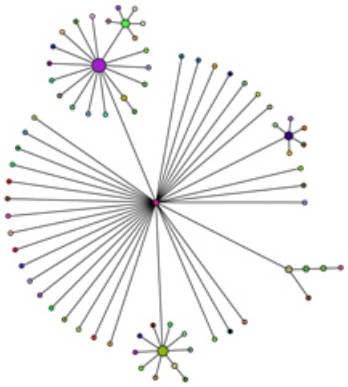
California Statewide Emerging Technologies Program

Technology Development Actors Study



LIVINGSTON ENERGY INNOVATIONS

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Front cover diagram by Sanjay Krishnan

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Executive Summary

In 2010, the Statewide Emerging Technologies Program (ETP)[1] expanded its approach for identifying the next wave of advanced, proven technologies that can be adopted into utility energy efficiency (EE) and related programs. The ETP expansion added five new program elements to the original core activity of performing Technology Assessments.

The new elements aimed, among other objectives, to engage with upstream market actors to increase the availability of California-appropriate emerging technologies (ETs), and to expand ETP understanding of and connections with the downstream market to stimulate demand for and acceptance of specific ETs.

The decade-long evolution of the ETP and this recent expansion have provoked a number of questions about the nature of technology development and about the organizations and people whose actions enable the progression of advanced technologies from the lab to the marketplace

The investor-owned utilities (IOUs) decided to undertake this study to enhance their understanding of technology development actors (TDAs) and their roles in the technology development (TD) landscape for EE and Integrated Demand-side Management (IDSM) products and services.

This study, the first to investigate these TDAs and their interactions, examines TD phases from applied R&D to product commercialization and market adoption. It aims to provide guidance for the current program as well as to inform ETP enhancements for the next program cycle.

To accomplish these goals, SCE retained Livingston Energy Innovations, LLC (LEI) to conduct an interview and analysis-based study. LEI completed 60-minute structured interviews with each of 19 TDA stakeholders, representing 19 distinct organizations across the following seven sectors:

1. Utilities	2. Academic Institutions	3. Private Industry
4. Government Agencies	5. 3rd Party Implementers	6. Other EE Organizations
7. R&D Institutions		

In addition to purposefully targeting multiple sectors, this study also aimed for geographical diversity. The majority of interviewees and their organizations are based outside of

[1] The Statewide ETP is implemented by the four California investor-owned utilities: Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas Co. (SoCal Gas) and San Diego Gas & Electric (SDG&E).

California. Moreover, participation in the study was not contingent on an individual TDA's or her/his organization's knowledge of the California ETP.

The original scope of this study called for interviews and characterization of TDAs representing the full spectrum of IDSM technology activities, including demand response and distributed renewable generation as well as EE. In practice, the difficulty of enlisting TDAs varied among IDSM technology domains. We found TDAs in the distributed generation (DG) domain to be generally unavailable or unwilling to participate in the study, so the project scope and this report have been redirected to cover EE and DR TDAs but not DG TDAs.

Interview questions for this study addressed each TDA's TD phases or "stages," the TDA's roles and core strengths, their TD processes, criteria and metrics, and the TDA's working relationships and influence with peers and partners. It is important to note that during these interviews, the word "utilities" was used in the broad sense, and thus the interviewees did not specifically refer to the California utilities.

LEI distilled more than 150 pages of TDA interview transcripts to extract themes and trends for each of the seven sectors, and across all sectors.

Key study findings include the following:

- All TDAs perceive their activities as proceeding in discreet phases, but details of how the TDAs conceptualized the TD lifecycle vary considerably.
- More than half of the TDAs identified Ideation as a TD phase, and 26 percent identified Technology Screening as a TD phase.
- The TD phase most frequently cited as a core strength was Assessment & Demonstration, mentioned by 52 percent of the TDAs.
- TDAs in all seven sectors cited Research & Development Institutions as a primary partner.
- TDAs in all seven sectors named Private Industry as a primary or secondary partner, but Private Industry TDAs only identified partners in two of the other six sectors, and both of these as secondary partners only.
- The majority of TDAs view energy utilities, in general, as important partners for their TD initiatives, with end-user customer connections, funding, marketing capabilities, rebates, and technical expertise as the most frequently cited benefits from working with utilities.
- The majority of TDAs see some gaps in energy utilities' involvement in their projects. The utility involvement gap most frequently identified was two-way information exchange, cited by four TDAs.

Implications and opportunities from the study findings include the following:

- There is wide variation in how TDA interviewees within any sector conceptualized TD phases.
- TDA interview responses confirmed that this study included all relevant TD sectors.

- Although this study set out to characterize the TD landscape, interviewee responses identified a number of factors such as business and personal relationships and flows of information, funding, and IP TD interactions that can best be characterized as a commercial "ecosystem" rather than as a landscape.
- Private Industry, which depends on technology commercialization to assure its long-term viability, appears to operate semi-autonomously from other sectors, and to not consider entities in the Utilities sector as TD partners. Industry stands to benefit by expanding its engagement in TD partnerships, particularly in ET and related initiatives which share a strong interest in strengthening and accelerating TD.
- The ETP has strong qualifications for building new pathways among TDAs and TD organizations with the goal of accelerating emerging technologies into utility EE and IDSM programs and into the market. Specifically, these qualifications include a culture that promotes objective and agnostic perspectives on products and technologies, clear regulatory mandates to accelerate program and market entry for qualified new technologies, and access to program funding[2] for assessments and the other ETP elements as a means to accelerate this process.

In conclusion, despite some missing pathways, weak connections, and gaps, the TD ecosystem for EE and DSM technologies exhibits considerable robustness as a balanced, synergistic and interdependent system.

Although the study findings cannot be generalized due to the small sample size, there may be significant opportunities to create new and better pathways among TDAs and their organizations to enable the movement of concepts and technologies from the lab to the marketplace. In particular, further investigation of partnerships with Private Industry TDAs should be undertaken, to either reinforce the findings of this study or to clarify the significance of what the Private Industry TDAs reported.

The ETP, with its high visibility and record of success, has the opportunity to construct or contribute to pathways by leveraging its resources and those of other EE programs.

[2] Although all TDA organizations have access to funding, utilities, government agencies and (to some extent) private industry are the only TDA organizations that operate primarily as funders. The other TDAs, including research institutions and 3rd party implementers, rely on external funders for their financial viability. This asymmetry does not present an insurmountable obstacle, but deserves consideration when developing pathways and other means to overcome gaps in the TD ecosystem.

Background

The California Statewide Emerging Technologies Program (ETP) helps utility EE and related integrated demand side management (IDSM) programs identify emerging or underutilized technologies that can provide substantial energy and electric demand savings to utility customers. Historically, ETP's role has been to assess technologies that are either emerging or are underutilized, and to communicate the assessment findings to the California investor-owned utilities' EE program managers. ETP's technology assessment role can be compared to *Consumer Reports*, with a target audience of EE program managers instead of mass market customers.

In 2010, the ETP expanded its approach for identifying the next wave of advanced, proven technologies, adding the following five new elements to its original core activity of performing Technology Assessments[3]:

- scaled field placements,
- demonstration showcases,
- market and behavioral studies (in support of specific emerging or underutilized technologies),
- technology development support, and
- business development outreach (called Technology Research Incubator Outreach, or TRIO).

The introduction of these new elements aimed, among other objectives, to engage with upstream market actors with the goal of increasing availability of California-appropriate emerging technologies (ETs), and to expand ETP understanding of and connections with the downstream market to stimulate demand for and acceptance of specific ETs.

This aligns with direction provided in the California Energy Efficiency Strategic Plan (CEESP), which recognizes that many technology actors participate in the development and deployment energy efficient technologies, and directs California to:

"Engage the full-range of participants - private entities, national labs, clean energy and environmental groups, green venture capital firms, federal, state and local governments, utilities and consumers."[4]

Achieving engagement with the full range of participants will require significant time and resources, as well as robust strategies for support of TD processes. The CPUC has led several

[3] In the 2013-2014 program, these elements are described as tools that can be used to support different ETP objectives, and these elements are not in and of themselves subprograms.

[4] California Energy Efficiency Strategic Plan – January 2011 Update, Section 11, Research and Technology – Page 81

action planning initiatives that attempt to engage the full-range of participants to agree on these strategies, but further refinements are needed for successful implementation.

For its part, the ETP since its inception has encountered and worked with TDAs from numerous sectors as part of technology identification, screening, selection, and assessment activities for energy efficiency and related technologies up to 2010. These TDAs have included representatives from a range of organizations that conduct assessments of energy efficiency technologies.

Over the last two years, the scope and diversity of ETP engagements with organizations across multiple sectors has increased with the introduction of the new elements. More utilities, government agencies, consultants and other entities have initiated or expanded their emerging technology assessment activities. However, the technology development (TD) landscape and the TDAs involved in EE and IDSM domains are not well understood and no systematic effort to chart them have been undertaken.

To fill this gap, the four California IOUs decided to undertake this study to investigate key aspects of TDAs and their role in the TD landscape for EE and DSM products and services. The study examines a cross-section of TDAs and their interactions, including their TD phases from applied R&D to product commercialization and market adoption, with the goal of enhancing the IOUs' understanding of TDAs and the TD landscape. This report aims to provide guidance for the current program as well as to inform ETP enhancements for the next program cycle.

To accomplish these goals, the IOUs retained Livingston Energy Innovations, LLC (LEI) to conduct an interview and analysis-based study. LEI completed 60-minute structured interviews with each of 19 TDA stakeholders, representing 19 distinct organizations across seven sectors:

1. Utilities	2. Academic Institutions	3. Private Industry
4. Government Agencies	5. 3rd Party Implementers	6. Other EE Organizations
7. R&D Institutions		

In addition to its purposeful targeting of multiple sectors, this study also aimed for geographical diversity. The majority of interviewees and their organizations are based outside of California. Moreover, participation in the study was not contingent on an individual TDA's or her/his organization's knowledge of the California ETP.

The original scope of this study called for interviews and characterization of TDAs representing the full spectrum of integrated demand side management (IDSM) technology

activities[5], including demand response and distributed renewable generation as well as EE. In practice, the difficulty of enlisting TDAs varied among IDSM technology domains.

We found the TDAs we contacted in the distributed generation (DG) field to be generally unavailable or unwilling to participate in the study. Media reports at the time of TDA interviewee recruitment suggest that adverse business conditions for DG companies may have been a factor. As a result, the scope for the TDA study and this report was redirected to cover EE and DR TDAs but not DG TDAs.

To address the movement of technologies from the lab to the marketplace, this study assumed that most TDAs' activities fell into distinct phases such as:

- Research & Development
- Product Development
- Assessment & Demonstration
- Commercialization

For the purpose of this study, we used the following phase definitions:

Research & Development – basic science / pure research through applied research and development to proof of concept.

Product Development – proof of concept through fully-functional prototype to initial laboratory demonstration.

Assessment & Demonstration – initial laboratory demonstration to field demonstration and assessment to validation of technical and human factors performance / usability.

Commercialization – final configuration of the product for volume manufacturing through initial commercial product launch and scale-up for sustainable market penetration. This includes initial acceptance by early adopters as defined in Diffusion of Innovation theory.[6]

Adoption – commercial product broadly accepted by early adopters and early majority users as defined in Diffusion of Innovation theory.

Standards – the technology, usually represented by several competing commercial products, receives recognition by industry standard-setting bodies such as American National Standards Institute (ANSI) and ASTM International. The technology may also be included in energy codes such as California Title 20 or Title 24, and the International Energy Conservation Code (IECC).

[5] The justification for including IDSM TDAs was to enhance ETP collaboration on DG & DR technology initiatives relevant to the ZNE and IDSM programs.

[6] Everett Rogers (2003), **Diffusion of Innovations (5th Edition)**

It is important to recognize that phases may overlap, as explicitly indicated in the first three definitions on the previous page, that there may be gaps between phases, and that some TDAs may enter and exit phases in different sequences.

Objectives

This section outlines the purpose of the TDA study and the key topics that it aims to address.

This study examines TDAs whose activities influence the availability of new technologies in the California market and/ or offer lessons to California's Emerging Technologies Program that could help improve ETP operations. It focuses on leading TDAs in the EE and DSM field from across North America and on their interactions, including their involvement in TD phases from applied R&D to product commercialization and market adoption.

This report aims to provide the following:

- insight into how public and private entities and individuals that are involved in the movement of new technologies from the lab to the market are positioned with regard to energy utilities and each other,
- enhanced understanding of TDAs' roles in the TD landscape for EE and DSM products and services, exploring the extent to which they coordinate activities
- information about TDA organizations' core competences and their working relationships with other TDAs,
- opportunities for organizations and individuals involved in R&D for energy efficiency (EE) and demand-side management (DSM) activities to optimally relate to energy utilities and how energy utilities can relate to them,
- guidance for the current ETP as well as to inform enhancements for the next program cycle.

In the process of refining study objectives , the California statewide Program Coordination Group (PCG), the SCE project manager, and LEI discussed and decided not to pursue the following additional topics:

- Information channels used by or potentially used by the ETP to learn about early stage technologies
- Market viability of specific ETs
- Societal-level challenges for the IDSM industry, such as greenhouse gas reduction and calculation methodologies.

Although important, these topics were deemed likely to trigger proprietary or confidentiality concerns and not essential to the goal of clarifying key aspects of TDAs and the TD landscape.

Shortly after completion of the TDA interviews for this study, the CPUC released the Decision Providing Guidance on 2013-2014 Energy Efficiency Portfolios[7]. The Implications and Opportunities section of this report provides some observations relative to the following point in the Decision:

- Existing and potential connections linking TD phases and non-Utility TDAs with Utility EE and IDSM programs, which the Decision refers to as a "clear path of approaches and specific projects activities for transitioning new technologies from major external initiatives into the utility programs."[8]

[7] CPUC 12-05-015, Decision Providing Guidance on 2013-2014 Energy Efficiency Portfolios and 2012 Marketing, Education, and Outreach (May 10, 2012), Page 421

[8] *Op.cit.*, page 421

Methodology

This section describes the selection of organizations and TDAs for participation in the study and the development of the interview questions.

Table 1 below shows the preliminary concept for selecting and recruiting TDAs active in the EE and IDSM domains to participate in the study. Initial study planning focused on identifying relevant California and North American IDSM technology assessment organizations. The intent was to recruit a set of 20 IDSM TDAs expected to be collectively active across the entire range of TD phases, as described in the Background section.

Table 1: Preliminary List of TDAs and Phases - Used for Study Planning

TDA	R&D	Prod. Dev.	Assessment & Demonstration	Commercialization	Adoption	Standards
ETP			√			
C&S Program						√
Core EE programs				√	√	
CEC	√	√				√
CEC/PIER	√					
DOE	√		√			
LBNL	√	√				
GTI	√	√	√			
UC Davis	√					
NYSERDA	√		√	√		
BPA			√	√	√	

The SCE project manager and LEI reviewed this preliminary list and excluded two groups of TDAs—Core EE Program staff and Codes & Standards Program staff—to optimize the study's focus on non-Utility sectors and TDAs[9].

[9] California utility ETP staff were excluded for the same reason.

At the project kickoff meeting, the PCG and the SCE project manager and approved the sectors shown on the next page for inclusion in the study:

1. Utilities
2. Academic Institutions
3. Private Industry
4. Government Agencies
5. 3rd Party Implementers
6. Other EE Organizations
7. R&D Institutions

Table 2 below illustrates the final study design, incorporating the seven TDA sectors listed above and the TD phases defined in the Background section of this report. This design assumes that each TDA is active in and knowledgeable about some phases and not others, and aims to capture interviewee perspectives that collectively span all TD phases. It over-weights sectors expected to yield more diverse and significant insights into the TD process. The design also includes "Adoption" and "Standards" to identify any TDAs that are involved in these activities.

Table 2: Technology Development Sectors, Actors and Phases Used for Interviews

	Technology Development Phases					
Technology Sector & TDAs	**R&D**	**Prod. Dev.**	**Assessment & Demonstration**	**Commercialization**	**Adoption**	**Standards**
Utilities			√	~		
Academia	√	√		√		
Private Industry	√	√	√	√	√	√
Government	√	√	√	~		√
3rd Party Implementers			√	√	√	~
Other EE Organizations			√	√	√	√
R&D Institutions	√	√	√			

LEI and the SCE project manager developed a list of potential study topics in collaboration with statewide ETP program managers. ED and other attendees reviewed and commented on

the proposed topics during the project kickoff at the February 2, 2012 ETP PCG meeting. The following preliminary topics list incorporates feedback received during the kickoff discussion and in follow-up discussions held through mid-February 2012.

- TDA roles, core competencies, fields of influence, and relationships to one another
- programmatic approaches to prioritizing research topics
- length of TDA involvement in the energy efficiency ecosystem
- degree of program's influence on technology commercialization success
- typical TDA project funding sources and degree of funding stability
- alliances between TDAs that may further CEESP objectives in key IDSM technology domains
- options that are available to other programs that are not available to ETP and why; the role that drivers such as intellectual property ownership have on those options
- differences and similarities between the other entities and the investor-owned utility industry.
- support that the TDA would like to see
- TDA needs in order to be more successful in new technology introduction

Based on this topics list, LEI drafted a survey instrument for conducting one-hour telephone interviews with each selected TDA.

We screened the study topics and edited the interview questions to eliminate any that might lead to disclosure of or the need to withhold confidential or proprietary information. We took into consideration potential interviewee sensitivities, and revised the questions to minimize potential self-reporting bias and to elicit factual, repeatable, verifiable responses. The interview guide then received a final edit so that it would require no more than an hour for the average interviewee to complete.

In the process, it became clear that the original study goal of characterizing each TDA and providing TDA profiles in the final report would allow readers to identify the TDA organizations and possibly the individual TDAs who provided a wealth of valuable but potentially sensitive information in the interview process. In order to present this information without compromising interviewee confidentiality, the study approach has been redirected to focus on findings by sector without providing TDA profiles.

Appendix B - Interview Format and Questions contains the final interview guide, which consists of an introductory section, four batteries of questions, and a closing section. The interview questions cover the following topic areas:

- Technology development phases for each TDA
- Technology development strengths for each TDA
- Criteria and processes for selecting, balancing, funding, and potentially discontinuing tech development initiatives

- Metrics for evaluating technology development success
- Technology development peers and key technology partners for each TDA
- Roles of energy utilities in technology development projects and initiatives, and how their roles can be enhanced.

Following completion and approval of the interview guide, the SCE Project Manager sent an email invitation to each TDA. LEI followed up by telephone and email to confirm their interest and schedule telephone interviews with each.

The final TDA interviewee list appears in **Appendix A – Who was interviewed?**

Findings

LEI distilled more than 150 pages of TDA interview transcripts to extract themes and trends for each of the seven sectors, and to identify crosscutting patterns reflected in multiple sectors. The data from the interviews are summarized in **Appendix C – Technology Development Phases by Sector**, **Appendix D – Utility Involvement Benefits and Gaps,** and **Appendix E - Technology Development Process, Criteria and Metrics**[10].

This Findings section includes tables and figures derived from the interviews and the appendices, plus commentary that summarizes trends and themes identified in the TDA interview process. The topics addressed include TD phases and TDA organizations' core strengths, TDAs' working relationships, and roles of utilities in TD projects and initiatives as well as opportunities for increased coordination with utilities.

This section serves as an intermediate step toward the analysis and interpretation of the interview results to address the objectives and topic introduced in the previous sections.

Although the tables and discussion below include frequencies for interviewee responses, these quantitative findings are not intended to imply certainty about TDA views and processes. The scope of this study was deliberately broad rather than deep, and utilized a small sample size. Consequently, study findings cannot be generalized or applied to any sector or to the TDA population as a whole with confidence.

The study benefited from a nearly 100 percent acceptance by TDAs who were invited to take part in interviews. The only technology development actors that chose not to take part were two from leading Private Industry companies, who declined to participate after extensive negotiations.

The representative of one U.S.-based company in the Private Industry sector stated that management considered their in-house TD approach and their network of TD partners to be confidential and proprietary. This TDA communicated his company's concerns part way through the interview process, so information from his interview is not included in this report. The representative of another company in the Private Industry sector that operates internationally did not state a reason for non-participation, but it is possible that senior management perceived greater potential risks than benefits from participation.

The majority of the TDAs interviewed are based outside of California, so study findings are unlikely to reflect bias relative to practices that are unique to California.

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[10] Appendix E presents the frequency analysis for data from Section C of the survey, which examined each technology development actor's decision-making process and metrics of success. Because the process for each entity went through different phases, the responses are tallied by phase. The N varies according to how many entities included each particular phase.

We did not find strong patterns in the data, so we simply present it as an appendix for review by the reader and as a basis for future research.

Technology development phases

Appendix C – Technology Development Phases by Sector provides a summary of the TD phases described by each TDA during interviews. It is noteworthy that the TDs interviewed required little or no prompting to identify phases ("stages") in their own companies. Typical interactions took the form of the interviewer stating "Please walk me through the stages of what your organization does with a new idea *[this sentence is from the interview guide script]*. Many organizations recognize distinct technology development stages from the research lab to the marketplace deployment *[this sentence added to prompt the interviewee when necessary]*."

In addition, Appendix C also highlights TD phases that each TDA has identified as core strength of her/his organization. The sub-section following this one addresses TDA strengths.

Table 3 below, derived from Appendix C, summarizes which phases the TDAs identified most frequently in conceptualizing TD.

Table 3: Technology Development Phases Identified across TDAs

Phase	Number of TDAs Identifying This Phase
a) Research & Development	4
b) Product Development	7
c) Assessment & Demonstration	13
d) Commercialization	13
e) Adoption	0
f) Standards	18[11]
Ideation	10
Technology Screening	4

Two interviewees used Pilot as a synonym for Assessment & Demonstration and one used Invention as a synonym for Research & Development.

Even taking this into account, only four out of nineteen TDAs clearly identified Research & Development as a TD phase. In three other cases, interviewees used the word "research" in a different sense, meaning market research or opportunity scanning.

More striking, only two out of the five R&D TDAs interviewed clearly identified Research & Development as a TD phase.

[11] Note that only three TDAs listed Standards as a phase during the initial part of the interview, but that when asked indirectly about codes and standards activities, 18 out of 20 TDA described significant codes and standards work activities that they are involved in.

Ten of the TDA interviewees identified a new phase. This additional phase is Ideation (or equivalently, Idea Scoping, Idea Generation, Roadmapping, or Concept Research).

TDAs that recognized both Ideation and Research & Development as TD phases, placed Ideation upstream of Research & Development. Another five TDAs identified Technology Screening as an early phase, also generally upstream of Research & Development. These additional TD phases are included at the bottom of Table 3 with the numbers of TDAs that identified them.

The Implications and Opportunities section of this report includes discussion of the significance of these findings as well as those in the following sub-sections of this chapter.

TDA core strengths

Table 4 below, derived from Appendix C, summarizes which TD phases the TDAs identified most frequently as core strengths for their organizations.

Table 4: Technology Development Phase Core Strengths as Reported by TDAs

Phase	Number of TDAs Listing This as a Strength
a) Research & Development	2
b) Product Development	6
c) Assessment & Demonstration	10
d) Commercialization	8
Ideation	4
Technology Screening	3

Assessment & Demonstration stands out as a core strength identified by more than half of the nineteen TDAs for their organizations. Commercialization and Product Development also appear as core strengths for a significant number of TDA organizations.

Four of the ten TDAs that specified an Ideation phase also listed it as a core strength for their organizations. Three of the four TDAs that specified a Technology Screening phase also listed it as a core strength.

Only two of the nineteen TDAs identified Research & Development as a core strength, and only one of the five Research & Development TDAs identified it as a core strength for their organization.

TDA working relationships

Table 5 on pages 18 -19 illustrates the TDAs' working relationships, as reported by TDAs in each sector. This table shows the primary and secondary partners and peers for each sector.

For the purpose of this study we defined "primary partner" as an organization that is highly-valued and necessary TD project collaborator. A "secondary partner" is an organization that is valued and that is somewhat necessary for TD project support.

We defined "peer" as an organization that has significant skills and competencies in one or more TD phases, but that is not identified as valued or as engaging in collaborative activities with the TDA.

Table 5: TDA Working Relationships

Technology Sector & TDA	Primary Partners	Secondary Partners	Peers
Utilities			
Utility 1	utilities, other EE orgs	utilities, other EE orgs	[none identified]
Utility 2	utilities, other EE orgs, industry, R&D	[none identified]	[none identified]
Academia			
Academic Institution 1	R&D, academia, 3rd party implementers, industry, end users	utilities, academia	[none identified]
Academic Institution 2	R&D, academia	academia	[none identified]
Private Industry			
Industry 1	[none identified]	R&D, academia	industry competitors, academia
Industry 2	industry partners	R&D, industry partners	industry competitors
Government			
Government Agency 1	end users, R&D, industry, utilities, other EE orgs, government	[none identified]	R&D
Government Agency 2	end users, industry, utilities, other EE orgs	[none identified]	[none identified]
Government Agency 3	R&D, utilities, other EE orgs, government	[none identified]	[none identified]

Table 5: TDA Working Relationships (cont'd.)

Technology Sector & TDA	Primary Partners	Secondary Partners	Peers
3rd Party Implementers			
Implementer 1	utilities, industry	R&D, academia	[none identified]
Implementer 2	utilities, R&D, 3rd party implementers, industry		[none identified]
Other EE Organizations			
Organization 1	other EE orgs, utilities, industry, R&D		[none identified]
Organization 2	utilities, 3rd party implementers, other EE orgs, R&D	government	[none identified]
Organization 3	industry, government	Industry, government	[none identified]
R&D Institutions			
R&D Institution 1	R&D, academia, utilities, other EE orgs	industry	[none identified]
R&D Institution 2	R&D, other EE orgs	industry, government	[none identified]
R&D Institution 3	R&D, utilities, industry, government		other EE orgs
R&D Institution 4	[no information provided]	[no information provided]	[no information provided]
R&D Institution 5	utilities, industry	R&D, academia, government	other EE orgs

The sectors in which the majority of TDAs identified TD partners include R&D, Private Industry, and Utilities.

- 14 TDAs across all seven sectors cited R&D Institutions as a partner, and in most cases, as a primary partner. R&D Institution TDAs identified partners in all other sectors, except for 3rd Party Implementers.

- 13 TDAs in all seven sectors named Private industry as a TD partner. However, Private Industry TDAs only identified partners in two of the six other sectors, and both of these, R&D and Academia, as secondary partners only.

- 12 TDAs across nearly all sectors identified Utilities as primary partners, with one notable exception. Neither of the two Private Industry TDAs identified Utilities as partners or peers. This finding contrasts with Private Industry TDA responses to other interview questions about Utility involvement in their initiatives. Their responses to other interview questions described some involvement with Utilities and some interest in expanding Private Industry connections with Utilities.

Three of the interviewees identified partners and peers in sectors not initially identified as part of the TDA landscape. Two cited **End Users** as partners, and one identified **Competitors** as part of their peer network.

Roles of energy utilities in TD projects and initiatives

Table 6, derived from **Appendix D – Utility Involvement Benefits and Gaps**, summarizes the number of TDAs reporting various types of benefits from involving utilities in their TD projects. As noted previously, the majority of interviewees are based outside of California, so these findings refer to utilities in general, not just to California IOUs. However, the findings for TDAs based in California and for those located outside of California were similar[12].

Table 6: Primary Benefits of Utility Involvement

Benefits of Utility Involvement	# Citations
end-use customer connections (access to early adopters)	7
Utility funding [of TD initiatives] (cost sharing)	6
marketing (drive the market, influence the market)	5*
channel for rebates (incentives)	4
technical expertise (technical involvement)	4**
experience w/technology introduction (understanding of what works)	3**
opportunities to collaborate (collaborative network)	3
identify needs and gaps in the marketplace; market transformation	1 each

[12] 10 of the TDAs interviewed are based outside of California, 9 are based inside California.

* One interviewee identified "Utilities are a good way into market" as a benefit. This benefit was recorded as equivalent to "marketing." This does not alter the study findings or implications.

** One interviewee identified "insights into new technologies" as a benefit. This benefit was recorded as both "technical expertise" and "experience with technology introduction." This does not alter the study findings, implications.

One third to one quarter of the TDAs identified the top three benefits – customer connections, TD project funding, and marketing support - as important to them and their organizations.

Two of the benefits cited, TD project funding and rebates, have purely financial implications. The others relate to types of expertise that utilities bring to TDA projects, such as marketing capabilities. One TDA stated "If [Utilities] can drive the market, we will build it."

Opportunities for increased coordination with energy utilities

Table 7 below, derived from Appendix D, summarizes the number of TDAs reporting various types of assistance they would like to receive in their TD projects from energy Utilities[13]. These findings point to gaps and opportunities for enhanced Utility roles in interviewees' TD projects.

Table 7: Primary Gaps in Utility Involvement

Gaps in Utility Involvement	# Citations
two-way information exchange (information sharing)	4
collaboration [with other TDAs]	3
funding	2
focus on (integrated) systems	2
better ET to EE program connections (bridge building)	2
road mapping (to coordinate TD initiatives)	2

These findings reflect less uniformity and more spread in the TDA responses as compared with Primary Benefits of Utility Involvement tabulated in the previous sub-section. The two gaps most frequently cited, information sharing and collaboration, are loosely connected, and can be collectively viewed as an area of consensus for about a third of the interviewees.

[13] The majority of TDA interviewee responses referred to utilities in general; only two (one Utility and one R&D Institution) specifically mentioned California IOUs and the ETP.

Otherwise, the responses are relatively evenly spread across the range of topics and do not suggest a significant consensus. It bears repeating that the majority of interviewees are based outside of California, so these findings refer to Utilities in general, not just to California IOUs.

The interview responses from which this data was compiled included the following comments:

- "Not clear how Utilities think and how regulators work."
- "We could cooperate (via NDA that prohibits sharing with other manufacturers), or a third party could look at technologies/ideas, and then bring themes[14] back to Utilities."
- "[Our program] to ET relationship seems stronger than the [California utilities'] ET to EE connection, but progress is being made."

Technology Development Phase Links and Gaps

Figure 1 on page 24 combines findings regarding TD phases and core strengths for each sector in a sequential view to reveal connections and gaps between phases. It also offers a starting point for assessment of where beneficial inter-sector connections could be created or reinforced. Note that "strongly linked phases" means that the interviewee described internal processes, usually between two core strengths, that tied the phases together. "Weakly linked phases" means that the interviewee did not identify internal processes linking the phases, or otherwise signaled that there was not a strong connection.

Following are some observations about the findings displayed in this diagram:

- As stated previously, most of the interviewees identified Assessment & Demonstration and Commercialization phases as core strengths, and for many interviewees, these are strongly linked. However, the two Private Industry TDAs interviewed did not cite Assessment & Demonstration as a core strength.
- Most of the TDAs interviewed described the phases for their institution as sequential, regardless of whether a phase was a core strength for that TDA or not, with the exception noted below for the five R&D Institutions.
- For the two Utilities, Ideation is weakly linked to Technology Screening and then to Assessment & Demonstration. For both Private Industry interviewees, Ideation is strongly linked to Product Development and then to Commercialization.
- The five R&D Institutions stated that they participate in activities in phases from Ideation to Assessment & Demonstration, but not necessarily in sequence and not necessarily making phase-to-phase connections.
- The three Government Agencies and two Private Industry interviewees show the greatest number of strongly linked phases. This strongly linked downstream progression terminates

[14] The interviewee appeared to use the term "themes" in the sense of "generic versions of proprietary concepts."

for Government at the Assessment & Demonstration phase, and for Private Industry at the Commercialization phase.

Figure 1: Technology Development Phase Links and Gaps by Sector

Technology Actor	Ideation	Technology Screening	Research & Development	Product Development	Assessment & Demonstration	Commercialization	Standards
Utilities (ET staff only)							
Academia							
Private Industry							
Government							
3rd Party							
Other EE Organizations							
R&D Institutions							

Implications and Opportunities

This section presents implications and opportunities based on review and analysis of the study findings. As mentioned in the previous section, due to the small sample size, study findings cannot be generalized within any sector or applied to the TDA population as a whole with confidence. Thus, the implications discussed in this section would require further investigation and verification with a larger TDA population to achieve statistically significant results.

Perspectives on Technology Development

One objective of this study was to determine TDAs' views of the TD process. Study findings show wide variations among TDAs' views, particularly among the TD phases described by the interviewees. The phases varied widely between interviewees and we did not have a large enough sample size to make conclusions about variance within each sector.

For instance, as shown in Table 3 and Figure 1 in the previous section, about half of the TDAs interviewed view the TD process as beginning with Ideation. However, what is meant by Ideation varies among TDAs. For the two Utilities, the two 3rd Party Implementers, and the three Other EE Organizations, Ideation is the starting point for identifying potential new programs and measures. For the two Private Industry interviewees and remaining other interviewees, Ideation is the starting point for generating potential new products and services.

From these disparate starting points, technology development tends to follow two different paths. For the two Private Industry interviewees and their partners, Ideation leads to Product Development and then to Commercialization. For the two Utilities and their partners, Ideation leads to Tech Screening, Assessment and Demonstration, and then Commercialization.

If these are representative of the larger population, reconciling these two paths to Commercialization presents a significant challenge for Utility ET initiatives and for organizations that partner with Utility ET programs or support ET activities.

Range of TDAs Studied

This study used an informal consensus-based process involving statewide ETP staff plus CPUC staff and consultants to select the seven sectors from which TDAs were recruited for interviews. These sectors were intended to include relevant TDAs who were all active in the energy efficiency and IDSM TD domain.

Nearly all TDAs responded to interview questions about partners, peers, and additional organizations for future study by citing entities and individuals within the seven selected sectors. In two cases, interviewees identified partners and peers outside of the seven sectors. Both of these interviewees cited **End Users** as partners. Based on this finding, end users may either be regarded as a new TD sector to investigate, or they can be disregarded because end-users arguably do not engage in structured TD activities. If end users are disregarded, these findings confirm that this study addressed all relevant TD sectors

Landscape to Ecosystem

The original scope of this study called for research to "assess and characterize the landscape of market actors in the emerging IDSM technology fields." During the interview, analysis and interpretation stages of the study, it became clear that the word "landscape" did not adequately distinguish the variety and complexity TDA activities and interactions.

In particular, interviewee responses to questions about Utility involvement in TD projects (see Appendix D) identify a range of significant factors such as business and personal relationships and flows of information, funding, and IP. Although the study did not set out to investigate these factors, TDA references to them imply the existence of a network of interactions among TDAs, and between them and their business environment – in other words, a commercial "ecosystem." The word ecosystem better reflects the relational nature of TDA interactions as compared to "landscape," which implies distinct, visible features.

Figure 1 in the previous section provides a basic visualization of the TDAs, their self-reported strengths and connections between TD phases, and the nature of the phase-to-phase links within each sector. By inspecting Figure 1, readers can recognize possible gaps and potential opportunities for future IDSM integrations and synergistic opportunities. Further research with larger sample sizes would be required to verify these initial findings.

The next subsection provides an example of how approaching TDAs and their organizations as an ecosystem, exploring relationships and networks as well as external features, can provide useful explanatory power. A question underlying this study was to what degree TDAs collaborate or operate in relative isolation. Study findings on this topic for the Private Industry sector have potentially significant implications for the ETP and its partners.

Role of Private Industry TDAs

As discussed in the Findings section, the TDAs interviews revealed an asymmetric set of relationships between Private Industry representatives in this study and the other sectors. One Private Industry TDA and 12 TDAs from across the other sectors named Private industry as a TD partner. However, the two Private Industry TDAs only identified organizations in two of the six other sectors as partners, and both of these, R&D and Academia, as a secondary partner only. And interviewees from all other sectors except Academia rate Private Industry as a primary partner, but there is no reciprocal connection.

This finding suggests that some Private Industry companies pursue their TD activities semi-autonomously, in relative isolation. This disengagement can have a negative impact on the pace and success of technology commercialization success. One Private Industry TDA stated in response to an interview question about their engagement with external partners "Not really, we don't trust anyone." This comment is consistent with the decisions by two other Private Industry TDAs to opt out of participating in this study.

An underlying assumption for the 2010 addition of five new program elements to the ETP was that Utilities and TDAs in all sectors can achieve greater success in moving technologies from the laboratory to the marketplace by working with upstream technology developers and manufacturers. Thus, it is significant that neither of the two Private Industry TDAs

participating in this study identified Utilities as partners or peers, although the majority of TDAs, across all other sectors, identified Utilities as primary partners.

This asymmetrical finding is partly offset by the two Private Industry TDA's responses to other interview questions about Utility involvement in their initiatives (see Appendix D). Some Private Industry responses mention collaboration with Utilities and interest in expanding Private Industry connections with Utilities. But the companies of the two Private Industry TDAs that participated in this study have a solid track record of moving technologies to market, even in the absence of reported robust interactions with other sectors.

The overall takeaway for this subsection may be that Private Industry, which depends on technology commercialization to assure its long-term viability, has a significant opportunity for more comprehensive and effective engagement in TD partnerships and particularly in ET and related initiatives which share a strong interest in in strengthening and accelerating TD. If this preliminary finding is borne out by future research, Utilities and their partners stand to amplify their own productivity and influence in successfully commercializing EE and IDSM technologies by pursuing enhanced, more symmetric relationships with Private Industry

Creating New Pathways

The preliminary findings of this study suggest that initiatives to strengthen TD connections and fill ecosystem gaps (see Figure 2) may provide benefits for all TD stakeholders. The five ETP subprogram elements introduced in 2010 were intended to formalize these initiatives.

Although some 2010 ETP enhancements are gaining traction, our preliminary findings indicate that the challenge of building new pathways to influence TDAs and the TDA ecosystem effectively may be a significant one. If these findings can be generalized, we expect that creating new, influential pathways will require specific, focused efforts with ongoing commitments of time and resources, plus strategic targeting.

If further research supports the need for these pathways within TDAs that operate in California, then by contributing to the creation of these pathways, the ETP stands to improve the effectiveness of interactions among TDAs and to contribute to objectives such as meeting California Energy Efficiency Strategic Plan goals for the ETP. One approach is for the ETP to provide opportunities for TD partners to engage in activities that strengthen connections and fill ecosystem gaps. Figure 2 on the next page illustrates three opportunities for creating new pathways and for gap filling within the ecosystem defined by the sample in our study. If these opportunities can be generalized to California, then these opportunities have the potential to increase ETP impact as well as that of other Utility initiatives.

The blue circles in Figure 2 highlight that the Utility TDAs interviewed classified Ideation as a core strength, and that TDAs in Academia, 3rd Party Implementers, and Other EE Organizations did not.

This suggests an opportunity for Utilities to contribute to the success of TDAs in these sectors by offering them access to Utilities' Ideation capabilities. This new pathway, represented by blue lines and arrows, could be mutually beneficial, since the outputs from these sectors further the Utilities' TD objectives. Moreover, non-Utility TDAs that lack core strength in

Ideation may be willing to better align their objectives with those of Utilities in recognition of this contribution, thus reinforcing existing pathways or creating new ones.

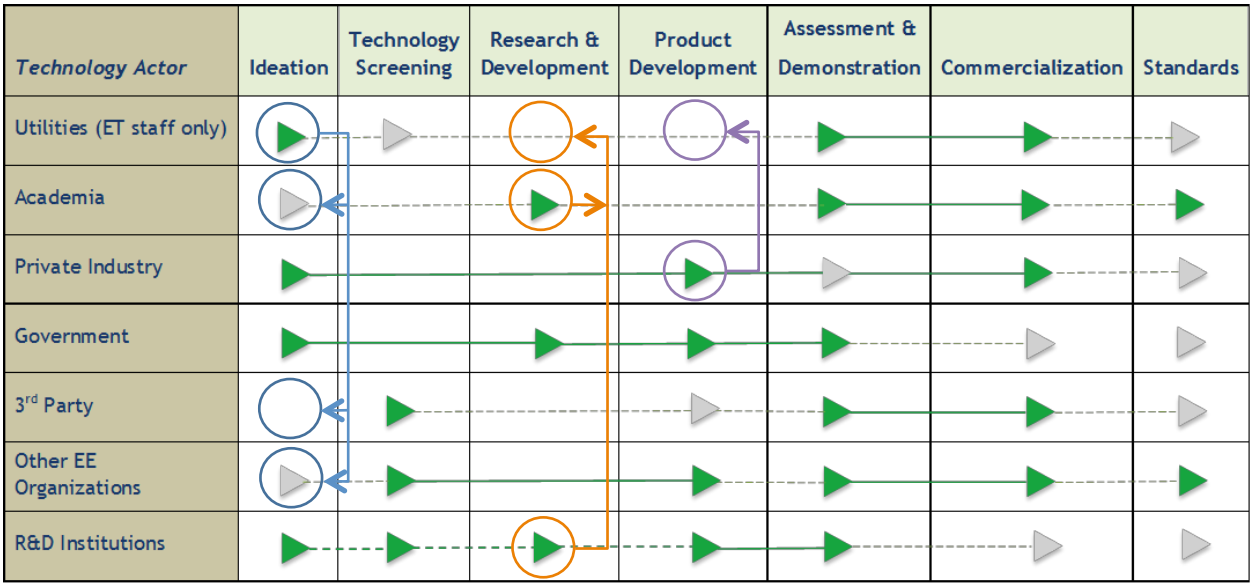
The orange circles in Figure 2 highlight that the Utility TDAs interviewed did not identify R&D as a core strength, while TDAs in Academia and R&D Institutions did.

This suggests an opportunity for Academia and R&D Institution TDAs to contribute to the success of Utility TDAs by offering them access to their capabilities and outputs. This new pathway, represented by orange lines and arrows, could be mutually beneficial, since both Academia and R&D Institutions typically look to Utilities for financial contributions as well as validation of their R&D objectives and products.

The violet circles in Figure 2 highlight that the two Private Industry TDAs interviewed classified product development as a core strength but the two Utility TDAs we interviewed did not. If Utilities seek to increase their impact on product development, then to increase engagement and build a more symmetric relationship with Private Industry, these Utility TDAs could create partnerships offering market and behavioral studies and other assistance to Private Industry in its Product Development activities.

If this kind of assistance is desired from Utilities, Private Industry TDAs may be willing to adjust their Product Development activities to better align them with Utility needs and goals for new EE and IDSM technology solutions. This new pathway is represented by the violet line and arrow in Figure 2.

Figure 2: Creating New Pathways to Fill TD Gaps



Role of the ETP

In the previous sub-section, we identified some possible opportunities for the ETP to build new pathways among TDAs and TD organizations with the goal of accelerating emerging technologies into utility EE and IDSM programs. The ETP has engaged in this type of activity since its inception, but the recent CPUC guidance decision on 2013-2014 programs was the first formal recognition of this function for the ETP'.

Increasing its involvement in building new pathways in the TDA ecosystem can potentially shift the scope and role of the ETP. The preliminary findings of this study shed some light on factors that reinforce this enhanced ETP role as well as others that potentially hinder it.

On the positive side, the ETP has qualifications making it well-suited to build pathways and otherwise enhance the efficacy of the TD ecosystem. These include a culture that promotes objective and agnostic perspectives on products and technologies, clear regulatory mandates to accelerate program and market entry for qualified new technologies, and access to program funding[15] for assessments and the other ETP elements as a means to accelerate this process.

However, Utilities face some disadvantages relative to other TD organizations. For instance, R&D Institutions can operate with long time horizons, Private Industry generally has unfettered access to confidential information on technology performance, and Other EE Organizations may be subject to less regulation and accountability.

This does not diminish the suitability of the ETP for monitoring and coordinating TD activities with other sectors and TDAs. It simply means that the ETP must sometimes operate under constraints that do not apply to its TD partners.

Although the sample size in this study was small, Table 6 in the Findings section lists some possible benefits that Utilities can offer to its TD partners, and Table 7 lists some unrealized benefits that Utilities may be able to deliver in the future. Collectively, these may offer a powerful set of incentives to pathway creation and enhancement of the TD ecosystem. Utilities could undertake a campaign in partnership with suitable TDAs in other sectors to promote increased awareness and commitment to Utility-specific energy efficiency objectives. If California's ETP agrees that it is in a position to assist in delivering benefits and filling gaps that it can also address, it can play a valuable role in driving the creation of new pathways using strategies such as those identified in the previous sub-section.

[15] Although all TDA organizations we interviewed have access to funding, the two utilities, the three government agencies and (to some extent) the two private industry representatives we interviewed are the only TDA organizations that operate primarily as funders. The other TDAs on our study, including the five research institutions and two 3rd party implementers, rely on external funders for their financial viability. This asymmetry, if it can be generalized, does not present an insurmountable obstacle, but deserves consideration when developing pathways and other means to overcome gaps in the TD ecosystem.

This discussion raises the question to what extent have Utility programs, including the California Statewide ETP, already altered the TD ecosystem over the last decade? The present study did not collect ETP-specific data on this topic. A corollary question is whether the TD ecosystem would sustain itself if Utility benefits in Table 6 were halted. In other words, have Utilities become indispensable in the TD ecosystem, or would the ecosystem reconfigure itself and revert to another structure without Utility involvement?

Conclusion

This study obtained information from interviews with 19 leading EE and DSM TDAs across North America and applied it to examine TD phases and to provide insights into the TDA ecosystem as it exists today.

Despite some missing pathways, weak connections, and gaps, the TDAs interviewed characterized the TD ecosystem for EE and IDSM technologies as exhibiting considerable strength and interdependence. Most TDAs interviewed indicated that their success was at least partially dependent on strong partnerships.

Although the findings cannot be generalized due to the small sample size, there may be significant opportunities to create new and better pathways among TDAs and their organizations to enable the movement of concepts and technologies from the lab to the marketplace. In particular, further investigation of partnerships with Private Industry TDAs should be undertaken, to either reinforce the findings of this study or to clarify the significance of what the Private Industry TDAs reported.

The ETP has the opportunity to construct or contribute to pathways by leveraging its resources and those of other EE programs. We expect that as the ETP and the other TDAs forge stronger connections, enhanced mutual understanding and a more efficient and robust set of TD processes will emerge to benefit California ratepayers and other stakeholders across North America.

Topics for Future Research

Based on the findings, implications and opportunities from this study, the following areas appear to warrant further investigation:

- TDAs and TD phases within utility EE and DSM organizations
- TDAs and TD phases in private industry
- Comparison of utility and private industry TDAs and TD ecosystems, including interactions between the two sectors
- TDA organizational goals and how these impact alignment with and the efficacy of collaboration with other sectors and other TDAs

Appendix A – Who was interviewed?

Who was interviewed?

Senior Director, Energy Efficiency Consulting Company (March 28, 2012)

Director, Emerging Technologies, Regional Energy Efficiency Agency (March 28, 2012)

Program Manager, Government Agency (April 2, 2012)

Associate Director, Technical Research, Energy Efficiency Consulting Company (April 2, 2012)

CEO and President, Private Industry (April 3, 2012)

Manager, Engineering Services, Utility (April 6, 2012)

Manager, Commercial Building Energy Alliances, U.S. DOE EERE (April 9, 2012)

Leader, Windows and Materials Group, National Laboratory (April 11, 2012)

Director, End-Use Application and Innovation, Statewide Energy Efficiency Agency (April 11, 2012)

Director, Energy Efficiency, Non-profit Energy Research Agency (April 11, 2012)

Research Contract Manager, Government Agency (April 13, 2012)

Manager, Technology & Innovation, Utility (April 13, 2012)

Executive Director, Academic Research Lab (April 16, 2012)

Principal Engineer, Applied Research, Private Industry (April 16, 2012)

Senior Analyst Power Planning Division, Regional Energy Agency (April 27, 2012)

Chief Innovation Officer, Academic Institution (April 24, 2012)

Deputy, Energy Research Center (April 30, 2012)

Senior Director of Customer Applications, Non-profit Energy Research Agency (May 10, 2012)

Executive Director, Non-profit Energy Standards Agency (May 10, 2012)

Appendix B - Interview Format and Questions

Interview Guide

A. Introduction

- Interviewer will introduce himself, remind the interviewee of the SCE study manager's email invitation, and confirm that the interviewee has 45 minutes to 1 hour available as scheduled.
- If the interviewee wants to verify the purpose of the interview, Jonathan will refer him/her to the Southern California Edison manager for this study and will ask if the interviewee would like to be contacted by the study manager via phone or email.
- Otherwise, Interviewer will thank the interviewee in advance for participating, and will state that:

  Because the energy technology development field is fairly small, it may not be practical to treat your responses as confidential. Because of that, the survey is designed to avoid sensitive topics. I will be taking notes, and I ask that you not to share any confidential or proprietary information during this interview.

  Do you have any questions before we start?

B. Role & Strengths

To start, I have some questions about your organization and your role in the organization.

1a. What does your organization do?

1b. What is your role?

[These responses should confirm which specific Technology Actor (TA) sector/s the interviewee organization belongs to.]

For this interview, I'd like to focus specifically on a few types of energy technologies: energy efficiency technologies, demand response technologies, and self-generation technologies such as solar or wind.

2. Which of the following types of energy technologies is your organization involved in?

   a. EE _____

   b. DR _____

   c. Self-Gen _____

   d. Other _____

If more than one, go to Question 3; otherwise skip ahead to Question 4.

3. Is your organization is involved in Zero Net Energy projects?
4. How long has your organization been working in the field of energy technologies?

Next, I have some questions about your organization's role in energy technology development.

5a. Please walk me through the stages of what your organization does with a new idea.

i. _____

ii. _____

iii. _____

iv. _____

v. _____

vi. _____

If the interviewee's response addresses stages of technology development, skip ahead to Question 6a. Otherwise, provide the following clarifying information and Questions 5b and 5c.

A typical linear model of technology development starts with coming up with an idea, concept testing (or research), prototyping, manufacturing, and commercializing the final product.[16]

5b. Which of these stages your organization is involved in?

i. Research & Development

ii. Product Development

iii. Assessment & Demonstration

iv. Commercialization

v. _____

5c. Is there another stage your organization is involved in that I didn't mention?

[16] Adapted from Myers & Marquis, 1969, "Successful Industrial Innovation."

6a. Some organizations contribute to or are involved with developing or determining or implementing new codes or standards for energy technologies. Is this the case with your organization?

If No, skip ahead to Question 7a.

6b. How is your organization involved in energy technology codes or standards?

7a. Would you say your organization is particularly well known by your peers for having a core competency or strength in some of these stages?

If No, skip ahead to Section D.

7b. Which stages would you say represent your company's top strengths? [*In other words, would you agree with your peers' views on this?*]

i. Stage of greatest strength (Stage A) _____

ii. Stage of next greatest strength (Stage B) _____

iii. Stage of third greatest strength (Stage C) _____

iv. Additional stage _____

v. Additional stage _____

Confirm that the stages are listed in order of descending strength. If more than 3 stages are mentioned, record all, but only ask questions about the top three.

8. Why would you say each stage is a top strength for your company?

i. Stage A _____

ii. Stage B _____

iii. Stage C _____

C. Process & Standards

1. When you are considering which new energy technologies to work on, what criteria do you base your decision on?

2a. Do you try to achieve a particular balance of technologies? *(E.g., by end use, or market sector, or project duration)*

If No, skip ahead to Question 3.

2b. Please describe your organization's approach to achieving this balance.

3. How does your organization allocate funding for energy technology development projects? *(E.g., allocate budget to carry a project all the way*

through to technology commercialization, use a stage-gate process to determine incremental funding, apply another method)

4a. For each stage of technology development that your organization is involved in, what metrics do you use to determine whether a technology development project is successful at that stage?

a. Stage _____ Metric _____

b. Stage _____ Metric _____

c. Stage _____ Metric _____

d. Stage _____ Metric _____

e. Stage _____ Metric _____

f. Stage _____ Metric _____

4b. For technologies that reach commercialization stage, what metrics do you use to measure success? *(Do not press if they are not comfortable with answering.)*

5. How do you determine whether your organization should discontinue a technology project?

D. Connections & Coordination

1. Going back to the stages you identified as top strengths, which organizations would you say are your organization's peers for each of the stage?

i. Peers for Stage A _____

ii. Peers for Stage B _____

iii. Peers for Stage C _____

Next, I'm going to ask you some questions specifically about your organization's work in the _____ stage (*starting with stage closest to ETP*).

2a. When your organization is working in the _____ stage, do you partner with any of the peers that you identified for this stage?

If Yes, skip ahead to Question 2d.

2b. In this stage, do you work with any other people outside of your organization?

2c. Who are they?

2d. What organization are they with?

2e. What role does these outside partners play in your energy technology development projects?

2f. What specifically do they typically contribute to your projects?

2g. Please rate how necessary these outside partners are to your projects, on a scale of 1 to 10 with 1 being "never necessary" and 10 being "always necessary."

2h. Would you consider these outside partners to be in-depth project collaborators, or would you consider them to just provide incidental project support?

Next, I'm going to ask you some questions specifically about your organization's work in the _____ stage (*highest-rated stage not yet covered*).

3a. When your organization is working in the _____ stage, do you partner with any of the peers that you identified for this stage?

If Yes, skip ahead to Question 3d.

3b. In this stage, do you work with any other people outside of your organization?

3c. Who are they?

3d. What organization are they with?

3e. What role does these outside partners play in your energy technology development projects?

3f. What specifically do they typically contribute to your projects?

3g. Please rate how necessary these outside partners are to your projects, on a scale of 1 to 10 with 1 being "never necessary" and 10 being "always necessary."

3h. Would you consider these outside partners to be in-depth project collaborators, or would you consider them to just provide incidental project support?

And now, I'm going to wrap up this section with some questions specifically about your organization's work in the _____ stage (*next highest-rated stage not yet covered*).

4a. When your organization is working in the _____ stage (Stage C), do you partner with any of the peers that you identified for this stage?

If Yes, skip ahead to Question 4d.

4b. In this stage, do you work with any other people outside of your organization?

4c. Who are they?

4d. What organization are they with?

4e. What role does these outside partners play in your energy technology development projects?

4f. What specifically do they typically contribute to your projects?

4g. Please rate how necessary these outside partners are to your projects, on a scale of 1 to 10 with 1 being "never necessary" and 10 being "always necessary."

4h. Would you consider these outside partners to be in-depth project collaborators, or would you consider them to just provide incidental project support?

5a. Are there any technology development stages where your organization often needs outside assistance? This could be a stage in which your organization already has a core competency, but would still like some more assistance.

If No, skip ahead to Question 6a.

5b. What type(s) of assistance do you need at this stage?

6a. Have you involved any energy utilities in your energy technology development projects?

If No, skip ahead to Question 7.

6b. What have been the greatest benefits of involving them in your projects?

6c. In what areas could they provide more assistance for your projects?

7. Are there any other technology development organizations that you recommend we speak to about the topics we covered in this interview?

E. Wrap up and next steps

That completes the interview. Thank you so much for your time and insights.

1. Do you have any questions before we wrap up?
2. If clarifying questions about what we discussed today come up as we compile our findings, may I contact you again?

Appendix C – Technology Development Phases by Sector

Technology Development Phases by Sector – Key Strengths Shown in Green

Utility ETP 1	Utility ETP 2
i. ***Roadmapping / identifying gaps***	i. ***Early stage***
ii. ***Scanning***	ii. ***Beta stage – ready for demonstration***
iii. ***Screening***	iii. ***Commercially available***
iv. ***Assessment***	
v. ***Handoff to programs***	
vi. ***Program implementation*** / *resource acquisition*	

Academic Institution 1	Academic Institution 2
i. ***Concept and market research***	i. ***Research*** / ***ideas***
ii. ***Prototype testing*** *(lab)*	ii. ***Proof of concept/data generation***
iii. ***Field demonstrations***	iii. ***Valley of death***
iv. ***Commercialization*** / ***codes and standards***	iv. ***Startup company creation***
	v. ***Large company licensing***

Private Industry 1	Private Industry 2
i. ***Ideation*** – *hunches and forward thinking*	i. ***Idea*** – *new, unusual and different*
ii. ***Project proposals*** – *to be funded*	ii. ***Quick engineering assessment / business case***
iii. ***Research*** – *on human factors, field applications*	iii. ***Pre-development plan / prototype*** – *analysis and prototype testing*
iv. ***Bring to market*** *in volume production*	iv. ***Product development*** – *to first generation commercial product*
v. ***Demonstration*** *with key specifiers – to prove performance*	
vi. ***Education programs***	
vii. ***Sales channels / utility programs***	

Technology Development Phases by Sector – Key Strengths Shown in Green

Government Agency 1	Government Agency 2
i. ***Basic Fundamental Science***	i. ***Ideation***
ii. ***Applied Research*** *– review basic fundamental science for solutions*	ii. ***Early development***
iii. ***Product Development*** *– for consumers*	iii. ***Demonstration***
iv. ***Market Deployment*** *– objective performance information provided to interested parties*	iv. ***Mass market activities***
	v. ***Market evaluation/ field impact evaluation***
	vi. ***Standards***

Government Agency 3
i. ***Commercialization***

3rd Party Implementer 1	3rd Party Implementer 2
i. ***Identification of technologies*** *that bring about savings*	i. ***Early product development***
ii. ***Research / opportunity understanding***	ii. ***Proof of concept***
iii. ***Incorporate into existing program***	iii. ***Entering the marketplace***
iv. ***Move into existing program or create 3P program***	iv. ***Viable early adoption***
	v. ***Fully commercial***

Technology Development Phases by Sector – Key Strengths Shown in Green

Other EE Organization 1	Other EE Organization 2
i. ***Screening*** *for new EE opportunities* ii. ***Initiative start*** *– energy savings and barriers, basic cost-effectiveness* iii. ***Product development / marketing*** a) ***Concept development*** *– secondary market research, limited lab testing* b) ***Product validation / assessment*** *– limited field deployment / demo* c) ***Market validation*** *– addresses market barriers with a market test* iv. ***Full scale implementation*** v. ***Long term monitoring / tracking***	i. ***Idea stage*** ii., iii. _____ iv. ***Pilot / Demonstration / Testing*** v. ***Near commercial*** vi. ***Commercial products***

Other EE Organization 3
i. ***Developing specification*** ii. ***Publication/completion of specification*** iii. ***Test tool development/test plan and procedure development*** iv. ***Implementation of testing and certification program*** v. ***Industry education and outreach***

Technology Development Phases by Sector – Key Strengths Shown in Green

R&D Institution 1	R&D Institution 2
i. ***Basic development/invention***	i. ***Ideation***
ii. ***Evaluation / characterization*** *of existing technologies*	ii. ***Technology / business case development***
iii. ***Joint development***	iii. ***Bench-top to demonstration / business modeling***
iv. ***Demonstration projects***	iv. ***Market entry / business plan execution***

R&D Institution 3	R&D Institution 4
i. ***Idea scoping*** *(for technology development by others)*	i. ***Technology Scouting***
ii. ***Proof of concept***	ii. ***Testing / Assessment*** *- secondary research, lab testing*
iii. ***Pilot (limited to 3-5 facilities)***	iii. ***Demonstration*** *- field performance data collection*
iv. ***Large pilot / hand over to industry***	iv. ***Deployment*** *-large numbers of units without instrumentation, also looking at barriers*
v. ***Market transformation***	v. ***Program / Market*** *- transfer to utility programs, market actors*

R&D Institution 5
i. ***Idea generation***
ii. ***Technology/market evaluation***
iii. ***Research initiation***
iv. ***Technology development***
v. ***Product development***
vi. ***Demonstration and deployment***
vii. ***Commercial introduction***
viii. ***Implementation***

Appendix D - Utility Involvement Benefits and Gaps

What have been the greatest benefits of involving energy utilities in your projects?

(Utility 1) *Knowledge sharing, cost sharing, increased speed to program delivery, resource acquisition.*

(Utility 2) *Leverage – they may contribute additional funds. Outside perspective/context for the project. Collaborative network has intrinsic if intangible value.*

(Academic Institution 1) *Source of funding. Delivery/distribution channel for EE rebates. Sourcing/participation from end user customers*

(Academic Institution 2) *I don't know.*

(Private Industry 1) *Accelerated demonstration / validation / learning curve to address end-users' unmet needs early on, before product is fully developed. Fast feedback from real clients.*

(Private Industry 2) *If they can drive the market, we will build it.*

Need to know their thinking about the grid, plans for rate schedules. Our equipment can capitalize on these.

(Government Agency 1) *… their experience with new technology introduction and performance expectations... It's good to tap into this experience. They are also key to getting new technologies to retailers via bill stuffer marketing, rebates.*

(Government Agency 2) *General feedback on things that utilities have tried that didn't work. Also, they have provided excellent technical feedback for specification definitions. For instance, California utility feedback on the parking lot lighting specification to meet CPUC requirements made [program name redacted] products more useful for utilities nationwide to reference in their programs and plans.*

[Our program] has benefited from interactions with ET and DR implementers and national level utility coordinating organizations such as CEE.

(Government Agency 3) *Lucky to have utilities with technical expertise. Good technical and management capabilities.*

Valuable role: partnerships on projects. [as] prime contractor and …technical involvement with outside researchers.

(3rd Party Implementer 1) *If a concept is not yet quantified, we will bring it to utilities for their perspective / input on whether the opportunity is positive. We seek funding to quantify the opportunity.*

Obtaining funding; getting input on our work in a given area and information on who else is in the space; getting opportunities to collaborate with others to avoid duplication of efforts.

(3rd Party Implementer 2) *Access to interested customers (early adopters); funding for projects; insights into new technologies, making it easier to get program acceptance downstream; credibility with end-users and other utilities due to the involvement of a utility.*

(Other EE Organization 1) *Rapid market adoption (when done right… We needed their incentives to scale up to large pilot / program… plus we benefited from utility marketing programs.*

(Other EE Organization 2) *We have a common understanding of what works and what doesn't work. They leverage investments based on this. We use their money for deployment and testing.*

(Other EE Organization 3) *We develop specifications and programs meeting the wants/needs of utilities [by our involvement] in the program during development, not at the end.*

(R&D Institution 1) *Access to utility organizations that can influence markets. Some have technical capabilities and resources. Pathways to early adopters, rebates… Tools distribution on behalf of [R&D organization].*

(R&D Institution 2) *Utilities are a good way into market. [They] touch all customers.*

Access to customer base – can learn from how they sell their product/manage operational costs. Can infer alternatives for EE benefits.

(R&D Institution 3) *Support pilots; customer connection. Help with market transformation – incentive funding requests to CPUC.*

Not involved in scoping. They prefer that we have this accomplished except for key areas that they are thinking about…

(R&D Institution 4) *…Collaboration is a key benefit / attribute. The challenge is the diversity of utility experience in EE. There is a continuum among utilities with regard to EE. Some are driven by other market factors, and have only gotten involved in EE recently…*

(R&D Institution 5) *Identify priority issues, needs, gaps in market place. Financial support. Identify customers and field test hosts.*

In what areas could energy utilities provide more assistance for your projects?

(Utility 1) *Coordinated research efforts; standardization of research agenda via tech roadmapping or other means.*

(Utility 2) *[no response]*

(Academic Institution 1) *Funding. Participate in demonstration projects that we want to get off the ground*

(Academic Institution 2) *Valley of death funding – need more definition to become commercial. Understanding of utility path to commercialization/criteria for technology success under utility structures. How they make money and how technologies can make them cleaner/more efficient. Not clear how utilities think and how regulators work.*

(Private Industry 1) *Provide more education on well documented technologies. Don't be so fearful to disseminate PIER results, so slow to take breakthrough technologies and best practices to market.*

Fill the gap between best practices and utility rebate program systems approach requirements – end users can't afford to apply for rebates, due to extensive program documentation requirements.

Shift from rebating widgets to focus on systems – no one is championing these.

Provide more, widespread demonstrations.

PIER and NYSERDA have lots of data and good survey instruments that can be reused for utility demonstrations.

(Private Industry 2) *Biggest need is common utility standards - coming together on smart grid and tariff structure/rate structure, and working quickly to develop national standards for implementing these. Right now, we choose not to engage in these areas as an OEM.*

Taking advantage of opportunities for dialogue about business case/subsidy opportunities. To move technologies that are on the cusp of meeting the business case.

We could cooperate (via NDA that prohibits sharing with other manufacturers), or a third party could look at technologies/ideas, and then bring themes back to utilities.

(Government Agency 1) *They are very cooperative – lots of insights and help. The relationship has been very positive and productive. Could possibly increase the amount of two-way information exchange.*

(Government Agency 2) *Our projects could have benefited from EE rebate programs that aligned better with our stakeholder needs. We would benefit from more utility "boots on the ground" – more utility engagement with [our program] project team.*

(Government Agency 3) *Would be good if utilities had better ET to EE program connections. For example, [project name redacted] was not developed into a program; also a [regulatory] coordination issue blocking utility programs. Need a better process to get ETs into programs.*

[Our program] to ET relationship seems stronger than the ET to EE connection, but progress is being made.

Wish that it were easier to contract with utilities.

(3rd Party Implementer 1) *The process stages from opportunity identification to implementation and the "valley of death" could use more bridge building. There isn't a clear path from identification and opportunity assessment to program implementation. This is in part due to silos and inefficiencies inside the utilities.*

(3rd Party Implementer 2) *More funding!*

Also, there is a tendency for utilities to resist at a programmatic level. They want super cost-effective solutions. It's hard to get volume and drop prices further for these near-cost-effective measures. It's best if utility portfolios, not individual technologies, are held to strict cost-effectiveness requirements.

(Other EE Organization 1) *One area is data collection – smart meter data, real-time data. This would make market segment targeting easier, also provides validation. We find it difficult to engage with utility metering departments, which are in flux with AMI.*

(Other EE Organization 2) *They aren't entrepreneurial, they are quasi-governmental.*

More direct engagement with end-use customers and private sector technology developers… Break down sanctity of "single relationship" with customers.

Would like more collaboration with developers, not holding customer relationships hostage. … really need to get to [end-use] customers not utilities.

(Other EE Organization 3) *Hope they will develop RFPs and share common language, tests to develop their [program name redacted] programs. Do peer outreach for review. Help with best practices guidelines, use cases.*

(R&D Institution 1) *Utilities have short-term focus on meeting energy efficiency goals. They need to take an approach that is longer-term and more focused on integrated systems. The CPUC is pushing them in this direction. For the transition to 2030 goals, utilities need to change their mix of activities.*

(R&D Institution 2) *Not always easy. Utilities service a lot of customers. Not always able to determine the relevance of a new technology for customers.*

Not all utility knowledge is sharable due to institutional barriers – have to speculate on who might buy a product. Information management with utilities is difficult – primary concern.

(R&D Institution 3) *None – [program name redacted] support in California has been great.*

They need help in roadmapping – we haven't done much yet.

(R&D Institution 4) *Their EE end-use personnel need to be more involved with [R&D institution]. Need more information-share from utilities' EE program staff as well as R&D*

staff. We get a lot from utility-facilitated project hosting at customer sites. We'd like more utilities to assist with hosting demonstrations.

(R&D Institution 5) *More understanding of market demographics. Understanding market research and market data.*

Appendix E – Technology Development Process, Criteria and Metrics

The tables below present the frequency analysis for data from Section C of the survey, which examined each technology development actor's decision-making process and metrics of success. Because the process for each entity went through different phases, the responses are tallied by phase. The N varies according to how many entities included each particular phase.

We did not find strong patterns in the data, so we simply present it here for review by the reader and as a basis for future research.

Technology Selection Criteria	#	Technology Selection Criteria	#
Energy savings market potential	7	New technology platforms & components	1
Energy savings quantity	5	Fundamental (non-tech) problem addessed	1
Market potential	4	Technical soundness	1
Non-energy benefits	4	Business case	1
Cost effectiveness	3	Partners' interest in adoption	1
Fit with company's core competencies	3	Opportunity for market success	1
ET selection framework	2	Timing in relation to utility funding	1
Customer preference / perspective	2	Utility program bandwidth	1
Niche opportunties & market gaps	2	Fit with CEESP	1
Availability of resources in company	2	Fit with utility programs	1
Cost trajectory	2	Fit with customer preferences for programs	1
Ability to confirm savings by EM&V	1	Reliability of technology	1
Savings persistence	1	Strong distribution channels	1
Price / cost to consumer	1	Time to commercialization	1
Roadmap process	1	Societal benefits	1
Utility program influence	1	Competitive solicitation	1
Impact vs. ease of influence	1	Company (team) capabilities & strengths	1
Short-term tech potential	1	Technical advantages in market	1
Novelty of technology	1	End user needs	1
Breakthrough vs. incremental science	1	Innovation	1
Potential to create new industry	1	Performance (from customer's perspective)	1
Potential to displace incumbent product	1	Peak reduction & DR capabilities	1
Price to manufacture	1	Marketplace trends	1
Scalability	1	Interactions with market actors	1
Manufacturer's capacity to produce	1	Technology-based opportunities	1
Motivated company principals	1	Funder preferences	1
N=	19		

Portfolio Balance Implemented?	
Yes	10
Somewhat	3
No	6
N =	19

Portfolio Balance Approach	#
By sector	6
Driven by funders ("No" responses)	4
By set topic areas	4
By technology, by sector	3
By technology	3
Customer needs & interests	2
By end use	1
By end user	1
Short, medium, long term	1
Mid-to-long term	1
Long term	1
Risk / benefit	1
Building square footage	1
Roadmap driven	1
Opportunistic	1
Address "tough to solve" problems	1
Support full range of solutions	1
Quantitative / qualitative analysis	1
Cost per kWh and energy savings	1
By EE savings potential	1
Utility needs & interests	1
Level of activity by others	1
Regional equity	1
By customer size	1
By objective	1
By project duration	1
Planning & state-driven priorities	1

Funding Allocation Approach	#	N=	19
Stage gate process	8		
Funder-driven	7		
Informal proposal (for pre-screening)	5		
Annual portfolio review	3		
Competitive solicitation	3		
Cost effectiveness	2		
Not applicable	1		
Macro-financial planning	1		
Leadership vision	1		
Opportunity for profitable business	1		
(business case)	1		
Membership revenue	1		
Testing certification revenue	1		

Ideation Metrics	**#**	N =	5
Tech success at small scale	1		
Business case	1		
Risks & unknowns	1		
Energy savings	1		
Recognition of breakthroughs	1		
Roadmapping	1		
None	1		

R&D Metrics	**#**	N =	3
Annual or 6-month performance goals	1		
Number of completed projects	1		
Speed of project completion	1		
Robustness of prototype	1		
Industry partner satisfaction	1		
Partner willingness to continue investing	1		

Product Development Metrics	**#**	N=	6
Functionality (does it work?)	2		
"Varies by project"	2		
Benefit vs. baseline technology	1		
Environmental /emission benefits	1		
Annual or 6-month performance goals	1		
Hand-off to manufacturer	1		
User acceptance	1		
Cost-effectiveness (for end-user)	1		

Assessment & Demonstration Metrics	**#**	N =	9
Validations of energy savings claim	2		
Customer interviews	1		
Qualitative & quantitative analysis	1		
Cost-effectiveness (cost, labor, savings)	1		
Driven by funder metrics	1		
Program reviews	1		
Stage gates	1		
Success meeting assessment objectives	1		
Technology performance	1		
Validation of demand reduction claim	1		
Understanding of variances between lab and field peformance	1		
Deployment by host site customer at larger scale	1		
Functionality (does it work?)	1		
Results disseminated	1		
Customer uptake	1		
Usefullness of results	1		
Better support moving into implementation	1		
None (for R&D)	1		

Commercialization Metrics	**#**	N =	17
Actual savings achieved by technology	6		
Royalties & equity payouts	3		
None	3		
Company success	2		
Sales volume (vs. projections)	2		
Appearance in code documentation	2		
Market share	2		
Cost / performance goals	2		
Program or market deployment	2		
High confidence in technology performance	2		
Number of stakeholders accessing / referencing the technology	2		
Customer acceptance	2		
Measures support utility program targets	1		
More energy savings faster, cheaper	1		
Return on investment	1		
Product reliabilty	1		
Progress on multi-year portfolio targets	1		
Product performance improvements	1		
Product in volume production	1		
Multiple manufacturers	1		
Initial savings tracking in market	1		
Utility program spending vs. budget	1		
Training and education program development	1		
Number of people reached via webinars & seminars	1		
Patent disclosures	1		
Press releases	1		
Positive user experience & customer acceptance	1		
Positive economics over product lifetime	1		
Recognized economic and societal benefits	1		
Tracking scorecard (for funder)	1		
Number of sites deployed	1		
Stage gates	1		
Financial projections	1		
Favorable EM&V results	1		
Market penetration	1		
Cost effectiveness	1		
Evaluation plan to track market progress and barrier reductions	1		

Other Phase Metrics	**#**	N=	19
None	3		
Risk vs. reward	2		
"Awareness" effectiveness	2		
Uptake into C&S	1		
Role of education materials in uptake	1		
Milestone questions	1		
Advisory committee review	1		
More energy savings faster, cheaper	1		
Market readiness	1		
Timeliness	1		
Budget accuracy	1		
Number, size, sophistication of firms involved	1		
Number of certifications performed	1		
Market transformation objectives	1		
Projects or reports completed	1		
Website downloads or hits	1		
Reliablity	1		
Reliable savings	1		
Cost effective for utility rebates	1		
Number of programs offered	1		
kW under contract	1		
Successful commercial entry	1		
Success raising private funding	1		
Creation of local jobs	1		
Go / no-go indication	1		

Termination Criteria	**#**	N =	19
Fundamental problem with no path to mitigation	8		
Stage gate process	6		
Monthly / annual reviews	2		
Competing tech makes project obsolete	2		
Milestones not met	2		
Unsatisfactory cost trends	2		
Something isn't progressing or meeting its potential	2		
Industry partner withdrawal or bankruptcy	1		
Lack of external (funder) interest	1		
Lack of faculty commitment to commercialization	1		
Product not affordable /cost effective	1		
Scope is too broad for a single product	1		
Weak business case	1		
Risks can't be mitigated	1		
Less than 3 major private stakeholders' support	1		
Fewer than 2 manufacturers	1		
No domestic manufacturers	1		
Poor-quality team deliverables	1		
Lack of funding	1		
Serious problems with user interactions	1		
Advisory committee review	1		
Project reaches a logical end point	1		
Technology performance	1		
Poor fit with budget or portfolio	1		
Duplication of outside efforts	1		
Significant market roadblocks	1		
None	1		