits of several priority measures. This initiative is the recommended primary data source for retrofits of the following priority measures:

[1] Note that the recommendations appearing in Table 10-1 represent the primary tracking initiative for each measure. In some cases, RER recommends that the primary data be supported or augmented with secondary data to cross-check data obtained from other sources. Secondary methods are discussed when appropriate.

- Adjustable speed drive pumps and fans (HVAC applications),
- 32 watt T8s with electronic ballasts,
- Energy management systems, and
- Compressed air optimization.

Initiative VIa: Integrating On-Site Commercial Surveys and Commercial & Industrial Sector Telephone Surveys. Because of the current uncertainties regarding the CEC data collection efforts, RER offers this initiative as an alternative to Initiative VI. This initiative collects tracking data through on-site surveys of commercial sites and through telephone surveys of commercial and industrial customers. The measures covered by this initiative are the same as those covered by Initiative VI.

- ***Initiative VII: Chiller Manufacturer Data Collection.*** This initiative entails the collection of chiller sales for new construction and replace-on-burnout installations from major chiller manufacturers.

As shown, these initiatives recommend tracking approaches for most of the priority nonresidential measures, with the exception of packaged refrigeration equipment and non-HVAC motors.[2] Initiatives V and VI recommend collecting data at the end-user level using on-site surveys and data obtained from building department records for new construction, and on-site surveys augmented with a telephone survey for retrofit/replace-on-burnout installations. Because of the rather unique structure of the chiller market, data useful for efficiency market share tracking can be obtained from major chiller manufacturers.

Defining Penetration Rates for Replace-on-Burnout and Retrofit Measures

Replace-on-Burnout. For energy efficiency measures that take the form of replace-on-burnout activities (say, purchase of a high-efficiency packages AC unit as a replacement for a failed unit), the penetration rate is defined as the ratio of replace-on-burnout purchases of high-efficiency units to the total purchases of all units of the equipment. Due to this definition, data collection should focus on customers who have replaced the equipment type in question (e.g., packaged air conditioning). This is done by screening for recent purchase activity (not the purchase of the high efficiency option, but rather the purchase of the equipment for which the option is available). *Note that, due to the need to screen on recent purchase activity, RER is not recommending the use of the CEC on-sites to track commercial replace-on-burnout measures.*

[2] Measures for which tracking recommendations are not provided are discussed in Subsection 10.7.

Table 10-1: Summary of Recommended Tracking Initiatives for Priority Nonresidential Measures

Priority Measure	Recommended Primary Tracking Initiative
Nonresidential Windows [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Nonresidential Windows [Retro.]	*None recommended (see below).*
Packaged Air Conditioning [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Packaged Air Conditioning [ROB]	III. Distributor Data Collection *(see Section 9)*
Chillers [NC]	VII. Chiller Manufacturer Data Collection
Chillers [ROB]	VII. Chiller Manufacturer Data Collection
Non-HVAC Motors	*None recommended (see below).*
Adjustable Speed Drive Fans [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Adjustable Speed Drive Fans [Retro.]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
32W T8s w/Electronic Ballasts [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
32W T8s w/Electronic Ballasts [Retro.]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
Energy Management Systems [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Energy Management Systems [Retro]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
Packaged Refrigeration Equipment	*None recommended (see below).*
Adjustable Speed Drive Pumps [NC]	V. CEC On-Site Survey/Building Department Data Va. On-Site Survey/ Building Department Data
Adjustable Speed Drive Pumps [Retro.]	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys
Compressed Air System Optimization	VI. CEC On-Site Survey/C&I Telephone Survey VIa. On-Site Survey/C&I Telephone Surveys

[NC] [Retro.] [ROB] and [Net Acquis.] denote new construction, retrofit, replace-on-burnout, and net acquisition decision types, respectively.

Retrofits. For retrofit measures, the penetration rate is defined as the ratio of the number of retrofits to the number of applications for which the retrofit would be applicable. For retrofit measures, it is not necessary to screen survey samples for customers who have done anything in particular. It would not be appropriate, for instance, to survey just those customers who have retrofit lighting systems over some period of time. Doing so would result in a meaningless and artificially high retrofit rate. (Most customers retrofit lighting systems with install high efficiency lighting. This does not mean, though, that the penetration rate for high efficiency lighting is a large number.) The same is true for the other retrofit measures: EMS, ASDs and compressor optimization. The bases (the denominators) for calculating penetration rates for the retrofit measures could be defined as follows:

- T8s and electronic ballasts – the total number of 4-foot fluorescent fixtures
- ASDs on fans and pumps – the total number of fans and pumps for which ASDs would be applicable
- EMS – the total number of HVAC systems for which EMS is applicable
- Compressed air optimization - total number of compressors

Timing

The three recommended initiatives are designed to collect data on a quarterly basis and could be developed and implemented by the fourth quarter of 1999, thereby producing tracking data by the first quarter of 2000. Table 10-2 summarizes the timing of the planning and implementation of each initiative. Note that these estimates rely on reasonable and timely cooperation from the major players in each of the initiatives. In particular, Initiative VI relies heavily on the implementation of the CEC residential survey effort.

Table 10-2: Summary of the Timing of the Planning and Implementation the Recommended Residential Tracking Initiatives

Initiative	Planning	Implementation
V. CEC On-Site Survey/Bldg. Dept Data	2nd – 3rd Quarter 1999	4th Quarter 1999
VI. CEC On-Site Survey/C&I Telephone Survey	2nd – 3rd Quarter 1999	4th Quarter 1999
VII. Chiller Manufacturer Data Collection	2nd – 3rd Quarter 1999	4th Quarter 1999

Costs

Table 10-3 presents a summary of the costs by initiative for the first and subsequent years. As shown, the estimated annual budget to develop and implement the three recommended tracking initiatives is in the range of $761,000 to $1,078,000 for the first year. Development costs are not incurred in subsequent years, which reduces the annual costs to roughly $648,000 to $896,000. As shown, estimated costs increase significantly if tracking needs are not incorporated in the CEC's data collection efforts.

Table 10-3: Summary of the Annual Costs for First and Subsequent Years for Planning and Implementing the Recommended Nonresidential Tracking Initiatives

Initiative	First Year	Second Year
V. CEC On-Site Survey/Bldg. Dept. Data	$172,000 to $233,000	$136,000 to $180,000
Va. On-Site Survey/Bldg. Dept. Data	*$868,000 to $1,345,000*	*$832,000 to $1,280,000*
VI. CEC On-Site Survey/C&I Telephone Survey	$499,000 to $695,000	$452,000 to $616,000
VIa. On-Site Survey/C&I Telephone Survey	*$810,000 to $1,196,000*	*$780,000 to $1,140,000*
VII. Chiller Manufacturer Data Collection	$90,000 to $150,000	$60,000 to $100,000
Total Cost with CEC Involvement	$761,000 to $1,078,000	$648,000 to $896,000
Total Cost w/out CEC Involvement	$1,768,000 to $2,691,000	$1,672,000 to $2,520,000

10.3 The CEC Commercial On-Site Survey

Initiatives V and VI below rely heavily on the incorporating efficiency market share tracking needs in the CEC's planned commercial on-site survey effort. This subsection provides some background information, discusses the results of meetings between RER and CEC staff, and proposes a plan for using the CEC surveys for tracking purposes.

Background

On September 25, 1998, the CEC's Demand Analysis Office presented a proposal to the California Board for Energy Efficiency (CBEE) for co-funding the CEC's data collection efforts. Until this year, customer surveys and the Database for Energy-Efficient Resources (DEER) updates were funded and performed by the utilities through DSM funds. Because this funding source is no longer available, the CEC sought funding from the CBEE to supplement funds requested by the CEC in its budget change proposal (BCP). The proposal submitted to the CBEE provided background on the CEC data collection efforts and summarized the budget requirements for continuing the survey implementation and DEER updates through 2002.

During its September 25 1998 meeting, the CBEE did not commit to fund CEC data collection for all four years included in the proposal, but agreed to earmark funding for the first year of the data collection effort in 1999 and return to the issue of future funding after more experience was gained in designing joint projects.

> "After discussion, the CBEE recommended that the CPUC direct the Interim Administrators to put $2.1 million in 'placeholder' funding in their filings for 1999 only. In addition, the CBEE's support for funding for these activities will depend in part on successful resolution of issues such as availability of information produced from these surveys to market participants, the CBEE and Interim Administrators, review of the survey questions, etc."[3,4]

On January 13, 1999 the CBEE's technical service consultants (TSCs) presented their understanding of the use of the $2.1 million:

> "… fund DEER; for remainder, [provide] support for survey activities, with stated priority for commercial survey amongst the sectors (but not necessarily limited solely to commercial survey in [the] event [that] some PCG [funds] could result in higher value by also providing some support for other surveys), but direction was to shape use of the money as well as possible to meet both CEC and CBEE information needs."[5]

To provide guidance to the CBEE regarding future CEC data collection funding issues, the TSCs also recommended that the CBEE adopt their understanding of the use of funds as stated above. As noted in the minutes of the January 13, 1999 CBEE meeting, the CBEE voted unanimously to award the CEC $2.1 million of MA&E funds for data collection activities.

> "Regarding III B, the technical consultants understanding of an earlier Board recommendation on funding to the CEC for specific load forecasting and energy efficiency database projects, the Board reaffirmed the summary contained in Item IIIB. The CEC will keep the Board apprised of its efforts to obtain co-funding as well as make information collected in the surveys more available to the public and

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3 California Board for Energy Efficiency Meeting Minutes, September 25, 1998.

4 The CBEE determined $2.1 million was determined according to priorities for 1999 data collection - $1.75 million for the commercial survey and $0.4 million for DEER database update. These figures were presented in the CEC's September 25, 1998 proposal to the CBEE.

5 MA&E Issues at January 13 CBEE Meeting. Proposed Order of CBEE Decisions and Related TSC Recommendations, January 13, 1999.

> useful to stakeholders interested in energy efficiency. This motion passed with a vote of 6-0…"[6]

The final transfer of funds is dependent upon CPUC authorization of the MA&E budgets in the 1999 program budget filings.

CEC Commercial Survey Proposal

The CEC's proposal to the CBEE identified a commercial survey that shows some promise as an element of a tracking system. In its September 25th proposal to the CBEE, the CEC explained that the commercial customer survey would entail conducting roughly 8,000 on-site surveys. These surveys would be conducted biannually, with data collection and analysis each taking several months to complete. The cost for the on-site surveys was estimated to be $4 million, or $500 per survey.[7] RER's understanding is that this sample size is not definite and could vary depending on the per-unit cost.

The CEC's proposal specified $1.75 million of the $2.1 million to implement the commercial survey effort in 1999.

Steps Needed to Use the CEC Surveys for Market Share Tracking

The results of RER's meetings with the CEC suggest that the CEC is willing to further investigate the possibility of incorporating market share tracking into their data collection effort. RER is particularly interested in the direct use of the commercial survey to collect customer-level data on efficiencies of recent installations of several priority measures. Some design changes to the CEC surveys would be necessary to accommodate this need. These changes relate to the following:

- Questionnaire design,
- Implementing surveys on a quarterly basis,
- Oversampling new construction sites,
- Accelerating the implementation of survey efforts, and
- Estimated costs.

Questionnaire Design. The commercial on-site questionnaire would need only minor changes to accommodate the collection of the appropriate tracking data. Utility instruments have included a variety of questions on equipment characteristics and recent equipment purchases, and these would presumably be retained by the CEC. Overall, RER expects that

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6 California Board for Energy Efficiency, Minutes for the Meeting of January 13, 1999.

7 This estimate does not include funding for the average equipment energy use follow-up study or the load-metered sites customer characteristics analysis.

tailoring the CEC survey instrument for the collection of tracking data would add little to the length of the instrument or field time.

Although the CEC recognizes the need and is willing to accommodate additional questions in the customer surveys, it is necessary to ensure that the survey length remains reasonable. Furthermore, CEC staff is dedicated to revising the survey instrument to yield more useful and more accurate data. This will involve not only revising and pretesting the questionnaire to reduce the number of "don't know" and "not applicable" responses, for example, but will also require more thorough training and monitoring of on-site surveyors. The manager of the commercial survey expressed interest in working with all involved parties in developing a survey that will be useful to both the CBEE and the CEC purposes.

Implementing Surveys on a Quarterly Basis. The CEC's proposed plan is to implement CEC customer surveys on a two-year cycle. This is similar to the approach previously taken by the utilities to support the Common Forecasting Methodology (CFM) process. In this plan, surveys were administered during the first year and data analysis was be conducted during the second year. This cycle has served the CEC forecasting needs well, but would be disadvantageous for efficiency market share tracking. Given the CBEE's four-year outlook (the "transition period" until 2002), the CEC's two-year cycle would produce only one data point for market shares.

RER proposes that the CEC consider implementing the customer surveys on a quarterly basis. This will provide an adequate number of data points for market share tracking. The CEC could then combine the quarterly data to meet its forecasting needs. Implementing surveys on a quarterly basis implies the following:

1) Surveys will need to be conducted *statewide* on a quarterly basis, which will be more costly than conducting all surveys at the same time.
2) The total number of completed surveys will not change; rather, they will be conducted in phases during the two-year period.
3) Conducting the on-site surveys on a quarterly basis could provide advantages relating to the quality of the fieldwork. A contract for ongoing quarterly data collection could provide data collection contractors with baseload work for a long period. This might mean that they would be able to hire full-time surveyors for the contract, which could result in better survey results and more accurate data.

Oversampling* New construction*. Discussions with CEC staff suggest that oversampling new construction sites could be beneficial for the CBEE's tracking needs, insofar as new construction constitutes an important market event. RER is recommending initiatives for tracking efficiency market shares of new construction, retrofit, and replace-on-burnout installations, and oversampling new construction sites would make the CEC surveys more useful in this regard. While the CEC staff did not commit to oversampling new construction, they are very aware that oversampling could have benefits for the development of marginal EUIs, UECs, and saturations to be used in forecasting.

Acceleration of the Commercial and Residential Surveys. Another issue with respect to timing is the implementation of the surveys. According to the CEC, it might be possible to begin commercial survey implementation by the late spring of 1999. While this would require the acceleration of retaining data collection contractors, it would serve the purposes of market share tracking well. If data analysis takes place about one month after the completion of each quarterly round of surveys, initial tracking results could be ready by early autumn.

Cost. Incorporating market share tracking into the customer survey will invariably increase the costs of survey administration. First, as mentioned above, statewide coverage on a quarterly basis will be more costly than conducting all surveys in a specific region at one time. Second, contract management will likely add to the costs of survey implementation. RER and the CEC staff are beginning to estimate these costs. If they are substantial, additional CBEE funding may be required should this strategy be adopted for tracking.

Logistical Problems

Several logistical problems must be overcome to successfully incorporate tracking needs into the CEC data collection efforts. These problems relate to confidentiality of data supplied by utilities and the collected survey data, acquiring sampling frame and billing data from utilities, CPUC approval of funding, and the CEC contracting mechanism.

Confidentiality. Confidentiality refers to the data supplied by the utilities (billing data in particular) and collected via customer surveys. Survey data is automatically confidential, but the confidentiality of the sampling and billing frame data supplied by the utilities is another issue that will need to be addressed.

Obtaining Sampling Frame and Billing Data from Utilities. The CEC's biggest concern and obstacle at this point is obtaining a sampling frame and billing data from utilities, which are necessary for implementation of the customer surveys. Utilities are hesitant to supply billing frame data to a state public agency, but might be more amenable if the surveys are used for market share tracking. If the CBEE assists the CEC in this regard, the CEC's overall efforts will clearly benefit.

Funding. The CPUC has not yet approved the transfer of $2.1 million to the CEC. Moreover, the funds are devoted to the commercial survey and DEER updates. As discussed above, if the residential survey was used to collect data for tracking purposes, it would need to be funded somehow in 1999. One option is for the CBEE to allocate additional funds for this purpose.

CEC Contracting Mechanism. The CEC contracting mechanism is time-consuming and constitutes a major obstacle for this effort. The latest proposal submitted to the CBEE in January 1999 provides an indication of the CEC contracting process. In particular, the CEC estimated that work could begin by June of 1999 at the earliest. One possible solution to this timing problem is to begin the data collection efforts under an existing contract with the CEC.

Summary of Advantages and Disadvantages

Accommodating tracking needs with CEC data collection efforts will obviously have some advantages and disadvantages, as summarized below.

Advantages include the following:

- The data collection infrastructure is already in place and CEC staff has been using these surveys since the mid-1970s.
- By oversampling new construction, downstream tracking could allow for distinction by decision type of installation.
- CEC customer surveys enable the tracking of other market effects, providing the surveys are not bogged down with too many questions.
- Efficiency market share tracking should be a long-term commitment (i.e., should continue beyond CBEE’s four-year outlook). The CEC is good candidate for long-term data collection.
- Data could also be segmented on a regional level—by weather zone, utility area, county, etc.
- This process might motivate utilities to provide CEC with sample frame and billing data.

Disadvantages include the following:

- Additional funding would be required in 1999.
- The CEC’s contracting mechanism is slow.
- The need to convince utilities to provide sampling frame and billing data to the CEC and confidentiality issues would need to be resolved.
- The CEC will need to change normal procedure by conducting surveys on a quarterly basis statewide. This introduces some logistical issues.
- The political environment might not be amenable to increased role of the CEC

10.4 Initiative V: Integrating CEC Commercial On-Site Surveys of Newly Constructed Facilities and Building Department Data

As indicated in Table 10-1, RER recommends tracking new construction installations of several nonresidential measures at the end-user level—through data collected via the CEC's planned commercial on-site survey effort and from building department compliance forms. Surveying the end user and collecting data from building department records is more favorable than collecting data at other market nodes for several reasons. First, as explained in Section 4, upstream market actors do not typically track product sales beyond the first invoice and/or are unable to distinguish sales by decision type.[8] Second, end-user-level data are preferred over data obtained from midstream market actors, such as builders and contractors. RER anticipates that these sources would not be reliable, long-term sources of data useful for efficiency tracking. RER's experience in past studies suggests that these market actors would be very reluctant to commit time or resources to such research efforts.

This tracking initiative would be the primary source of market tracking for the following four priority measures installed in the nonresidential new construction sector:

- Packaged air conditioning,
- Energy management systems,
- Windows,
- 32 watt T8s with electronic ballasts, and
- Adjustable speed drive pumps and fans (HVAC and water heating applications).

This initiative can also provide secondary data for motors installed in the commercial sector and chillers.

Figure 10-1 provides an overview of this tracking initiative. As shown, there are seven key elements to the tracking approach:

- Survey design,
- Conduct on-site surveys,
- Obtain building department compliance data,
- Building department and on-site survey data overlap,
- On-site and building department data calibration and verification,
- Market share tracking analyses, and
- Nonresidential new construction measure efficiency tracking database updates.

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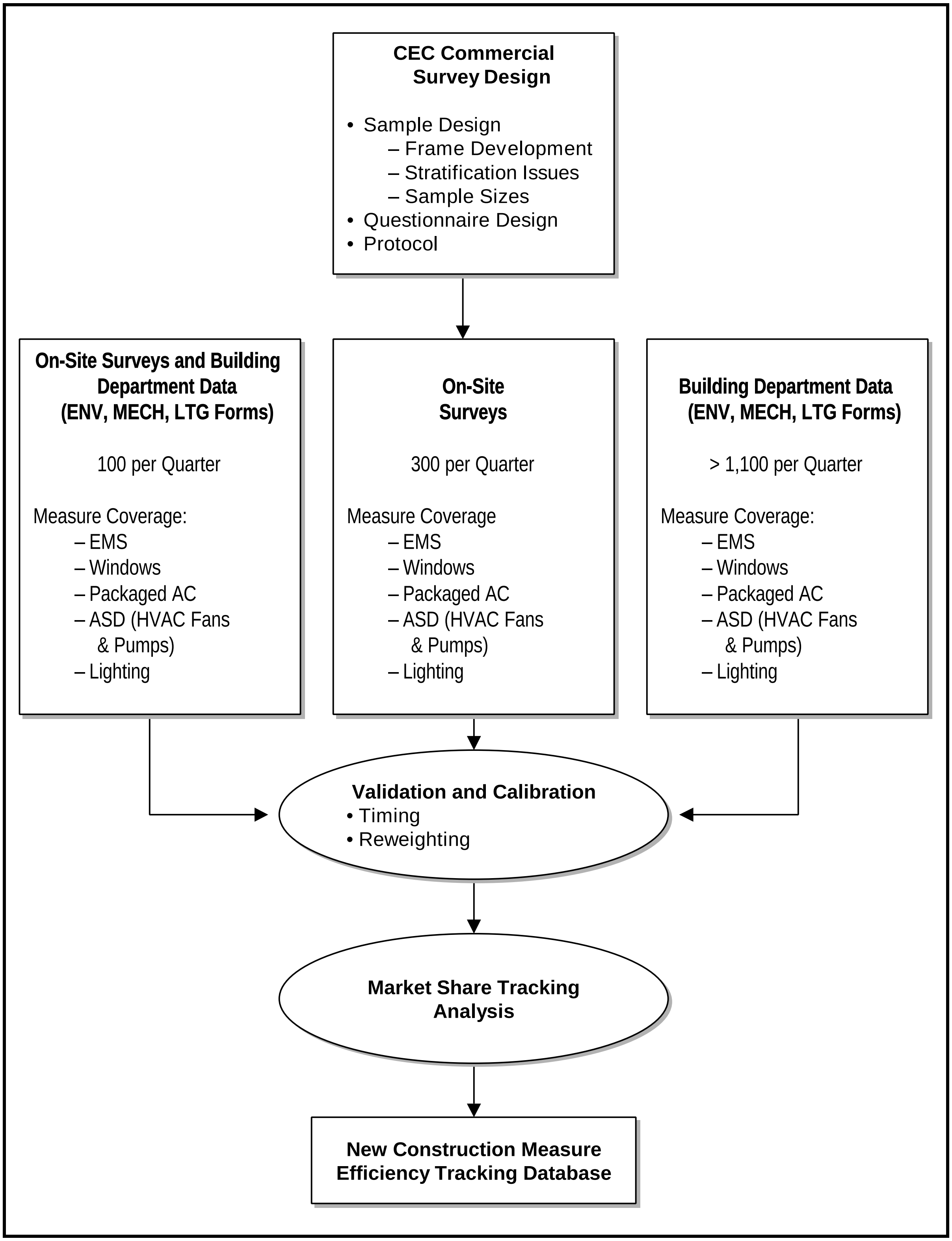
8 One possible exception to this finding is chiller manufacturers. Chiller distribution is typically from the manufacturer directly to the customer, and most chillers are designed and manufactured for customized applications. As such, the manufacturer tends to know where the equipment is ultimately installed.

Figure 10-1: Overview of Initiative V – Tracking Nonresidential New Construction Installations



Briefly, this initiative entails quarterly data collection from three samples of newly constructed nonresidential sites. A quarterly sample of 400 on-site surveys will be conducted using a stratified sample of newly constructed homes. This data will be augmented with the collection of data from at least 1,100 Compliance Certificates (ENV-1, MECH-1, and LTG-1 Forms, at a minimum) from a sample of building departments throughout California. In addition, for 100 of the 400 on-site surveys, both building department data and on-site survey data will be collected each quarter. Data from these three samples will verify the accuracy of the building department data, calibrate the timing of the installation of energy using equipment in newly constructed buildings, generate useful tracking parameters, and ultimately populate a measure efficiency tracking database.

The remainder of this recommendation details the data and measure coverage, procedure for developing the initiative, provides timing and cost estimates, and discusses other issues.

Measure and Data Coverage

On-Site Surveys. Table 10-4 includes measures covered by the on-site survey, whether this method is the primary or secondary data tracking source, the measures characteristics that can be collected during the on-site visit, and the corresponding data that would ultimately need to be used for tracking market shares.[9] The distinction between the data collected on-site and the data used for market share tracking is important. In most cases, the equipment type and model number are the only observable data that can be collected during the on-site visit. These data can ultimately be translated to useful efficiency and equipment characteristics by using product directories, publicly available product databases, or manufacturer-specific publications.

Building Department Data. The source of the building department data are ENV-1. MECH-1 and LTG-1 forms are used to record the planned installations of energy-using equipment in the nonresidential new construction sector.[10] Table 10-5 includes the measures covered by these forms, whether this initiative is the primary or secondary data source, and the characteristics of the measures that can be used for tracking market shares. Note that, unlike the on-site survey data, most data collected from the building department compliance forms are already in a form useful for efficiency tracking.

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[9] A designation of a primary source indicates that the on-sites will provide the primary data used to track market shares. A secondary designation indicates that this data will be either supplemental to other initiatives or used to cross-check data from other sources.

[10] ENV-1, MECH-1, and LTG-1 are the required forms. Other forms that could be available include ENV-2 to ENV-5, MECH-2 to MECH-3, and LTG-2 to LTG-5. These supplemental forms could provide additional useful information on the building envelope, lighting, and mechanical equipment characteristics. Copies of the forms are included in Appendix I.

In addition to the data for the high priority measures presented above, data on purchasing and decision-making practices relating to energy-using equipment, and end user characteristics can also be collected during the on-site surveys. Detailed data on non-priority measures can be collected from both the on-site surveys and from building department data.

Table 10-4: Measures and Measure Characteristics Covered by On-Site Surveys

Measure	Source Type	Data Collected On-Site	Tracking Data
Packaged Air Conditioning	Primary	Manufacturer and model number, size, heating and cooling capacities, fan HP, fuel type, and system type	Fuel type, system type, EER/ SEER, HSPF or COP, and size
Energy Management Systems	Primary	Manufacturer, control functions, area covered, and systems controlled	Control functions, area covered, and systems controlled
32 watt T8s with Electronic Ballasts	Primary	Lamp type, fixture counts, Lamps per fixture, ballast type, lamps per ballast	Fixture counts, lamps per fixture, ballast counts, percent (area or counts) of applicable lighting with 32 watt T8s with electronic ballasts.
ASD Pumps and Fans (HVAC and water heating applications)	Primary	Manufacturer, characteristics of all motors (see motors) – motor control type.	Motor controls, relevant characteristics of motors (load type, HP, efficiency, etc)
Motors	Secondary	Manufacturer, model number, HP, component type (pumps, fans, air compressors, other), process (HVAC, industrial process, etc.), control type (throttle valve, ASD, inlet vane etc.), efficiency, load type (constant variable, intermittent)	HP, efficiency, component type, process, and control type
Windows	Secondary	Glass type, number of panes, area, frame type, and tinting.	Glass type, number of panes, area, frame type, and tinting.
Chillers	Secondary	Manufacturer and model number, system type, cooling capacities, efficiency (kW/ton or COP), and fuel type	Manufacturer and model number, system type, cooling capacities, efficiency, and fuel type

Table 10-5: Measures and Measure Characteristics Covered by Building Department Data

Measure	Source Type	Data Available from Building Department CF-6R Forms
Packaged Air Conditioning	Primary	Manufacturer and model number, heating equipment type, cooling equipment type, efficiency and size
Energy Management Systems	Primary	Temperature control type, lighting control type, economizer
32 watt T8s with Electronic Ballasts	Primary	Lamp type, number of lamps, watts per lamp, ballast type, and number of lamps per ballast
Windows	Primary	Number of panes, U-value, frame type, glazing type
ASD Pumps and Fans (HVAC and water heating applications)	Secondary	Only HVAC-related (fans) HP, efficiency, number of fans, control type, load type
Motors*	Secondary	Only HVAC-related (fans) HP, efficiency, number of fans, control type, load type
Chillers	Secondary	Manufacturer and model number, system type, size, efficiency

* Since Title 24 compliance is directed at HVAC energy use, motor information is only available for HVAC fans.

Development

Development of this method entails 1) the integration of questions relating to collecting data useful for tracking the high priority measures and the CEC commercial on-site survey effort, 2) the collection of building department compliance forms, and 3) construction of a nonresidential new construction efficiency market share tracking database. Each of these components is discussed below.

*Integration of Market Share Tracking Data Requirement into the CEC Commercial (*New construction*) On-Site Surveys*

The integration of the market share tracking needs into the CEC commercial survey effort involves the following major issues:

- Oversampling of new construction, and
- Integration of market tracking questions into the on-site questionnaire design.

Additional issues were detailed above in Subsection 10.3.

***Oversampling* New construction.** As discussed above, assuming that the frequency of the CEC commercial survey effort can be changed to accommodate quarterly tracking and that the proposed sample size remains the same, roughly 1,000 on-site surveys will be completed each quarter. A stratified random sample of 1,000 completed surveys would not be expected to include a sufficient number of newly constructed facilities to support tracking of high priority measures with any reasonable precision.[11] To mitigate this issue, the CEC sample design will need to oversample new construction sites. It is anticipated that the CEC survey database will rely heavily on sample frame data received from individual utilities. RER's past experience reveals that it is difficult for the utilities to identify new construction customers, as this data is not typically included on their billing frame. Further, the CEC's biggest concern and obstacle to developing their customer survey effort is obtaining sample frame and billing data from utilities, which are necessary for implementation of the CEC's customer surveys.[12] Having noted these issues, data from commercial companies, trade associations, and tax assessor records can be used provide sufficient data to develop a population and sampling frame.

The new construction on-site survey data will be used primarily to calibrate and cross-check building department data, with the exception of motors and ASD pumps and fans. RER recommends a completed sample size of 400 on-site surveys of newly constructed facilities per quarter. This sample size would support the estimation of 1) the proportion of facilities with T8s and electronic ballasts (assumed to be 40%), within ±10% relative error, with 90% confidence;[13] and 2) the average efficiency above some base level (presumably the standard) for HVAC fan motors with the same precision.[14] The completed sample would need to be considerably larger if the on-sites were the primary tracking method for low saturation priority measures, such as high efficiency packaged air conditioners. These priority measures are accounted for in the relatively large sample sizes obtainable from the building departments.

Integration of Market Tracking Questions into the On-Site Questionnaire Design. The on-site questionnaire design will be critical for the success of the tracking effort. The survey should involve two phases: an interview with the building owner or facilities manager (or other relevant energy decision maker) and a thorough walk-through inspection of the relevant measures. RER recommends that the CEC on-site survey

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[11] Sample stratification is also an important sample design consideration. Stratification of the sample by building type and climate zone would allow for the examination of market share trends by these stratification variables. This would be particularly important for weather sensitive measures.

[12] Utilities are hesitant to supply billing frame data to a state public agency, but might be more amenable if the surveys are used for market share tracking.

[13] These estimates are based on a recently completed survey of the California commercial new construction market.

[14] This assumes a coefficient of variation of one and that 80% of new buildings have HVAC fan motors installed. RER looked into air conditioning efficiency level data collected for two recently completed new construction project in California – SDG&E's Commercial New Construction Program and PG&E's CEUS study, in particular. The coefficient of variation from those data ranged from 0.7 to 0.8 for an estimate of the average efficiency level above standard. Insofar as this study included a number of other measures, we decided to use a slightly more conservative estimate of 1.0.

questionnaire be thoroughly reviewed to ensure that questions designed to collect the data required to develop the market tracking database (e.g., the equipment characteristics outlined in Table 10-4) are included. Further, if possible, the questionnaire should include questions on self-reported attitudes of building owners or facilities managers.

Collecting Building Department Data

This recommended tracking initiative requires that at least 1,100 sets of ENV, LTG, and MECH forms be collected from a sample of building departments every quarter.[15] Obtaining this information from building departments will require the cooperation of a significant sample of building departments in allowing on-site collection of the compliance forms and/or in copying and sending the data to a central clearinghouse.[16]

As discussed in Section 9, RER conducted an informal survey of 23 building departments throughout California. Roughly 59% of the surveyed building departments would, with some encouragement, be willing to assist in the collection of nonresidential compliance forms. Given that financial incentives could be offered to pay for internal building department staff time to fulfill requests, it is anticipated that a statistically significant sample of compliance forms can be collected for the purposes of efficiency market share tracking.

As mentioned above, data from both an on-site survey and from building department data will be collected for at least 100 of the 350 on-site surveyed sites. Information from building departments will be gathered and used to develop contacts for the on-site surveys.

Construction of the Nonresidential New Construction Efficiency Market Share Tracking Database

Data collected through on-site surveys and from building department compliance forms must be recoded to construct an efficiency market share tracking database. Several important issues regarding the development of the tracking database include data entry, recoding data

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[15] Requiring at least 1,100 forms would support the estimation of the percentage of covered priority measures that are considered to be high efficiency or the percentage of equipment with add-ons, such as ASDs. For example, if it is assumed that 20% of newly constructed facilities install EMS, a sample size of roughly 1,100 would be required to support an estimate of ±10% with 90% confidence. We could also consider estimating the average efficiency level above the standard for packaged air conditioning equipment. Using a coefficient variation of one, this would require a sample size of about 280. Assuming about 30% of newly constructed homes have packaged air conditioning, 1,100 would provide a sample size large enough to produce reliable estimates of average efficiencies.

[16] In RER's Residential Market Effects Study, collection of compliance forms was accomplished using both on-site data collection and by Building Departments copying and sending compliance forms directly to RER.

into useful tracking parameters, sample weighting, calibrating timing between purchases and actual installations, and estimating window efficiency parameters.

Data Entry Database Format. Data entry will be a major portion of the work effort every quarter. Data from the on-site surveys and building departments will be collected in hard copy format that will need to be entered into an electronic database. RER recommends a conventional database format, such as Excel or Access.

Recoding Collected On-Site Data into Useful Market Share Tracking Parameters. An efficient methodology must be developed to translate the data collected on-site into useful tracking data. In general, the on-site survey will be used to obtain equipment types and model numbers, which then must be translated into efficiency and size data. Typically, this can be accomplished by using manufacturer product literature and product availability databases and should be done during the post processing of the data.

Translating Building Department Data into Useful Market Tracking Parameters. The ENV-1, LTG-1, and MECH-1 forms exist in hard copy format only. Further, these forms are typically attached or photocopied onto site plans. With the exception of windows, the measure characteristics data reported on the compliance certificates can be directly used for tracking. That is, actual equipment size and efficiency data are recorded on these forms. The window data are by individual window and will need to be size-weighted to get average U-values for each building.

Weighting the Samples. Considerable care will need to taken to correctly post-weight the on-site and building department data to reflect the population of commercial new construction in California.

Calibrating Timing of Installation. The data collected in the tracking database will be used to infer the extent of market transformation attributable to programs targeting the priority measures. A critical part of this effort is to ensure the comparison of tracking parameters for equipment purchased in the same period. This is an issue in the new construction sector, where there can be considerable time lags between the time equipment is purchased and when the building is first occupied. Both on-site and building department data will be collected from at least 100 buildings. These sites will be used to reconcile installation dates across samples.

Leveraging Window Data. Detailed data on window U-values can be obtained from the ENV-1 building department forms. The on-site data are less likely to have detailed data on window U-values, as these data are not observable after installation. However, both sources can provide frame type and number of panes. RER recommends exploring the possibility of leveraging the U-value data from the building department data to on-site data using the frame type and number of panes.

Timing and Schedule

There are a number of issues relating to the timing and scheduling of this initiative. The major issue is the timing of the CEC commercial survey effort. Preliminary indications from the CEC are that this effort can begin as early as the second quarter of 1999, but is more likely to spill over into the third quarter of 1999. Once this process begins, the timing of the tracking survey implementation will depend on the time necessary to develop the survey design and implement the initial on-site surveys. Other timing issues include time needed to foster relationships with the building departments to facilitate collection of the compliance forms, the time necessary to collect the compliance forms, development of the tracking databases, and the on-going operation of the tracking system. Table 10-6 presents a summary of the timing and a recommended schedule for implementing this tracking initiative.

As presented in Table 10-6, once the initial tracking system is operational, the scheduling of quarterly updates will need to be closely monitored. RER anticipates that, in coordination with the CEC project managers, sample design updates will need to be done during the on-site data collection of the prior quarter. On the other hand, once relationships with the building departments are established, most data could be forwarded and/or collected on-site in a timely manner, requiring relatively little field work from the tracking system operator.

Table 10-6: Summary of Timing and Scheduling of Intiative V

Task	Timing	Scheduling
Survey Design	6-8 Weeks	3rd Quarter 1999
Initial On-Site Surveys	8-12 Weeks	4th Quarter 1999
Initial Building Department Contacts	6-8 Weeks	3rd Quarter 1999
Initial Building Department Data Collection	4-8 Weeks	3rd Quarter 1999
Initial Tracking Database Development	3-5 Weeks	3rd Quarter 1999
On-Going Sample Design Update	2-3 Weeks	Quarterly from 4th Quarter 1999
Quarterly On-Site Surveys	8-10 Weeks	Quarterly from 1st Quarter 2000
Quarterly Building Department Data Collection	4-6 Weeks	Quarterly from 1st Quarter 2000
Update Tracking Database	3-5 Weeks	Quarterly from 1st Quarter 1999

Cost Estimates

Table 10-7 presents a summary of the estimated costs by task to develop and operate this tracking initiative.[17] Note that the costs associated with the on-site survey effort are estimated costs to integrate the tracking effort with the CEC commercial survey project. In particular, these costs do not include the costs for conducting the on-sites, the initial survey design, and questionnaire design. These costs are assumed to be incurred by the CEC commercial survey effort. However, some coordination and review time costs are budgeted. In addition, the time needed for collecting building department data is greater for this commercial initiative than for the residential initiatives. This is due primarily to the format of the compliance data as opposed to the verification data. Again, the compliance data exist as hard copy data usually attached to building plans. This will require substantial field time to collect the data. RER anticipates that this process will be streamlined as the cooperation of building departments increases.

Ranges of costs are provided as a guideline; the final budgets would depend on the features adopted for the final tracking system and cooperation from involved parties.

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[17] The cost estimates presented here were derived after the analysis presented in Section 8 was conducted. The cost scores included in Section 8 represent RER's fist estimate of costs that were derived for the purposes of comparing alternative tracking methods. Detailed budgets were not formulated until the recommended tracking methods were identified. In retrospect, these detailed cost estimates may differ slightly from the scores for the cost criteria presented in Section 8.

Table 10-7: Summary of Costs of Initiative V, by Major Task

Task	Estimated Cost
Development and First Quarter:	
Survey Design Review and Coordination with CEC	$5,000 - $8,000
Initial Coordination of On-Site Survey with CEC	$15,000 - $20,000
Building Dept. Contacts and Development	$15,000 - $25,000
Initial Building Department Data Collection	$20,000 - $25,000
Tracking Database Development	$15,000 - $20,000
Subsequent Quarters:	
Quarterly Sample Design Update	$3,000 - $5,000
Quarterly Coordination of On-Site Surveys with CEC	$3,000 -$5,000
Quarterly Building Department Data Collection	$20,000 - $25,000
Quarterly Tracking Database Update	$8,000-$10,000
First Year Cost	**$172,000 - $233,000**
Subsequent Year Cost	**$136,000 - $180,000**
Fixed Costs	**$36,000 - $53,000**

As shown in Table 10-7, the cost to implement the system in the first year of operation is roughly $172,000 to $323,000. Costs in subsequent years would drop slightly to the range of $136,000 to $180,000. These costs could be lowered, but at the cost of data quality and/or measure coverage. Some suggestions for decreasing the budget include the following:

- ***Collecting Only On-Site Data.*** This would lower the cost marginally if only the CEC commercial on-site surveys are used. The trade off is a lack of coverage in window U-values, and a considerable decrease in sample sizes for other covered measures. Further, insofar as this is an integrated system, the ability to calibrate the timing of equipment installations and the option of leveraging the window U-value data from the building department data to the on-site sample would be lost.
- ***Collecting Only Building Department Data.*** This would be a streamlined approach covering only three priority measures. The cost of a system relying solely on building department compliance data would be roughly $125,000 to $150,000 annually.[18] This is not a recommended approach.
- ***Coordination of Data Collection from Building Departments with the Residential Tracking Initiative I.*** If Initiative I of the residential tracking initiatives is adopted, there can be some economies with respect to the cost incurred to develop the building department contacts and the collection of data.

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[18] A detailed description of the use of other building department data is provided in the Section 5.

The significance of these savings depends on the amount of cooperation and the record keeping practices of each building department. However, the costs for each individual initiative do not include economies across initiatives. Conservatively, the savings could be $30,000 to $50,000 per year. At the very least, these efforts should be coordinated between the residential and nonresidential tracking system managers.

Other Issues

Timely versus Retrospective View of Data. The timing of purchases in the new construction market is an issue when implementing this initiative. As explained earlier, some measures might have been purchased by the builder up to a year in advance of the building tenants moving into the facility. These timing issues are accounted for during the calibration portion of the tracking analyses. However, the result is that data collected in any quarter may not reflect purchases of equipment in that quarter. The result could be adjustments to prior quarters' shares, thereby resulting in a tracking method that will provide accurate data when viewed retrospectively, but may be less representative of the most recent quarter.

Expanding the Role of Building Departments. RER's informal survey of building departments indicated their willingness to support tracking efforts. RER recommends that this relationship be explored to encourage as many building departments as possible to participate in data collection for efficiency market share tracking efforts. Future recommendations by the CEC for Title 24 revisions are not due until the year 2001. At that time, it should be recommended that building departments 1) collect installation verification forms similar to the CF-6R form in the residential sector, or 2) file copies of the compliance forms separate from the building plans. A statewide system to collect these data should then be developed.

10.5 Initiative Va: Integrating On-Site Commercial Surveys and Building Department Data

Because of the current uncertainties regarding the CEC data collection efforts, this initiative is offered as an alternative to Initiative V. This initiative integrates data from on-site surveys in the commercial new construction sector with data from building department compliance records, and would be the primary source of market tracking for the following five priority measures installed in the nonresidential new construction sector:

- Packaged air conditioning,
- Energy management systems,
- Windows,
- 32 watt T8s with electronic ballasts, and
- Adjustable speed drive pumps and fans (HVAC and water heating applications).

This initiative can also provide secondary data for motors installed in the commercial sector, ASD pumps and fans, and chillers.

In the absence of a CEC commercial on-site survey effort, RER still recommends that data be collected through on-site surveys of newly constructed commercial buildings and from building department records. The development, timing and scheduling of this initiative is essentially identical to the procedure explained above for Initiative V and will not be repeated here.

Cost Estimates

Table 10-8 presents a summary of the estimated costs by task to develop and operate this tracking initiative.[19] Note that the costs associated with the on-site survey effort are significantly higher than those estimated for Initiative V above. This cost increase is due to funding the on-site surveys directly from the market-tracking budget. Ranges of costs are provided as a guideline; the final budgets would depend on the features adopted for the final tracking system and cooperation from involved parties.

As shown in Table 10-8, the cost to implement Initiative Va in the first year of operation is roughly $868,000 to $1,345,000. Costs in subsequent years would drop slightly to the range of $832,000 to $1,280,000. As with the other initiatives, these estimated costs could be lowered, but at the cost of data quality and/or measure coverage.

[19] The cost estimates presented here were derived after the analysis presented in Section 8 was conducted. The cost scores included in Section 8 represent RER's fist estimate of costs that were derived for the purposes of comparing alternative tracking methods. Detailed budgets were not formulated until the recommended tracking methods were identified. In retrospect, these detailed cost estimates may differ slightly from the scores for the cost criteria presented in Section 8.

Table 10-8: Summary of Costs of Initiative Va, by Major Task

Task	Estimated Cost
Development and First Quarter:	
Survey and Sample Design	$25,000 – $30,000
Initial On-Site Surveys	$175,000 - $280,000
Building Dept. Contacts and Development	$15,000 - $25,000
Initial Building Department Data Collection	$20,000 - $25,000
Tracking Database Development	$15,000 - $20,000
Subsequent Quarters:	
Quarterly Sample Design Update	$3,000 - $5,000
Quarterly On-Site Surveys	$175,000 - $280,000
Quarterly Building Department Data Collection	$20,000 - $25,000
Quarterly Tracking Database Update	$8,000-$10,000
First Year Cost	**$868,000 – $1,345,000**
Subsequent Year Cost	**$832,000 – $1,280,000**
Fixed/Development Costs	**$36,000 - $65,000**

Cost estimates for on-site surveys are based upon $500 to $800 per on-site.

10.6 Initiative VI: Integrating CEC On-Site Commercial Surveys and a Commercial/Industrial Telephone Survey

Overview

As indicated in Table 10-1, RER recommends tracking the retrofits of several nonresidential measures at the customer level. This initiative would be the primary data source for the following purchases:

- Energy management systems,
- 32 watt T8s with electronic ballasts,
- Adjustable speed drive pumps and fans (HVAC applications), and
- Compressed air optimization.

This initiative can also provide secondary data for motors, packaged air conditioning, and chillers.

Figure 10-2 provides an overview of the five key elements to this tracking initiative:

- Integrate tracking efforts with CEC commercial on-site surveys,
- Conduct a telephone survey of commercial sites to augment tracking sample,[20]
- Conduct telephone survey of industrial sites,[21]
- Conduct market share tracking analyses, and
- Update measure efficiency market share tracking database.

This tracking initiative uses the CEC commercial survey to collect tracking data wherever possible. However, as will be explained in detail below, the CEC survey does not cover the industrial sector and the proposed sample sizes will not be sufficient to support a statistical analysis of market shares.[22] To mitigate these shortcomings, RER recommends a telephone survey to 1) augment commercial on-sites, and 2) collect data on measures installed in the industrial sector.

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[20] One option is to conduct the survey during the recruitment of customers for the on-site survey. Based on a response rate of 30%, the CEC can expect to speak with roughly 3,000 commercial customers during the recruitment process. The drawback to this approach is that it could affect the response rate of the on-site survey.

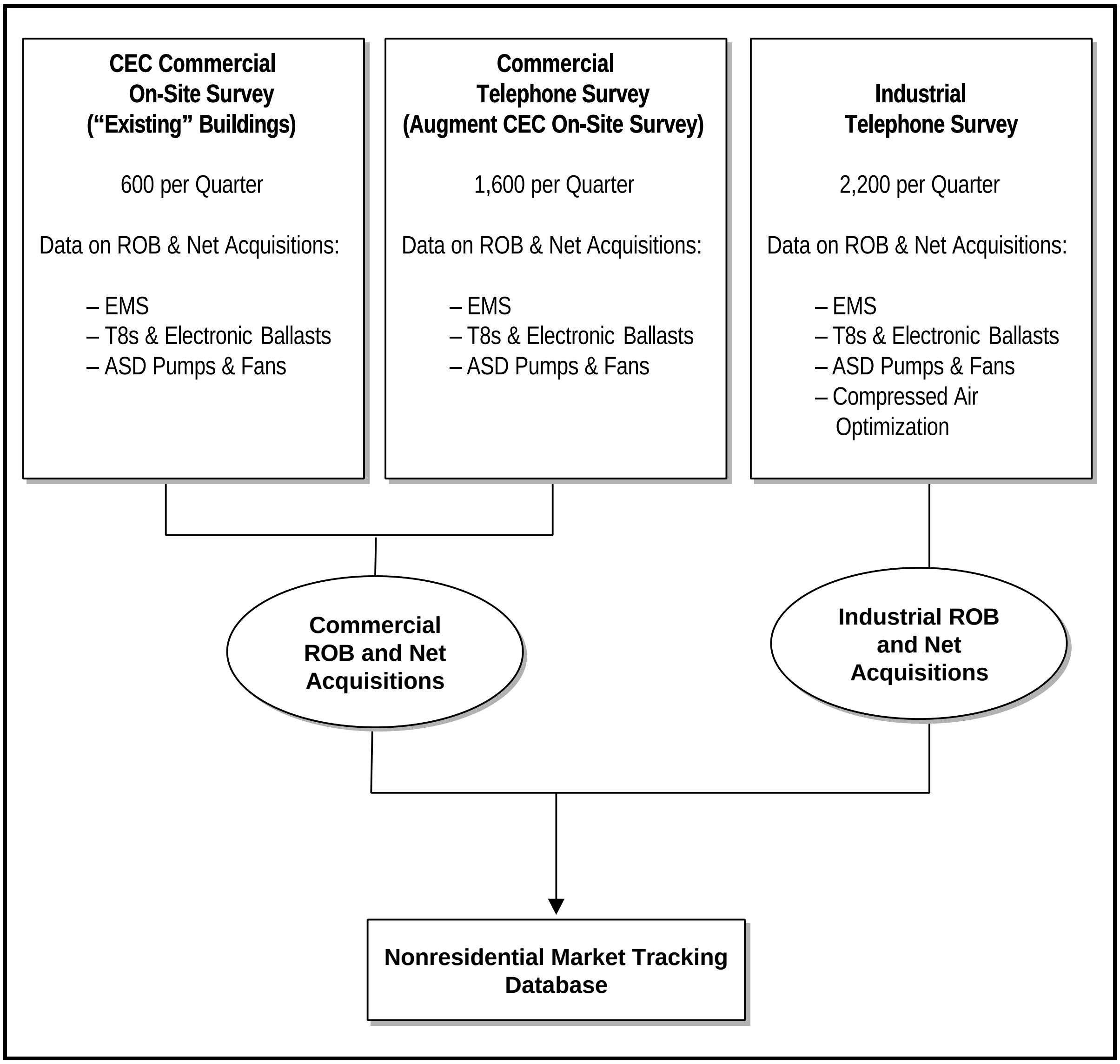
[21] As will be explained below, this can be viewed as an optional task based on the impact on market transformation programs in this sector for high efficiency lighting, HVAC EMS, and ASDs on HVAC fans and pumps.

[22] Assuming the CEC is amenable to conducting the survey quarterly, and that the existing proposed sample size would be spread evenly across quarters, this would result in a sample of 1,000 on-sites per quarter. Further, if the nonresidential Initiative V is adopted and 400 new construction sites are sampled, the sample size for existing buildings would be 600.

The following features of this recommended initiative are discussed below:

- Data and measure coverage,
- Initiative development,
- Timing and scheduling,
- Estimated costs, and
- Other issues.

Figure 10-2: Overview of Initiative VI – Tracking Nonresidential Retrofits



Measure and Data Coverage

This initiative integrates CEC on-site surveys and a telephone survey of commercial and industrial sites to collect data for tracking replace-on-burnout, net acquisition, and retrofit installation. The measure and data covered for these two methods are discussed below.

CEC Commercial On-Site Survey

Table 10-9 includes the measures covered by this initiative, whether it is the primary or secondary source for tracking data, the characteristics of the measures that can be collected during the on-site visit, and the characteristics of the measures that would ultimately be used for tracking market shares. The distinction between the data collected on-site and the data used for market tracking is important. In most cases, the equipment type and model number are the only observable data that can be collected during the on-site visit. These data will ultimately be translated into useful efficiency and equipment characteristics by using product directories or other manufacturer-specific publications, or databases of available products.

Because this initiative focuses on retrofit and replace-on-burnout installations, the data obtained for tracking should pertain only to replacements or retrofits made during the reporting period (e.g., the past six months). Furthermore, as indicated in Table 10-9, in order to estimate penetrations of retrofits or installations of add-on measures—ASDs and EMS, in particular—the collected data should reflect the percentage of feasible applications that were recently retrofitted or to which a measure was installed (for example, the percentage of ASDs that were installed on only those motors that did not have them six months ago).

In addition to the specific data for the high priority measures presented above, data on purchasing and decision-making practices relating to energy-using equipment, detailed data on competing measures, and end user characteristics can also be collected during the on-site visits. Further, other priority measures could also be included in this system, although the data collected for these measures would be secondary.

Table 10-9: Measures and Measure Characteristics of Recent Purchases Covered by the On-Site Surveys

Measure	Source Type	Data of Recent Purchases of Measures Collected During the Interview	Tracking Data
Energy Management Systems	Primary	Control functions, area covered, and systems controlled with recently purchased controlling/monitoring equipment for all feasible applications.	Control functions, area covered, and systems controlled with recently purchased controlling/monitoring equipment for all feasible applications.
32 watt T8s with Electronic Ballasts	Primary	Lamp type, fixture counts, lamps per fixture, ballast type, lamps per ballast of recent lighting retrofits.	Percent (area or counts) of feasible applications that were retrofitted with 32 watt T8s with electronic ballasts of sites that have recently retrofitted lighting equipment.
ASD Pumps and Fans (HVAC)	Primary	Percent of HVAC fans and pumps controlled by ASDs of sites that have recently retrofitted HVAC system/equipment for all feasible applications.	Percent of HVAC fans and pumps controlled by ASDs of sites that have recently retrofitted HVAC system/equipment for all feasible applications.
Packaged Air Conditioning	Secondary	Manufacturer and model number, size, heating and cooling capacities, fan HP, fuel type, and system type of recent purchases.	Fuel type, system type, EER, SEER, HSPF or COP and size of recent purchases.
Motors	Secondary	Manufacturer, model number, HP, component type (pumps, fans, air compressors, other), process (HVAC, industrial process, etc.), control type (throttle valve, ASD, inlet vane etc.), efficiency, load type (constant variable, intermittent) of recent purchases.	HP, efficiency, component type, process and control type of recent purchases.
Chillers	Secondary	Manufacturer and model number, system type, cooling capacities, efficiency (kW/ton or COP), and fuel type of recent purchases.	Manufacturer and model number, system type, cooling capacities, efficiency, and fuel type of recent purchases.

Commercial and Industrial Telephone Surveys

Table 10-10 presents the measures and data covered by the commercial and industrial telephone interviews. In order to collect the types of data required for measure tracking during the telephone interview, it is imperative that the correct respondent be identified. This individual needs to be knowledgeable about recently purchased equipment/retrofit activities at the site, such as the building or facility manager, purchasing officer, or building owner. Obtaining this type of detailed, technical information via a telephone survey could be problematic. However, recent experiences in the commercial sector indicate that obtaining this information is possible if extra effort is taken to ensure that the most knowledgeable person at a site is interviewed. Furthermore, individuals are more likely to remember details about recent purchases than of transactions that had occurred further in the past.

In addition to the data for the high priority measures presented in Table 10-1, information on purchasing and decision-making practices relating to energy-using equipment, detailed data on competing measures, and demographic characteristics can also be collected during the telephone interview.

Development

Development of this method requires 1) determining the required sample sizes, 2) integrating tracking needs into the CEC commercial on-site data collection effort, 3) designing and implementing the commercial and industrial telephone surveys, and 4) constructing the nonresidential measure efficiency tracking database covering replace-on-burnout and net acquisitions for the covered measures. Each of these components is discussed below.

Sample Sizes

The sample sizes for retrofit installations need to support the estimation of tracking parameters for the relevant priority measures. For EMS, HVAC ASD pumps and fans, 32 watt T8s with electronic ballasts, and compressed air optimization, this entails the estimation of the percent of feasible applications that have been retrofitted within the last period. A six-month window for recent purchases is used in order to lower the required quarterly sample sizes and is an approach similar to the approach used in Initiative II.[23]

[23] The main feature of this approach is that it allows for lower completed sample sizes pr quarter, but requires a lag time of one quarter before the required sample targets are met (see Initiative II, Section 9).

Table 10-10: Measures and Measure Characteristics of Recent Purchases Covered by the Commercial and Industrial Surveys

Measure	Source Type	Data of Recent Purchases of Measures Collected During the Interview	Tracking Data
Energy Management Systems	Primary	Control functions, area covered, and systems controlled with recently purchased controlling/monitoring equipment for all feasible applications.	Control functions, area covered, and systems controlled with recently purchased controlling/monitoring equipment for all feasible applications.
32 watt T8s with Electronic Ballasts	Primary	Percent (area or counts) of feasible applications that were retrofitted with 32 watt T8s with electronic ballasts of sites that have recently retrofitted lighting equipment.	Percent (area or counts) of feasible applications that were retrofitted with 32 watt T8s with electronic ballasts of sites that have recently retrofitted lighting equipment.
ASD Pumps and Fans (HVAC applications)	Primary	Percent of HVAC fans and pumps controlled by ASDs of sites that have recently retrofitted HVAC system/equipment for all feasible applications.	Percent of HVAC fans and pumps controlled by ASDs of sites that have recently retrofitted HVAC system/equipment for all feasible applications.
Compressed Air Optimization	Primary	Maintenance procedures for maintaining optimal performance of compressed air system and for reducing air compressor leaks.	Maintenance procedures for maintaining optimal performance of compressed air system and for reducing air compressor leaks.
Packaged Air Conditioning	Secondary	Manufacturer and model number, fuel type, and system type of recent purchases	Fuel type, system type, EER, SEER, HSPF or COP and size of recent purchases
Motors	Secondary	Manufacturer, model number, HP, component type (pumps, fans, air compressors, other), process (HVAC, industrial process, etc.), control type (throttle valve, ASD, inlet vane etc.), load type (constant variable, intermittent) of recent purchases.	HP, efficiency, component type, Process and control type of recent purchases.
Chillers	Secondary	Manufacturer and model number, system type, efficiency (kW/ton or COP), and fuel type of recent purchases.	Manufacturer and model number, system type, cooling capacities, efficiency, and fuel type of recent purchases.

In order to develop suggested sample sizes, it is assumed that the annual penetration rates for all of these measures are at least 6%. Table 10-11 presents the required sample sizes for various precision levels. RER recommends a sample size of 2,200, which will support a precision level of ±20% relative error with 90% confidence to estimate a semiannual penetration rate of 3%.[24,25] Of course, higher degrees of precision can be achieved; the major trade off would be increased survey and administration costs.

Table 10-11: Sample Sizes for Required Relative Precision Levels (Assuming 3% Semiannual Penetration)

Precision Level		
Confidence Level	Relative Error	Required Sample Size
95%	10%	12,400
90%	10%	8,700
90%	20%	2,200
80%	10%	5,300
80%	20%	1,330

Packaged air conditioning and chillers were also considered as candidates for tracking using this method. However, as in the residential sector, this would require a sample design that presents a significant problem with required sample sizes. Specifically, for packaged air conditioning, assuming a lifetime of 15 years, a saturation of 40%, and a response rate of 50% in order to obtain a sample size of 250 sites that have replaced a packaged air conditioner in the last six months would require almost 37,000 calls. This is not a recommended approach. In particular, it is recommended that 1) only secondary information on these measures is collected using this initiative, 2) that packaged air conditioners are covered under residential Initiative III (Distributor Data Collection), and 3) chillers are covered under nonresidential Initiative III.

Integration of Market Share Tracking Needs into the CEC Commercial On-Site Surveys

Integration of the market share tracking needs into the CEC commercial survey effort involves the following major issues:

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[24] To the extent that valid sample sizes are required by sector, this would require a completed sample of 2,200 commercial and 2,200 industrial surveys.

[25] RER attempted to recommend sample sizes required for achieving a precision level of ±10% relative error with 90% confidence. However, in some instances the sample sizes required for this standard precision level would be prohibitively high. For example, as shown in Table 10-11, a sample size of 8,700 would be required to estimate market shares with this precision. In this case, RER recommends smaller sample sizes that would result in less precision.

- Coordinating with the CEC on-site survey on sample design, (e.g., required sample sizes and stratification), and
- Integration of market tracking questions into the on-site questionnaire design.

Sample Design Issues. As discussed above, assuming the frequency of the CEC commercial survey effort can be changed to accommodate quarterly tracking and that the proposed sample size remains the same, roughly 600 on-site surveys will be completed each quarter. Coordination issues between the CEC survey planning team and the market tracking team should include discussion on sample design, stratification variables, and development of contact lists including customer names and telephone numbers.

Integration of Market Tracking Questions into the On-Site Questionnaire Design. The on-site questionnaire design will be critical for the success of the tracking effort. The survey should involve two phases: 1) an in-person interviews with a building owner or facilities manager and 2) a thorough walk-through inspection of the relevant measures. RER recommends that the CEC on-site survey questionnaire be thoroughly reviewed to ensure that questions designed to collect the necessary data for developing the market tracking database (e.g., the equipment characteristics outlined in Table 10-4) are included. They key element critical to tracking is to identify sites that have recently retrofitted one or more of the measures targeted for tracking with this initiative. Further, the questionnaire should include questions on self-reported attitudes, decision-making practices, and other relevant information from building owners or facilities managers.

Augmenting the CEC On-Site Surveys with Commercial Sector Telephone Survey

The commercial on-site survey will need to be augmented with a telephone survey to reach the desired completed sample sizes. Based upon the required sample sizes presented above, a telephone survey of an additional 1,600 commercial sites will be required.[26] Development of this telephone survey should be a relatively straightforward process. In particular, RER recommends the following:

1) The sample design should be completed in conjunction with the on-site survey design. This will ensure consistency in stratification approach, and will use the same customer frame.
2) The sample should include a question to screen for new construction.
3) The survey instrument must be closely related to the on-site survey. If possible, the tracking questions should be the same allowing for the change from on-site to telephone protocol.

[26] This is equal to the difference between the suggested required sample size of 2,200 and the 600 CEC on-site surveys of existing buildings.

4) A standard telephone survey protocol should be used.
5) A computer assisted data entry system should be used to ensure data entry and quality control.

Telephone Survey of the Industrial Sector

The replace-on-burnout and retrofit decision type in the commercial sector should be well covered by the CEC on-site and telephone surveys. However, one can argue that sampling only from the commercial sector might not be representative of the nonresidential sector for some of the high priority measures. In particular, HVAC EMS, ASD HVAC fans and pumps, and high efficiency lighting opportunities exist in both the commercial and industrial sectors. Furthermore, compressed air optimization is one priority measure found almost exclusively in the industrial sector. Because market transformation programs will target the industrial sector and it if it is assumed that practices differ across these sectors, RER recommends a telephone survey of industrial sites.

In particular, RER recommends that a quarterly telephone survey of 2,200 completed industrial sites be conducted for tracking replace-on-burnout and retrofits of priority measures in the industrial sector.[27] Development of the telephone survey should be a relatively straightforward process. In particular, RER recommends the following:

1) Use a sample design that is stratified by two-digit SIC code.
2) Where possible, utilize the contacts made by the CEC commercial on-site project team to gather industrial contacts from utility sources.
4) A question to screen for new construction should be included in the survey.
5) A standard telephone survey protocol should be used.
6) A computer assisted data entry system should be used to mitigate data entry and quality control.

Construction of the Efficiency Market Share Tracking Databases

Construction of the measure efficiency market share tracking database involves entry of data collected with the on-site and telephone surveys, recoding collected data into useful market share tracking parameters, and weighting data according to sampling scheme.

Data Entry. Data entry will be a major portion of the work effort for each quarter. Data from the on-site surveys will be collected in hard copy format that will need to be entered into an electronic database. It is anticipated that the data from the telephone survey can

[27] The suggested completed sample size is designed to support inferences about high priority measures by sector (commercial and industrial).

utilize a computer assisted data input (CATI) technique. This will decrease data entry needs. RER recommends a conventional database format be used for the resulting database, such as Excel or Access.

Recoding Collected On-Site Data into Useful Market Share Tracking Parameters. An efficient methodology will need to be developed to translate the data collected on-site into useful market tracking data. In general, the on-site survey will be used to obtain equipment types and model numbers, which will need to be translated into efficiency and size data. Typically, this can be accomplished by using product literature or other product databases and should be done during the post processing of the data.

Weighting the Samples. Considerable care will need to taken to correctly post-weight the samples of on-sites to reflect the population of replace-on-burnout and retrofits installations.

Timing and Schedule

There are a number of issues relating to the timing and scheduling of this initiative. The major issue is the timing of the CEC commercial survey effort. Preliminary indications from the CEC is that this effort can begin as early as the second quarter 1999, but is more likely to spill over into the third quarter of 1999. Once this process begins, the timing of the tracking survey implementation will be impacted by the time necessary to develop the survey design and implement the initial on-site surveys. Other timing issues include the time needed to develop the commercial and industrial telephone survey, to develop the tracking databases, and to administer the on-going operation of the tracking system. Table 10-12 presents a summary of the timing and a recommended schedule for implementing this tracking initiative.

As presented in Table 10-12, once the initial tracking system is operational, the scheduling of quarterly updates will need to be closely monitored. RER anticipates that in coordination with the CEC project managers, sample design updates will need to be done during the on-site data collection of the prior quarter.

Table 10-12: Summary of Timing and Scheduling of Initiative VI

Task	Timing	Scheduling
Survey Design	6-8 Weeks	3rd Quarter 1999
Initial On-Site Surveys	8-12 Weeks	4th Quarter 1999
Initial Commercial Telephone Survey	4-6 Weeks	4th Quarter 1999
Initial Industrial Telephone Survey	6-10 Weeks	4th Quarter 1999
Initial Tracking Database Development	3-5 Weeks	4th Quarter 1999
On-Going Sample Design Update	2-3 Weeks	Quarterly from 4th Quarter 1999
Quarterly On-Site Surveys	8-12 Weeks	Quarterly from 4th Quarter 1999
Quarterly Commercial Telephone Survey	4-6 Weeks	Quarterly from 4th Quarter 1999
Quarterly Industrial Telephone Survey	6-10 Weeks	Quarterly from 4th Quarter 1999
Update Tracking Database	1-2 Weeks	Quarterly from 1st Quarter 2000

Cost Estimates

Table 10-13 presents a summary of the estimated costs by task to develop and operate this tracking initiative.[28] Ranges of costs are provided as a guideline; the final budgets would depend on the features adopted for the final tracking system and cooperation from involved parties. Also, note that the costs associated with the on-site survey effort are estimated costs to integrate the tracking effort with the anticipated CEC commercial survey project. In particular, these costs do not include the costs for conducting the on-sites, the initial survey design, and questionnaire design. These costs are assumed to be incurred by the CEC commercial survey effort. However, some coordination and review time costs are budgeted.

[28] The cost estimates presented here were derived after the analysis presented in Section 8 was conducted. The cost scores included in Section 8 represent RER's fist estimate of costs that were derived for the purposes of comparing alternative tracking methods. Detailed budgets were not formulated until the recommended tracking methods were identified. In retrospect, these detailed cost estimates may differ slightly from the scores for the cost criteria presented in Section 8.

Table 10-13: Summary of Costs of Initiative VI, by Major Task

Task	Estimated Cost
Development and First Quarter:	
Survey Design Review and Coordination with CEC	$5,000 - $8,000
Initial On-Site Survey Coordination with CEC	$15,000 - $20,000
Telephone Survey Development	$25,000 – $50,000
Initial Commercial Telephone Survey	$40,000 - $55,000
Initial Industrial Telephone Survey	$60,000 - $80,000
Tracking Database Development	$15,000 - $20,000
Subsequent Quarters:	
Quarterly Sample Design Update	$2,000 - $4,000
Quarterly On-Site Surveys Coordination	$3,000 -$5,000
Quarterly Commercial Telephone Survey	$40,000 - $55,000
Quarterly Industrial Telephone Survey	$60,000 - $80,000
Quarterly Tracking Database Update	$8,000 - $10,000
Estimated First Year Cost	**$499,000 - $695,000**
Estimated Subsequent Year Cost	**$452,000 - $616,000**
Fixed Costs	**$47,000 - $89,000**

Commercial and industrial telephone survey costs estimates based upon $30 to $40 per complete.

As shown in Table 10-13, the estimated cost to develop and implement this initiative in the first year is $499,000 to $695,000. This cost would decrease in subsequent years to $452,000 to $616,000. The following are some examples of ways in which the costs can be mitigated with changes in the scope of the initiative.[29]

- ***Sample Size/Cost Trade Off.*** Increasing the telephone sample size will increase the survey costs. For example, the estimated costs in Table 10-13, assume a 90/20 precision level. If decreasing the precision to an 80/20 precision level is acceptable, costs could be lowered by as much as $250,000.
- ***Omit the Industrial Telephone Survey.*** Depending on the viewed importance of air compressor optimization and perceived difference equipment replacement and retrofit practices across the commercial and industrial sector, the industrial telephone survey could be omitted. This would decrease the annual cost by $240,000 to $320,000.
- ***Semiannual Tracking.*** Tracking could be done on a semiannual instead of a quarterly basis.

[29] Note that these changes to the scope may not produce additive cost impacts.

10.7 Initiative VIa: Integrating Commercial On-Site Surveys and Commercial & Industrial Sector Telephone Surveys

Because of the current uncertainties regarding the CEC data collection efforts, this initiative is offered as an alternative to Initiative VI. As its title implies, RER recommends collecting data with on-site survey of commercial sites and with telephone surveys of commercial and industrial customers to track efficiency market shares of retrofits of the following priority measures:

- Energy management systems,
- 32 watt T8s with electronic ballasts,
- Adjustable speed drive pumps and fans (HVAC applications), and
- Compressed air optimization.

This initiative can also provide secondary data for replace-on-burnout installations of motors, packaged air conditioning, and chillers.

This initiative uses a telephone survey of 2,200 commercial and 2,200 industrial sites to gather information about retrofit activities. The required information includes:

- The number of feasible/applicable applications at each site,
- The number of feasible/applicable applications with the high efficiency measure,
- The number of feasible/applicable applications retrofitted in last six months, and
- The time when the retrofit occurred.

RER recommends conducting on-site surveys with a sample of 120 sites with reported retrofit activity that were identified through the telephone surveys. The on-site survey data will be used to calibrate the self-reported data obtained with the telephone survey data. The calibration factors will be leveraged to the telephone survey data for sites reporting no retrofit activity.

Measure and data coverage, development, timing, schedule, and estimated costs of this alternative initiative are presented below.

Measure and Data Coverage

The measure and data coverage of this alternative initiative is identical to that of Initiative VI, and will not be repeated here. See Subsection 10.6, Table 10-9, and Table 10-10 for details.

Development

The development of this initiative involves 1) determining the required sample sizes, 2) developing and implementing the commercial telephone survey, 3) developing and implementing the commercial and industrial on-site surveys, and 4) developing the nonresidential measure efficiency tracking database for retrofit and replace-on-burnout market events.

Sample Sizes

The sample sizes for retrofit installations need to support the estimation of tracking parameters for the relevant priority measures. For EMS, HVAC ASD pumps and fans, 32 watt T8s with electronic ballasts, and compressed air optimization, this entails the estimation of the percent of feasible applications that have been retrofitted within the last period. A six-month window for recent purchases is used in order to lower the required quarterly sample sizes and is an approach similar to the approach used in Initiative II.[30]

In order to develop suggested sample sizes, it is assumed that the annual penetration rates for all of these measures are at least 6%. Table 10-11 presents the required sample sizes for various precision levels. RER recommends a sample size of 2,200, which will support a precision level of ±20% relative error with 90% confidence to estimate a semiannual penetration rate of 3%.[31] Of course, higher degrees of precision can be achieved; the major trade off would be increased survey and administration costs.

Table 10-14: Sample Sizes for Required Relative Precision Levels (Assuming 3% Semiannual Penetration)

Precision Level		
Confidence Level	**Relative Error**	**Required Sample Size**
95%	10%	12,400
90%	10%	8,700
90%	20%	2,200
80%	10%	5,300
80%	20%	1,330

30 The main feature of this approach is that it allows for lower completed sample sizes pr quarter, but requires a lad time of one quarter before the required sample targets are met (see Initiative II, Section 9).

31 To the extent that valid sample sizes are required by sector, this would require a completed sample of 2,200 commercial and 2,200 industrial surveys.

Packaged air conditioning and chillers were also considered as candidates for tracking using this method. However, as in the residential sector, this would require a sample design that presents a significant problem with required sample sizes. Specifically, for packaged air conditioning, assuming a lifetime of 15 years, a saturation of 40%, and a response rate of 50% in order to obtain a sample size of 250 sites that have replaced a packaged air conditioner in the last six months, would require almost 37,000 calls. This is not a recommended approach. In particular, it is recommended that 1) only secondary information on these measures is collected using this initiative, 2) that packaged air conditioners are covered under residential Initiative III (Distributor Data Collection), and 3) chillers are covered under nonresidential Initiative III.

Developing and Implementing the Commercial and Industrial Telephone Survey

The purpose of the telephone survey is to gather self reported information on retrofit activities over the most recent six month period, on the amount of feasible applications, and the existence of any high priority measures prior to six months ago. Further, the questionnaire should include questions on self-reported attitudes, decision-making practices, and other relevant information from building owners or facilities managers.

This initiative recommends conducting a survey of industrial and commercial telephone surveys. One can argue that sampling only from the commercial sector might not be representative of the nonresidential sector for some of the high priority measures. In particular, HVAC EMS, ASD HVAC fans and pumps, and high efficiency lighting opportunities exist in both the commercial and industrial sectors. Furthermore, compressed air optimization is one priority measure found almost exclusively in the industrial sector. Because market transformation programs will target the industrial sector and it if it is assumed that practices differ across these sectors, RER recommends a telephone survey of industrial sites.

In particular, RER recommends that a quarterly telephone survey of 2,200 completed commercial and 2,200 industrial sites be conducted for tracking retrofits of priority measures in the these sectors. Development of the telephone survey should be a relatively straightforward process. In particular, RER recommends the following:

1) Use a sample design that is stratified by two-digit SIC code.
2) Where possible, utilize the contacts from utility sources.
4) A question to screen for new construction should be included in the survey.
5) A standard telephone survey protocol should be used.
6) A computer assisted data entry system should be used to mitigate data entry and quality control.

In addition, during the telephone survey, sites that have retrofitted measures within the last six months will be recruited for the on-site survey effort. Based on the sample design assumptions, this will result in the identification of roughly 60 commercial and 60 industrial sites that have had some retrofit activity within the last six months.

Developing and Implementing the Commercial and Industrial On-Site Survey

The onsite questionnaire design will be critical for the success of the tracking effort. The survey should involve two phases: 1) in-person interviews with a building owner or facilities manager and 2) a thorough walk-through inspection of the relevant retrofitted measures. They key element critical to tracking is to identify sites that have recently retrofitted one or more of the measures targeted for tracking with this initiative. Further, the questionnaire should include questions on self-reported attitudes, decision-making practices, and other relevant information from building owners or facilities managers.

Develop Efficiency Market Share Tracking Database

This task is similar to the market share database development tasks described in Initiative VI. An additional task of developing calibration factors, applying these factors to the telephone data and calculating the final market tracking parameters for the retrofit measures will be required.

Time and Scheduling

Table 10-15 presents a summary of the timing and a recommended schedule for implementing this tracking initiative. Because this alternative initiative is independent of the funding and contracting constraints associated with the CEC, development of this initiative can begin as early as the second quarter of 1999.

Table 10-15: Summary of Timing and Scheduling of Initiative VIa

Task	Timing	Scheduling
Survey Design	6-8 Weeks	2nd Quarter 1999
Initial Commercial Telephone Survey	6-8 Weeks	3rd Quarter 1999
Initial Industrial Telephone Survey	6-8 Weeks	3rd Quarter 1999
Initial On-Site Surveys	8-12 Weeks	3rd Quarter 1999
Tracking Data Analysis	3-4 Weeks	4th Quarter 1999
Initial Tracking Database Development	3-5 Weeks	3rd Quarter 1999
On-Going Sample Design Update	2-3 Weeks	Quarterly from 3rd Quarter 1999
Quarterly Commercial Telephone Survey	6-8 Weeks	Quarterly from 3rd Quarter 1999
Quarterly Industrial Telephone Survey	6-8 Weeks	Quarterly from 3rd Quarter 1999
Quarterly On-Site Surveys	8-12 Weeks	Quarterly from 3rd Quarter 1999
Tracking Data Analysis	3-4 Weeks	Quarterly from 4th Quarter 1999
Update Tracking Database	1-2 Weeks	Quarterly from 4th Quarter 1999

Cost Estimates

Table 10-16 presents a summary of the estimated costs by task to develop and operate this tracking initiative.[32] Ranges of costs are provided as a guideline; the final budgets would depend on the features adopted for the final tracking system and cooperation from involved parties.

Table 10-16: Summary of Costs of Initiative VIa, by Major Task and Quarter of Implementation

Task	Estimated Cost
Development and First Quarter:	
Survey Development	$25,000 - $50,000
Initial Commercial Telephone Surveys	$60,000 - $80,000
Initial Industrial Telephone Surveys	$60,000 - $80,000
Initial On-site Surveys	$60,000 - $96,000
Tracking Data Analysis	$5,000 - $15,000
Tracking Database Development	$15,000 - $20,000
Subsequent Quarters:	
Quarterly Sample Design Update	$2,000 - $4,000
Quarterly Commercial Telephone Survey	$60,000 - $80,000
Quarterly Industrial Telephone Survey	$60,000 - $80,000
Quarterly On-site Surveys	$60,000 - $96,000
Tracking Data Analysis	$5,000 - $15,000
Update Tracking Database	$8,000 - $10,000
Estimated First Year Cost	**$810,000 - $1,196,000**
Estimated Subsequent Year Cost	**$780,000 - $1,140,000**
Fixed Costs	**$30,000 - $50,000**

On-site survey costs based upon assumption of $500 to $800 per site.
Commercial and industrial telephone survey costs estimates based upon $30 to $40 per complete.

As shown in Table 10-13, the estimated cost to develop and implement this initiative in the first year is $810,000 to $1,196,000. This cost would drop in subsequent years to $780,000 to $1,140,000. These costs are provided as guides to implementing the initiative.

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[32] The cost estimates presented here were derived after the analysis presented in Section 8 was conducted. The cost scores included in Section 8 represent RER's fist estimate of costs that were derived for the purposes of comparing alternative tracking methods. Detailed budgets were not formulated until the recommended tracking methods were identified. In retrospect, these detailed cost estimates may differ slightly from the scores for the cost criteria presented in Section 8.

- ***Sample Size/Cost Trade Off.*** Increasing the telephone sample size will increase the survey costs. For example, the estimated costs in Table 10-13, assume a 90/20 precision level. If decreasing the precision to an 80/20 precision level is acceptable, costs could be lowered by as much as $250,000.
- ***Omit the Industrial Telephone and On-site Survey.*** Depending on the viewed importance of air compressor optimization and perceived difference equipment replacement and retrofit practices across the commercial and industrial sector, the industrial telephone survey could be omitted. This would decrease the annual cost by $270,000 to $350,000.
- ***Semiannual Tracking.*** Tracking could be done on a semiannual basis as opposed to quarterly.

10.8 Initiative VII: Chiller Manufacturer Data Collection

As indicated in Table 10-1, RER recommends tracking efficiency market shares of chiller installations in new construction, as well as chiller replacements, with data collected from chiller manufacturers. Tracking efficiency market shares of chillers in California at the manufacturer level, rather than through midstream market actors or at the site level, is favored for several reasons, most of which relate to the structure of the chiller market and relative costs of implementing tracking alternatives.

As described in Section 4, the chiller market is somewhat unique because 1) most units are purchased and distributed directly from the manufacturer to the customer, and 2) most chillers are customized to meet the building's unique load profile. Because of these characteristics, manufacturers can track sales to the final end user and thus can likely identify sales by decision type. Furthermore, collecting data from manufacturers instead of, say, contractors or engineers makes more sense from an economical perspective. As noted in Section 8, a small number of manufacturers produce the majority of chillers sold in the U.S. The major chiller manufacturers include Trane, Carrier, York, and McQuay. By targeting major manufacturers instead of midstream market actors, fewer data suppliers would need to be recruited to cover the same portion of the market. (Not to mention the fact that contractors and engineers are not expected to be reliable, long-term data sources.)

For the reasons cited above, RER recommends tracking chiller efficiencies through data collection from manufacturers. Essentially, this requires developing relationships with major chiller manufacturers and obtaining their sales data on a quarterly basis (e.g., "manufacturer-direct data collection").[33]

Manufacturer-direct data collection would be implemented in a manner similar to the recommended residential tracking initiative involving data collection from HVAC equipment distributors (residential Initiative III). In particular, this method would first require developing relationships with and recruiting chiller manufacturers to be ongoing suppliers of data. Data supplied by manufacturers would need to be segmented by chiller type, fuel use, efficiency, location of final installation (state), and other relevant variables. RER has discussed tracking needs and the possibility of obtaining chiller sales data with one major chiller manufacturer who expressed an interest in exploring such a relationship further. In addition, RER's past experience with chiller manufacturers leaves the impression that at least some chiller manufacturers would be willing to participate in this tracking effort pending a confidentiality agreement.

[33] A second option involves hiring a market research firm with expertise in the chiller market to collect the required data from manufacturers and provide quarterly reports. This option is discussed below.

To compare the two options above, the measure and data coverage, development, timing and scheduling, and cost estimates are presented below for each.

Measure and Data Coverage

This recommended initiative pertains only to chillers. It should be noted, however, that a few of the major chiller manufacturers, namely Trane, Carrier, and York, produce several lines of HVAC equipment for both residential and nonresidential buildings. One might assume, therefore, that these manufacturers can produce data relating to all HVAC priority measures. However, because chiller sales are typically conducted through a separate division/sales office, one would need to forge agreements with multiple divisions to obtain data for other priority HVAC measures. It is also important to note that some smaller manufacturers specialize in the production of specific chiller types, so these manufacturers should also be targeted to participate in the tracking initiative. Smaller chiller manufacturers include Heatcraft, Dunham Bush, Teco, Yazaki, Napps, and Alturdyne.

As explained in Section 4, chillers fall into one of four primary categories: 1) reciprocating liquid chiller packages (RLCP), 2) large tonnage liquid cooled (LTLC), 3) absorption chillers, and 4) gas engine chillers. Data obtained from manufacturers should be segmented according to these chiller types. Table 10-17 includes other required segmentation variables, as these factors determine overall chiller efficiency. Other segmentation variables should include building type and decision type of the installation.

Table 10-17: Measures and Measure Characteristics Requirements for Tracking

Chiller Characteristics Required for Tracking (Segmentation Variables)	
Size (tonnage)	Efficiency (kW/ton)
Compressor type (screw, reciprocating)	Fuel type
Cooling type (air, water, condensorless)	Refrigerant type
Building Type	Decision type

As mentioned above, Initiative I (CEC nonresidential on-site surveys and building department data collection) and Initiative II (CEC on-site surveys and commercial/industrial telephone survey) can be secondary data sources for tracking chiller efficiencies.

Development

Development of this option requires 1) the recruitment of chiller manufacturers to participate in the tracking initiative, 2) the design and implementation of a data collection protocol, and 3) development of a chiller efficiency market share tracking database.

Recruitment of Chiller Manufacturers

Because the chiller market is dominated by only a handful of manufacturers, the success of this initiative could depend upon the cooperation of key market actors.[34] Thus, developing positive relationships successfully with major manufacturers will be critical. The first step of this initiative involves recruiting chiller manufacturers to supply the data required for tracking efficiency market shares of chillers installed in new construction and as replacements in California. The success of this initiative depends upon the following factors:

- First, it is essential that the confidentiality of proprietary sales data be guaranteed. In particular, tracking data should be reported only at an aggregated level that ensures the confidentiality of any single manufacturer.
- Second, the burden on staff and time should be minimal and/or data suppliers should be compensated for their time.
- Third, the precise data fields required for tracking would need to be identified, which might require on-site visits with the manufacturer representative. To maintain relationships with manufacturers and to encourage long-term participation, on-site visits will likely be necessary not only during the development stage, but throughout the operation of this tracking initiative.

Development of Data Collection Protocol

The formats of sales records are likely to differ across manufacturers. To minimize time and resource burdens on data suppliers, the data collection protocol will need to be flexible and, in most cases, tailored to individual manufacturers. RER recommends on-site visits to ensure a thorough understanding of the available data and to assist the manufacturers in developing reports useful for market tracking. As emphasized by the Wisconsin tracking experience, flexibility and willingness to accept any data the market actor is willing to provide (and in any format) greatly contributes the success of data collection efforts.

[34] For example, depending on the chiller type, three to five major manufacturers account for 60% to 90% of the national chiller market

Construction of the Efficiency Market Share Tracking Databases

Construction of the chiller efficiency market share tracking database involves combining data obtained from all participating manufacturers and recoding it into useful market share tracking parameters.

- ***Database Development.*** Database development will be a major portion of the work effort. In general, it is RER's understanding that distributors keep equipment sales data in electronic format. The first step will be to develop protocols for the individual distributors to retrieve the data in a usable format. However, it is anticipated that these data will be in various formats that will require translation into a standardized format. For this purpose, RER recommends a conventional database format, such as Excel or Access.
- ***Recoding the Collected Sales Data into Useful Market Share Tracking Parameters.*** Depending on the initial data formats, an efficient methodology will need to be developed to translate the data obtained from manufacturers into useful market tracking data. This issue should be addressed during the on-site visits in developing a data collection protocol, as the data available from manufacturers might already be in a format useful for tracking.

Timing and Scheduling

The timing and scheduling of this initiative is a function of the time needed to recruit manufacturers, to implement the initial data collection, and to maintain the system (e.g., maintain relationships with manufacturers and obtain data on a quarterly basis). A summary of the timing and scheduling of this initiative by major task is presented in Table 10-18. The time needed to recruit manufacturers is most subject to uncertainty. As shown, RER recommends that at least six to twelve weeks be reserved for this task. Furthermore, the recruiting process should be an ongoing procedure to recruit additional manufacturers and retain their cooperation after the initial development period.

Table 10-18: Summary of Timing and Scheduling – Collection of Distributor Sales Data

Task	Timing	Scheduling
Initial Recruitment of Chiller Manufacturers	6-12 Weeks	2nd – 3rd Quarter 1999
Initial Collection of Quarterly Manufacturer Sales Data	2-4 Weeks	3rd Quarter 1999
Initial Chiller Tracking Database Development	3-4 Weeks	3rd Quarter 1999
Quarterly Collection of Manufacturer Sales Data	2-4 Weeks	Quarterly from 4th Quarter 1999
Update Tracking Database	2-4 Weeks	Quarterly from 1st Quarter 2000

Cost Estimates

Table 10-19 presents a summary of the estimated costs to develop and operate the manufacturer-direct data collection option for tracking chiller efficiency market shares.[35] Ranges of costs are provided only as a guideline; final budgets would depend on the features adopted for the final tracking system.

Table 10-19: Summary of Costs of Initiative VII, by Major Task and Year of Implementation

Task	Estimated Cost
Development and First Year:	
Recruitment of Manufacturers (fixed)	$30,000 - $50,000
Quarterly Data Collection	$5,000 - $10,000
Tracking Database Development (fixed)	$10,000 - $15,000
Subsequent Quarters:	
Quarterly Collection of Manufacturer Sales Data	$10,000 - $15,000
Quarterly Tracking Database Update	$5,000 - $10,000
Estimated First Year Cost	**$90,000 - $150,000**
Estimated Subsequent Year Cost	**$60,000 - $100,000**

Retaining Services of Market Research Firm

RER identified market research firms as an alternative to obtaining chiller sales data directly from the manufacturers. The primary advantage of this approach is that some firms specializing in nonresidential HVAC markets often have already developed relationships with key market actors, which significantly reduces the time and resources required to recruit data suppliers. RER has identified and had telephone conversations or met in person with two such market research firms. Both firms agreed that, because of the market structure, manufacturers are the appropriate market node to collect data required for tracking chiller efficiencies. However, both also explained that they would collect information from multiple market nodes to triangulate sales data and to provide a comprehensive characterization of the California chiller market.

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[35] The cost estimates presented here were derived after the analysis presented in Section 8 was conducted. The cost scores included in Section 8 represent RER's fist estimate of costs that were derived for the purposes of comparing alternative tracking methods. Detailed budgets were not formulated until the recommended tracking methods were identified. In retrospect, these detailed cost estimates may differ slightly from the scores for the cost criteria presented in Section 8.

Although this option is attractive, one should approach it with caution. First, despite their expertise in the industry, the two firms had opposing opinions on the success of collecting data from manufacturers. One firm stated quite confidently that the information required for tracking could be obtained from manufacturers on a quarterly basis, and that the cost of doing so would be fairly reasonable. The other firm's reaction was just short of a refusal to embark on the project, stating that getting the necessary cooperation from manufacturers would be "highly unlikely." Second, market research firms specialize in "snap shots" of markets, rather than ongoing data collection. This implies that data would not necessarily be collected from the same market actors every period.

Should a market research firm be retained for tracking efficiency market shares of chillers in California, the methodology and research methods of the firm should be transparent, and the data requirements and final product should be explicit.

Development

The development of retaining the services of a market research firm to collect data for tracking chiller efficiency market shares is relatively straightforward. In particular, this option involves 1) identifying market research firms with expertise in the U.S. chiller market, and selecting a market research firm to conduct data collection activities, and 2) specifying methodology and reporting protocols.

As mentioned above, RER identified and discussed tracking possibilities with two market research firms with expertise in the U.S. nonresidential HVAC market. While these companies were the only market research firms referred by other market actors during RER's research into alternative tracking methods, there are likely to be others that specialize in the chiller industry. Tracking needs and data requirements should be reviewed with all such firms before the final selection. Furthermore, each firm's proposed methodology should be reviewed in detail to ensure adequate market coverage and data accuracy.

Reporting protocols should be specified in a way that will best accommodate tracking needs and will need to be addressed during the selection process. For example, the quarterly deliverable (assuming data will be collected on a quarterly basis) might be in the form of a report that presents the data and summarizes market trends. In addition, an annual report could include a comprehensive market characterization and a discussion of trends in the industry. In contrast, the agreed upon deliverable might only be the data required for tracking in an electronic database that is to be updated every quarter, which would be submitted to another party that would conduct analysis and evaluation activities.

Timing and Cost Estimates

The scheduling and timing of this option depend primarily upon the time needed to identify all qualified firms, and to review tracking needs and data requirements, in addition to the time the market research firms can provide the first deliverable. Because these firms are likely to already have developed relationships with key manufacturers, the turnaround time between hiring a firm and receiving the first deliverable should be considerably shorter than with the manufacturer-direct option.

The costs for retaining a market research firm to conduct data collection activities will vary across firms and will depend upon each firm's level of expertise in the industry and the extent to which the firms have existing relationships with key manufacturers. Estimated costs seemed to be a function of the extent of each firm's perceived relationships with key market actors. For example, one firm indicated that collecting data directly from manufacturers "would not be cheap." This firm does not currently collect any shipments data from chiller manufacturers. The other firm, who does collect information from major manufacturers, indicated that costs would be very reasonable. Even though neither market research firm could provide specific cost estimates to be included in this report, RER estimates that costs for this option will be comparable, if not lower than those estimated included above in Table 10-19.

10.9 Measures for Which Tracking Methods Have Not Been Recommended

Nonresidential Window Retrofits

As mentioned in Section 8, the nonresidential window retrofits measure was dropped as a priority measure primarily because it is difficult to concretely define what constitutes a window retrofit in the nonresidential sector. Window retrofits in nonresidential buildings typically involves film application, and does not necessarily imply glazing or window assembly replacement.

Non-HVAC Motors

Non-HVAC motors are predominantly installed in the industrial sector. As explained in Section 4, a comprehensive tracking initiative for non-HVAC motors should include the following motor characteristics:

- Efficiency,
- Size (HP),
- Component type (fan, pump, air compressor, etc.),
- NEMA design, and
- Enclosure type.

There are a number of existing sources for these data, though none can provide the data that meet the requirements of this study. These sources are summarized below.

- ***National Electrical Manufacturers Association (NEMA).*** NEMA is the predominate trade association for motor manufacturers. Manufacturers provide data periodically to NEMA, who aggregates and provides these data to contributing members only. In general, the data is comprehensive at a national level only. RER's conversations with representatives of NEMA's statistical department indicate that NEMA does not generate data on a regional or state level, is unwilling to provide the data to nonmembers, and cannot disaggregate the data by distribution channels.
- ***DOE Motor Challenge Program.*** The objective of the DOE Motor Challenge Program is to increase the adoption of energy efficiency motors and motor-driven systems. The program adopts a systems approach and strives toward training key market actors in not only equipment right-sizing and motor specification, but system maintenance practices as well. Data collected under the Motor Challenge Program consist of an industrial motor systems inventory that was constructed as part of the program's Market Opportunities Assessment project. This national motor systems inventory is based upon data collected with on-site surveys of industrial sites across the country. A major portion of this effort focused on characterizing facility managers' maintenance procedures and their awareness and knowledge of opportunities to reduce motor system energy usage. The motor

systems inventory provides a "snapshot" of the industrial motor systems market and is not an ongoing effort.

There are no formal recommendations for the tracking of non-HVAC high efficiency motors.[36] This decision is due to a number of reasons relating to the relative tracking costs, need for detailed data on motor characteristics, data coverage at particular market nodes, and willingness of market actors to supply the required data for tracking initiatives.

- ***Distributors Unwilling to Supply Data.*** RER completed an informal survey of distributors in California. RER's findings indicate unwillingness on the part of distributors to participate in a tracking effort. This is primarily because they do not routinely keep records of this type of data and many have severe staffing problems. The distributors that did show interest also indicated that they would require an incentive in order to participate.
- ***Complex Distribution Channels.*** As summarized in Section 4, the distribution channels for motors are fairly complex. Tracking motors at any single node would likely exclude large portions of the market. For instance, only tracking distributions to end users would ignore distribution by manufactures to OEMs.
- ***High-Cost Options.*** As will be explained below, the only viable tracking methods are relatively costly. These include conducting on-site surveys of end users (primarily industrial sites) and designing and implementing a distributor survey. In the latter case, the cost is high with no guarantee that a successful long-term tracking system will be developed. Furthermore, because of the market structure, data would need to be collected from a variety of distributor types to achieve adequate market coverage.

Although no formal recommendations are offered to track motors, the following are some informal initiatives that could generate some useful motor tracking data, but at considerable cost and, in some cases, with no guarantee of success.

- ***Conduct On-Site Survey of a Pre-Screened Sample of Industrial Sites.*** The cost for a typical industrial on-site survey is substantial, ranging from $500 to $1,000 per site. However, if tracking non-HVAC motors is a high priority, the survey could be streamlined to include an on-site that examines purchasing decisions relating to only non-HVAC motor replacements. This approach would lower the cost per site considerably by focusing on sites that have recently purchased non-HVAC motors. The pre-screening process would be relatively inexpensive given the high saturation of non-HVAC motors in the industrial sector and the number of motors at each site. The cost for this effort would be in the

[36] Adoption of the nonresidential tracking Initiatives V and VI will develop some secondary information on non-HVAC motors in the commercial sector. Further, to the extent possible, motor data will be collected as part of the industrial telephone survey contained as an option in Initiative VI.

range of $350,000 to $550,000 annually. This estimate is based on the design and implementation of a streamlined industrial survey focusing on collecting motor characteristics data, the costs of pre-screening sites that have recently purchased motors, a quarterly sample of 300 industrial sites, and would include data entry and administration costs.[37] The cost estimate would increase to construct and update a complete motor systems inventory.

- ***Collect Data from Distributors.*** As explained in Section 4, approximately 50% of three-phase motors are sold through distributors or directly to end users. The remaining motors are sold through OEM channels. The motors sold to OEMs tend to be standard efficiency and have not historically been eligible for energy efficiency programs. Tracking motors at the distributor level presents many problems primarily related to the distributors unwillingness to participate in the process, record keeping practices, achieving adequate market coverage, and confidentiality issues. These conclusions were drawn from secondary literature and from an informal survey of motor distributors in California.

  Six motor distributors were surveyed for the type of sales information they record at the point-of-sale, how this information is stored, and their willingness to participate in a statewide tracking program. None of the distributors was interested in participating in any sort of tracking program. Moreover, the information they collected was incomplete and would not meet tracking requirements. In particular, sales were not necessarily tracked by model number and were not necessarily stored in an electronic database. Although the six distributors represent less than 10% of California distributors, another 20 to 30 calls were placed and detailed messages were left explaining the nature of the call, with no response. One could argue that this lack of response is indicative of their interest and that additional completed surveys would result in the same conclusions.

  These results are discouraging from the standpoint of developing a tracking initiative based upon distributor data. However, the experience in Wisconsin of tracking motors indicates that this option should not be completely discounted. There are certainly a large number of distributors that could be ultimately contacted and a representative sample could possibly be recruited to supply data. In addition, the problem of record keeping by the distributors could be mitigated with the development of a customized tracking system that could be adopted by distributors. This approach has been adopted in the Wisconsin effort. RER also recognizes that a tracking system based on distributor data does, in fact, omit a large portion of the motor market. However, periodic tracking of the mix of motor efficiencies sold through distributors could provide reasonable estimates of changes in the market over time.

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[37] This sample size is based on predicting the average efficiency of a motor above some standard, and assuming a coefficient of variation of one and a ±10% relative precision level with 90% confidence.

Estimates of cost and timing are difficult for developing a tracking system based on distributor data. However, review of the budgets cited in the Wisconsin experience indicates that an annual budget of $80,000 to $150,000 would seem reasonable. Again, a large caveat needs to accompany adoption of this method. In particular, the data coverage is limited, there is no guarantee of long-term success of this method, and a considerable amount work will be related to recruiting and keeping distributors willing to participate.

- ***Obtain Data from NEMA.*** There are severe limitations to using NEMA as a data source for motor purchases for the reasons discussed above, which primarily relate to the confidentiality of the data, data coverage, and availability of state-level data. However, during a telephone interview, NEMA staff explained that lobbying the participants in the motor and generator section for releasing data at a trade area level is an option. NEMA would not guarantee that this would be successful. Should this option be further explored, RER recommends lobbying of key NEMA members in an attempt to obtain data on a state rather than national level. Doing so would not be a cost less endeavor and might require considerable time and effort to secure the needed endorsements.
- ***Coordinate with the DOE Motor Challenge Program Evaluation Efforts.*** Preliminary discussions with the DOE Motor Challenge Program manager indicate that a program evaluation effort will soon be undertaken. Because the evaluation approach has not yet been designed, RER recommends continuing discussions with program representatives to explore the possibilities of coordinating the DOE's and CBEE's information needs.
- ***Conduct Industrial Telephone Survey.*** Non-HVAC motor purchases in the industrial sector could be tracked using an industrial telephone survey. This would be a relatively expensive endeavor, given that the survey targets industrial sites that have recently purchased motors. Note that this would be significantly different from the industrial telephone survey recommended in Initiative VI. It requires considerably more detailed screening of the sites and the level of detail of the required data is greater.

The major drawback to this method is that the data required for tracking are fairly detailed and technical and might not be obtained reliably with a telephone survey. The Wisconsin experience reveals that data quality suffers dramatically when relying on telephone surveys to collect such detailed data. In order to mitigate these problems, the telephone survey protocol should include the use of multiple callbacks to ensure the respondent is the most knowledgeable and appropriate person. In addition, the use of incentives and requiring the interviewee to provide copies of invoices might alleviate these shortcomings. A telephone survey of 300 industrial sites that recently purchased motors would cost between $80,000 to $125,000 annually. Again, a large caveat needs to accompany adoption of this method. In particular, the data coverage is limited and there could be severe data quality issues.

A number of other issues relating to the tracking of non-HVAC motors were identified during the feasibility study:

- ***Motor Repair versus Motor Replacement.*** A number of studies, such as the DOE Industrial Motor Systems Market Opportunities Assessment, discuss the impact of motor rewinds on the motor replacement market.[38] This factor could be included in the tracking of motor purchases if the tracking is conducted at the end-user level, or if motor repair shops participate in the tracking initiative.
- ***Tracking HVAC Motors.*** HVAC motor purchase activity could be tracked in new construction relatively inexpensively using the nonresidential recommended Initiative V. Tracking replace-on-burnout and net acquisition HVAC motor purchases would be more expensive requiring 1) a pre-screening survey followed by an on-site survey, or 2) a telephone survey. The approach to track HVAC motors in the industrial sector would be to conduct an industrial telephone survey targeting customers that have recently purchased motors.
- ***Tracking ASDs in Non-HVAC Applications.*** The ASD-related measures identified in the Needs Assessment are for HVAC fans and pumps only. Non-HVAC fan and pump applications could also be tracked, but again at a relatively high price. In particular, it would require an industrial telephone survey aimed at sites making recent ASD purchases. Further, to the extent that non-HVAC ASD applications are used in the commercial sector, a telephone survey would also need to be developed to cover commercial applications.

If any initiatives were adopted that use on-site surveys or targeted telephone surveys to track motor efficiencies in the industrial sector, these issues should be reviewed and mitigated during the design of the tracking system.

Packaged Refrigeration Equipment

The recommended tracking initiatives presented here exclude packaged refrigeration equipment for several reasons:

- First, and most importantly, efficiency standards do not yet exist for packaged refrigeration equipment, nor is there a standard for measuring energy efficiency and comparing the performance of most equipment types (Suozzo and Nadel, 1998).
- Second, packaged refrigeration equipment is a broadly defined measure comprised of numerous equipment types. Although Section 4 provides a general characterization of the market for packaged refrigeration equipment, the research reveals that markets can differ substantially across equipment types. For example, the channels of distribution for beverage merchandisers can be very different that those for small walk-in coolers. Developing a single cost-effective tracking

[38] See DOE, 1996.

initiative that would cover all packaged refrigeration equipment types would have tremendous shortcomings.

Should packaged refrigeration remain a tracking priority in the future, RER recommends the following:

1) Coordinate with future ENERGY STAR® programs that might cover any such equipment. The EPA is currently working to set up an ENERGY STAR® Vending Machine Program with manufacturers and vending companies to encourage the purchase of more efficient equipment. RER recommends that tracking of packaged refrigeration equipment should be coordinated closely with future ENERGY STAR® initiatives.
2) Define the measure more narrowly and group different types of packaged refrigeration equipment according to market similarities.

11

Summary and Conclusions

11.1 Project Overview

The primary purpose of this study is to develop and recommend strategies for tracking the efficiency market shares of energy efficient products in California. Early in this study, it was determined that the data required for tracking should meet the following requirements:

- Data must represent unit sales, and
- Data are/can be segmented by efficiency level, and
- Data are/can be segmented by geographic region, at least at the state level, and
- Decision type (*new construction* and *replace-on-burnout*/*retrofit/net acquisition*) must be identifiable, when applicable.

This scoping study was comprised of three major phases:

1. A Needs Assessment to identify priority measures for which tracking systems should be developed,
2. A Methods Assessment to characterize the markets of priority measures and identify alternative methods that could be used to implement tracking, and
3. A Feasibility Assessment to compare and evaluate the feasibility of each viable method for tracking the priority measures.

The Needs Assessment resulted in the 20 residential and nonresidential priority measures for which tracking initiatives should be developed. These measures are summarized in Table 11-1. The choice of these measures was based upon several criteria, including potential cost-effective savings attributable to the measure, the expected level of marketing efforts to promote the measure, the seriousness of market barriers associated with the measure, and the extent to which market intervention can reduce such barriers. This phase utilized information obtained from the California Demand Management Advisory Committee (CADMAC) market effects studies, interviews with industry experts and participants and RER's analysis of DSM potential studies and recent utility program plans and program impact evaluations.

Table 11-1: Final Priority Measures for Tracking Initiatives

Residential Sector Measures	Nonresidential Sector Measures
Duct Sealing	High Efficiency Windows
High Efficiency Central Air Conditioning	High Efficiency Packaged Air Conditioning
Compact Fluorescent Fixtures	High Efficiency Chillers
Horizontal Axis Clothes Washers	High Efficiency Motors
High Efficiency Windows	Adjustable Speed Drive Fans
Compact Fluorescent Lamps	32 Watt/T8 Lamps with Electronic Ballasts
High Efficiency Gas Furnaces	Energy Management Systems
High Efficiency Refrigerators	High Efficiency Packaged Refrigeration Equip.
High Efficiency Dishwashers	Adjustable Speed Drive Pumps
High Efficiency Gas Water Heaters	Compressed Air System Optimization

As part of the Methods Assessment, RER characterized the markets for the identified priority measures and determined the point(s) in the distribution channels where it makes the most sense to collect data required for tracking. The Methods Assessment also entailed the identification and review of a wide range of alternative data sources and data collection methods. These sources include existing data sources, such as shipments data consumer panel data, and scanner data, as well as undeveloped data sources, including downstream market actor surveys and data collection from upstream and midstream market actors. The Methods Assessment revealed the following:

- The data required for tracking efficiency market shares by efficiency level and decision type do not currently exist. Therefore, undeveloped methods – e.g., data collection from key market actors – would need to be developed and implemented.
- Tracking by decision type substantially limits the range of viable options. In particular, upstream market actors typically do not keep sales records that identify whether the measure was installed in *new construction* or as a *replacement* or *retrofit*. This result implies that data collection is sometimes limited to end user level data collection through either on-site, mail, or telephone surveys, or from midstream market actors, such as builders or contractors.

The final phase of this Scoping study, the Feasibility Assessment, is based upon a review of current Wisconsin tracking initiatives and interviews with those involved it their development, interviews with other key market actors (e.g., potential data suppliers), and information collected throughout the course of this research.

RER evaluated each applicable method for each measure and decision type according to the following criteria:

- Viability,
- Reliability,
- Cost,
- Economies,
- Timeliness,
- Versatility,
- Leverage,
- Context, and
- Barriers to implementation.

RER then reviewed the feasibility evaluation results and considered possible ways to integrate methods to take advantage of available economies, and researched possible cooperative efforts with other organizations to formulate the final recommendations for tracking efficiency market shares in California.

11.2 Summary of Tracking Recommendations

Table 11-2 summarizes RER's recommendations for tracking the efficiency market shares of the residential and nonresidential priority measures. Initiatives I through IV pertain primarily to the residential measures (with the exception of Initiative III, which also covers nonresidential packaged air conditioning equipment) and Initiatives V through VII include strategies for tracking nonresidential measures. These initiatives represent a variety of tracking methods targeting different market actors along the distribution channel. Four of the six initiatives recommend data collection at the site level, through a combination of on-site surveys, telephone surveys, and data obtained from building departments throughout the state. The remaining three approaches involve data collection at other points in the distribution channel – from appliance retailers, equipment distributors, and even manufacturers.

It is clear that no single method for collecting data from any one market actor can provide the optimal solution to tracking efficiency market shares in California. The recommended tracking initiatives integrate methods and take advantage of the strengths of the highest scored methods to produce workable tracking solutions. For instance, the relatively high scores of some of the methods, such as on-site surveys, are a direct result of potential available economies. The recommended initiatives also exhibit economies across sectors. In particular, RER recommends obtaining building department records for new construction installations in both residential and nonresidential sectors. These economies and the associated lower per-measure costs are applicable only insofar as all measures covered by the economies are actually included in the overall tracking system. In order to take full advantage of this factor, RER considered initiatives that grouped measures by methods exhibiting such economies. Recommending a single tracking method for each measure without considering the impact of economies across priority measures and sectors would be myopic.

RER also considered the advantages of integrating two methods where one method provides considerable secondary data and helps fill in some of the weaknesses of another method. The result is an integrated method that provides more reliable results than the two component methods. An example of this approach is the use of on-site data to calibrate building department verification and installation data.

Table 11-2: Summary of Tracking Recommendations

Initiative	Decision Type	Measure Coverage (Primary)	Description
I: Integrating On-site Surveys and Building Dept. Data	New Construction	Duct Sealing Central AC CFL Fixtures Windows Gas Furnaces Gas Water Heaters Dishwashers	Integrates data from building department installation records for at least 1,100 homes and data collected with 400 on-site surveys per quarter in residential new construction sector. Assuming development begins in the 2nd quarter of 199 one complete year of tracking data can be available by t 4th quarter of 2000.
II: On-site Surveys of Prescreened Residential Sites	Retrofit	Duct sealing Windows	Conduct a telephone survey to identify residential sites have recently retrofitted windows or air distribution duc then conduct 250 on-site surveys per quarter (per measu to record measure efficiency parameters required for tracking. Assuming telephone prescreening begins in the 2nd qua of 1999, one complete year of tracking data can be available by the 4th quarter of 2000.
III: Collecting Distributor Sales Data	Replace-on-burnout Net Acquisition	Central AC Gas Furnaces Gas Water Heaters Packaged AC	Collect quarterly sales data from HVAC and water heating distributors. If Initiative I is also implemented, tracking data will be available for new construction. These estimates together with the distributor data could be used to infer *replace-on-burnout* and *net acquisition* shares. Assuming recruitment of distributors begins in the 2nd quarter of 1999 and adoption of Initiative I, one comple year of tracking data can be available by the 4th quarter 2000.

Table 11-2: Summary of Tracking Recommendations (cont'd)

Initiative	Decision Type	Measure Coverage (Primary)	Description
IV: ENERGY STARâ /EGIA Retail Tracking	Replace-on-burnout Net Acquisition	CFL Fixtures & Lamps Clothes Washers Refrigerators Dishwashers	Obtain unit sales data collected under the ENERGY STAR® program and from smaller, independent non- ENERGY STAR® retailers in California. Assuming development of this initiative begins the 2nd quarter of 1999, one complete year of tracking data from ENERGY STAR® retailers co be available by the 4th quarter of 1999. One complete year of tracking data from smaller retailers and non- ENERGY STAR® partners cou be available by 3rd quarter of 2000.
V: Integrating CEC On-Site Commercial Surveys and Building Dept. Data.	New Construction	Nonres. Windows Packaged AC ASDs 32 watt T8s w/ Elec. Ballasts EMS	Integrates data obtained from building department compliance records and data collec with 350 commercial on-site surveys per quart conducted by the CEC.
Va: Integrating On-Site Commercial Surveys and Building Dept. Data.			An alternative to Initiative V, this strategy integrates data obtained from building departm compliance records and data collected with 35 commercial on-site surveys without CEC involvement.

Table 11-2: Summary of Tracking Recommendations (cont'd)

Initiative	Decision Type	Measure Coverage (Primary)	Description
VI: Integrating CEC On-Site Commercial Surveys and Commercial & Industrial Sector Telephone Surveys.	Retrofit	ASDs 32 watt T8s w/ Elec. Ballasts EMS Compressed Air Opt.	Integrates data from 600 commercial on-site surveys conducted by the CEC with data from telephone survey of commercial and industrial customers. Assuming survey development begins in the 3 quarter of 1999, one complete year of trackinç data could be available by the 4 th quarter of 2(
VIa: Integrating On-Site Commercial Surveys and Commercial & Industrial Sector Telephone Surveys.			An alternative to Initiative VI, data from 120 commercial on-site is used to calibrate data frc a telephone survey of 2200 commercial and 22 industrial customers without CEC involvement Assuming survey development begins in the 3 quarter of 1999, one complete year of trackinç data could be available by the 4 th quarter of 2(
VII: Chiller Manufacturer Data Collection	New Construction Replace-on-burnout	Chillers	Obtain sales data from major chiller manufacturers. Assuming recruitment begins in the 2 nd quarte 1999, one complete year of tracking data coul available by the 4 th quarter of 2000.

11.3 General Observations

In addition to the recommendations summarized above, RER offers some additional observations. These observations cover a wide range of caveats, exhortations and ruminations, and are presented below in fairly arbitrary order.

Difficulties of Tracking

While some tracking systems have been put in place in parts of the country, prior attempts to track market shares of high efficiency measures have had generally discouraging results. Previous scoping studies have generally painted a fairly pessimistic picture of the prospects for traditional tracking systems. Nonetheless, the specific tracking initiatives we have proposed should provide the kind of information on market shares that will be needed for the assessment of California's market transformation efforts.

Timing Issues

As explained in Section 9 and summarized above, developing the recommended market share tracking initiatives will take time. Depending upon lags in procurement and difficulties in implementing our recommendations or some other initiatives, it is likely that tracking results will not be available until the end of 1999. If we focus only on the need for tracking data over the transition period (up to 2002), this lag could appear ominous. However, as we have argued elsewhere in this report, tracking should continue to be a priority beyond the transition period. It will be important to know, for instance, if the reduction in PGC-funded program interventions at the end of the transition leads to the degeneration of energy efficiency in the State. This may mean that tracking systems need to be put in place with PGC funds, but that another method of financing and overseeing these systems will be necessary.

Collecting Comparable Data from Other Regions (Context)

One of the criteria used to select tracking options was the ability to yield information on other (non-California) areas. Such information could clearly be useful in assessing market effects, insofar as it would provide cross-sectional comparisons of market shares. One of the disappointments of the study was that very few options provide context in this sense at a reasonable cost. Of course, it is always possible to duplicate an initiative in another area (e.g., we could always conduct on-sites in other states to obtain comparison data); however, such data collection efforts would be likely to quite expensive. The heavy reliance of RER's recommendations on customer-level data (on-site surveys and building department data, for example) implies that the collection of comparable data from other regions would essentially require at least double the budgets proposed here.

Tracking by Decision Type

The tracking methods we have recommended are capable of tracking market shares by decision type when decisions differ substantially by these market events. RER imposed this capability as a data requirement for tracking because programs relating to these measures are categorized and designed by market event. If new construction programs and *retrofit* programs are to implemented to promote transformation, for instance, it seems logical to track new construction and *retrofit* shares separately. RER understands that the requirement of this capability results in tracking budgets that are sometimes higher than they would otherwise be. Nonetheless, we would argue that the additional costs are warranted.

Collecting Data from Multiple Market Nodes

Section 4 reviewed the markets for the priority measures and identified market nodes where data for market share tracking could be obtained. For most, if not all, measures, more than one node was cited. While this issue is not explicitly addressed in Section 4, it is important to recognize that there could be benefits in collecting data from multiple points in the distribution channel. Two primary benefits result from tracking at multiple nodes. First, doing so provides a “sanity check,” or helps to cross-reference results of tracking efforts.

Second, tracking from multiple nodes can provide indicators of the extent of market transformation on national as well as regional perspectives. For example, as discussed above, collecting data at the manufacturer level would not provide data specific enough to meet market share tracking needs in California. Most manufacturers use well established distribution channels and do not have the mechanism for knowing where the measures are ultimately purchased. Most manufacturers track sales only at the first point-of-invoice, which is typically a regional distribution center. Nonetheless, it still may be useful to pursue tracking at the manufacturer level. Market transformation is a primary objective of energy efficiency programs in California and other states. There has been some evidence that manufactures continue to produce the same mix of efficiencies, but that a greater percentage of high efficiency units are shipped to areas with higher demand for these products, such as California. This practice would work against market transformation efforts from a national perspective. Tracking efficiency mixes of manufacturer shipments on a national level can provide insights into this issue.

Data Collection [1] Market Share Tracking

While this phase of the study has identified logical points in the distribution channel for collecting data and the alternative methods for doing so, the *actual* data that should be collected for market share tracking has not specifically been addressed. One of the four data requirements for market share tracking in California is that data must be segmented by efficiency level. One cannot assume, however, that market actors keep sales or inventory records by efficiency level. Most often, sales and inventory records are maintained by product codes, model or part numbers, and possibly other parameters that would uniquely define a product, such as size or manufacturer. The point here is that the data collected will need to be converted or coded to be useful for market share tracking. Some resources for coding data in this manner are already available. For example, some organizations are creating or maintaining databases comprised of key characteristics for available products. For example, the Washington State Energy Office maintains the Motor Master database, which catalogs most induction motors in the 1 to 500 HP range that are available in the United States. Another example is the Ballast Master database, also maintained by the Washington State Energy Office. The EPRI market tracking study is an excellent resource for identifying such resources. Moreover, the EPRI study discusses coding options for market tracking.[1]

Availability of Baseline Data

We have not explicitly addressed the means of collecting baseline data to provide an historical perspective on market shares in California. Another study being conducted by Xenergy is addressing this issue.[2] We should note, however, that some of the methods discussed and recommended here (data collection from upstream market actors, in particular) might be able to yield historical data on market shares.

Tracking Should Be Long Term

It is tempting to think of the need for tracking as a short-run requirement for monitoring market transformation during the "transitional period." However, this would be a myopic view. While the transition period is an important interval, tracking initiatives need to be implemented on a longer-term basis, even if PGC funds are no longer used to support energy efficiency.

11.4 Reflections on the Cost of Tracking

Clearly, tracking market shares is an essential ingredient in the overall assessment of the market transformation effort. This is true in two respects. First, access to market share data will be critical for the support of decisions relating to the continuation of public funding for energy efficiency programs as the close of the transition period draws closer. Second, the availability of comprehensive market share tracking systems will greatly facilitate the assessment of the effectiveness of individual programs, program elements, and intervention strategies. Program administrators will have to have access to tracking data to assess the

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[1] The EPRI study focuses on market tracking for compact fluorescent lighting, horizontal axis clothes washers, commercial HVAC equipment, commercial and industrial lighting equipment, and motors (EPRI, 1997).

[2] See Xenergy, 1999.

effectiveness of these activities. If they are not available from a set of statewide initiatives such as those recommended here, they will have to be developed in the course of individual MA&E projects. Arguably, the available of a single set of consistent tracking systems would be preferable to piecemeal tracking as part of periodic program assessments. RER argues that the availability of uniform tracking data would foster more effective use of other MA&E funds allocated in 1999 and beyond.

Depending upon the specific options chosen by the CBEE, the development of a comprehensive tracking system covering the priority measures could cost around $2 million in the first year and between $1 and 2 million per year thereafter. The recommended initiatives would cost between $1.0 and $1.4 million for the residential sector and between $0.7 and $1.0 million and for the commercial/industrial sector. RER understands that the CBEE may consider these costs quite high. Indeed, the CBEE's Technical Services Consultants have recommended initial budgets for tracking initiatives be $375,000 each for the residential and commercial/industrial sectors. In light of the obvious discrepancy between our recommended budgets and the budgets currently being anticipated by the CBEE for market share tracking, some means of reconciling this difference is necessary.

The CBEE has a variety of options for reconciling the differences between our recommendations and current tracking budgets, including the following:

- Increase budgets for tracking,
- Track fewer measures, or
- Find less expensive means of tracking.

These options re considered briefly below:

Increase CBEE Budgets for Market Share Tracking. In light of the scoping study results, this would be the most reasonable option. The costs of the recommended tracking initiatives should be evaluated in the context of the size of California's market transformation efforts. Roughly $300 million per year will be spent to promote market transformation in California over the next three years. The first year cost of the recommended initiatives would amount to less than 0.8% of the total annual energy efficiency budget. The annual cost of maintaining the tracking system would be less than 0.6% of the annual energy efficiency budget.

The CBEE might also consider the budget in the context of historical utility expenditures on the collection of market data. For instance, California utilities have traditionally spent several hundred thousand dollars per year on the collection of commercial on-site data for forecasting and DSM planning. Utilities have also spent (and will continue to spend) far larger amounts of money for the evaluation of energy efficiency programs.

Track Fewer Measures. Some preliminary comments on our recommendations suggest that the CBEE may choose to prioritize the recommended initiatives rather than funding them all. While RER understands the desire to be parsimonious in the expenditure of funds for market share tracking, we are hard-pressed to recommend a prioritization scheme for three reasons:

- First, the research conducted for the Needs Assessment phase of this study implicitly prioritized the focus of market share tracking efforts. Each of these measures is considered important by the energy efficiency community.
- Second, prioritizing recommended initiatives really requires an implicit tradeoff between the costs and benefits of information, and this is essentially a policy decision. These options should be evaluated on the basis of a wider range of judgments than ours.
- Third, several of the recommendations are interrelated, so adopting one without the other may result in major economies being lost.

Nonetheless, if we were *forced* to exclude one of the residential initiatives ourselves, we would probably drop Initiative II, which deals with residential duct sealing and window retrofits. While these are important measures, they entail fairly high tracking costs. This would save between $332,000 and $410,000, thus reducing the cost of the residential tracking system to between $698,000 and $960,000. If we were *compelled* to drop a measure from the commercial/industrial sector, we would probably sacrifice the portion of Initiative VI dealing with compressed air optimization. We would do so partly on the basis of the difficulty of determining system efficiencies, and partly because tracking this measure requires industrial surveys that contribute relatively little to the development of information on other measures. This would produce savings of $240,000 to $320,000, leaving the overall commercial/industrial budget between $491,000 and $778,000. Of course, others could justifiably disagree with the value judgments underlying these choices.

Find Less Expensive Means of Tracking. In our judgment, the tracking initiatives recommended in this report are well designed and cost-effective. The recommended initiatives take advantage of a variety of economies that lower overall data collection costs substantially. For instance, they make extensive use of CEC survey efforts, data collected by Building Departments, and the tracking procedures of the ENERGY STAR® Program. (Had we ignored these efforts and designed independent approaches, the overall cost would have been at least twice as high.) Nonetheless, cheaper options may be available if certain conditions are relaxed. For instance, lowering precision levels and reducing sample sizes could yield some minor economies. We have offered suggestions for cutting costs throughout Sections 9 and 10. Overall, we suspect something on the order of 10% of the budget could reasonably be trimmed through the use of some of these suggestions.

If we were to take advantage of all of the above suggestions for reducing overall tracking costs—dropping duct sealing and window retrofits as well as industrial air compressor optimization, as well as tightening sample sizes—the total cost of tracking would be $628,000 to $864,000 for residential measures and $442,000 to $700,000 for commercial measures. Using the midpoints of these ranges, the CBEE could set budgets of $746,000 and $571,000, respectively.[3]

[3] The total budget would therefore be $1.317 million, which is very close to the $1.2 million rough estimate provided a few months ago in the interim report.

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