EMI CONSULTING

Pacific Gas and Electric High-Tech, Bio-Tech, and Office Market Profile Study Evaluation Year 2017

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FINAL REPORT

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EXECUTIVE SUMMARY

Pacific Gas and Electric Company (PG&E) contracted with EMI Consulting to conduct research supporting PG&E's development of a Commercial Buildings Program Implementation Request for Proposal (RFP). The objective of the research was to identify three to five high-opportunity market subsegments within high tech, biotech, and office (HBO) commercial markets and to summarize the market actors, primary end uses, and expected five-year trends that will impact their energy consumption. The primary output of the study is four briefs (one for each subsegment) that outline trends, opportunities and barriers, and customer desires. These results provide guidance on how to potentially categorize and engage these markets for future program design.

To identify high-opportunity subsegments within the HBO market, EMI Consulting normalized PG&E customer data by energy use intensity (EUI) and calculated average EUIs across all HBO NAICS codes. Subsegments that had the highest percent of buildings above the average EUI plus a sufficient population size (defined as greater than 100) were considered to have potential savings opportunity. PG&E used this analysis, along with industry expertise and conversations between PG&E strategic account managers (SAMs), the PG&E program manager, the PG&E evaluation liaison, and EMI Consulting, to select biotech, real estate, telecommunications (telecom), and data center subsegments as areas of focus for the rest of the study.

EMI Consulting then conducted 12 in-depth interviews with market experts, SAMs, and PG&E customers. Interviews topics included market trends, key market actors, decision-making processes, potential technologies, and perspectives on PG&E program offerings and support.

Since HBO companies are highly competitive by nature, engaging this market is a high-touch endeavor that relies heavily on developing trusted one-on-one relationships. In-person networking is integral to building these relationships in order to identify opportunities, create custom projects, and move projects through customer business processes and PG&E programs.

Interview subjects identified the following shared barriers among the subsegments:

- **Reliability concerns**. Reliability is the primary driver of business decisions; customers see energy efficiency as risky as it might disrupt normal operations.
- **Project timeline misalignment**. PG&E's custom project process is too slow for the customer's project timelines (typically quarterly). Customers must order equipment when budget is available, making the project ineligible if PG&E hasn't approved it.
- **Impractical program requirements and low incentive levels**. Customers count on incentives during budgeting, but that makes projects ineligible for PG&E incentives. Customers also have tight budgets for capital improvements and incentives are too low.

Looking into the future, consolidation is a general five-year trend across most of the subsegments (except real estate), and customers report that they expect this consolidation to increase energy intensity and their energy costs. Both customers and experts agree that the ability to identify opportunities within this landscape will be key for future program designs. Efforts including benchmarking similar buildings, increased visibility into which buildings perform well and which are energy hogs, and more robust analysis of which buildings to target before engaging customers could potentially increase program success.

1. INTRODUCTION

The objective of this study was to identify trends, market actors, primary end uses, and expected five-year trends that will impact energy consumption for high tech, biotech, and office (HBO) commercial markets. Specific study objectives were to:

1. Stratify office and high tech commercial markets and identify three to five high-opportunity subsegments, based on energy savings potential and motivations.

2. Provide brief summaries of trends in these subsegments, producing two-page briefs for the RFP.

To meet these objectives, EMI Consulting first analyzed PG&E customer and program participation data to identify high-opportunity subsegments within the HBO market. Analysis and stratification was based on buildings' Energy Use Intensity (EUI) compared to average EUI of the PG&E data set. Data cleaning, analysis methods, data limitations, results, potential additional analysis, and recommendations were described in a memo (see Appendix A1: Data Stratification Memo). EMI Consulting, PG&E strategic account managers (SAMs), the PG&E program manager, and the PG&E evaluation liaison discussed the relevance of customer data analysis results for each subsegment and used the analysis, these discussions, and industry knowledge to select biotech, real estate, telecommunications (telecom), and data center subsegments as the focus for the rest of the study.

EMI Consulting spoke with industry experts, the SAMs, and PG&E customers to summarize the trends within the selected subsegments. The interviewee sampling methodology for customer interviews was different for each subsegment:

- **Biotech.** The PG&E team determined that due to the sensitive nature of their relationships with the biotech sector, the evaluation team should only interview the sector's SAM, the SAMs' boss, and one large biotech firm.
- **Data centers.** The data center subsector, which includes office buildings and high-tech businesses, has a minimum square footage requirement for program participation. All of the buildings meeting this requirement had below-average EUIs, as determined in the Data Stratification Memo. In addition, many of these buildings have already participated in programs. As a result, data center SAMs determined the evaluation team should interview a customer who has been in the industry a long time and who could serve as an expert opinion.
- **Real estate**. The PG&E team determined that due to the unique nature of this sector, the evaluation team only needed to interview the sector's SAM.
- **Telecom**. The Telecommunications SAM chose the customers marked as high outliers in the Data Stratification Memo for the evaluation team to interview. These customers had EUIs in the 95-100th percentile compared to the rest of the electric and gas customers.

Table 1 illustrates the number of experts and customers interviewed for each subsegment. Interviews were exploratory in nature and discussed a set of standard topics as well as topics unique to the interviewee and their subsegment. Through these conversations, EMI Consulting collected information about key market trends affecting HBO companies today and in the next

five years, key market actors, decision-making processes, energy-efficient technologies, and perspectives on PG&E program offerings and support.

Table 1. HBO Interviewee List by Subsegment

HBO Subsector	SAMs	Experts	Customers	Total
Biotech	1	1	1	3
Data Centers	2	1	1	4
Real Estate	1	0	0	1
Telecommunications	1	0	3	4
Total		7	5	12

Originally, this study also included a review of AB802 and how its implementation might affect the HBO market. EMI Consulting reviewed five related documents that discussed how AB802 was created mainly to implement a statewide benchmarking program, but also includes provisions helping commercial buildings access whole building data. AB802 may also sanction the use of normalized metered energy savings, allow pay-for-performance payments, and allow more open-ended types of programs and projects, all of which could affect the HBO market. This part of the study was stopped, since the state has not finalized their AB802 guidance.

This report summarizes the findings of this study, primarily from the in-depth interviews. The results are actionable and should help inform future program design, including how to possibly segment the commercial market, to engage HBO market actors, and potentially to address key barriers in order to access untapped energy savings potential. The results will also allow the Commercial Programs Team to shape a Request for Proposal (RFP) for future program delivery.

This report should be used to understand general high-level trends and other information relevant to each subsegment, but not as a definitive resource for any of the content because of the significant data limitations in this study. As noted in the Data Stratification Memo (see Appendix A1: Data Stratification Memo), accuracy of data stratification was impacted by difficulties in rolling premise IDs into a building ID (i.e., uncertainty around whether all square footage was included for each building), a number of premise IDs having identical usage, buildings with gas-only data, and other indicators there was missing energy use data, as well as not having data on customer characteristics such as mixed-use facilities, buildings with multiple tenants, or portfolio accounts. Findings from the in-depth interviews should also be used generally, as interviewing one to four people in a market is not a significant sample size and their views and experiences may not reflect those of their peers.

The rest of this report provides:

- A brief account of the methodology behind choosing the real estate, biotech, telecom, and data centers subsegments for the in-depth interviews.
- Key findings of the study, including two-page briefs for each subsegment that highlight trends, barriers and opportunities, and the interviewees' expectations of PG&E.
- In-depth discussion of interview findings for each subsegment, including key decision-makers.

2. HBO MARKET SEGMENTS

For the purposes of this project, the HBO market was broadly defined as businesses associated with the two-digit NAICS codes PG&E provided, plus additional codes that appeared to fit within the HBO market based on their description, as shown in Table 2.[1]

Table 2. HBO NAICS Codes

Two-digit NAICS code	Description
51	Information
52	Finance and Insurance
53	Real Estate and Rental and Leasing
54	Professional, Scientific, and Technical Services
55	Management of Companies and Enterprises
61	Educational Services
81	Other Services (Except Public Administration)
92	Public Administration
Examples of additional codes	"Space Research and Technology," "Semiconductor Manufacturing"

EMI Consulting used data from two datasets obtained from PG&E—CoStar and geocoded customer data and program participation data—to conduct data analysis in order to identify which subsegments within the HBO market had the greatest energy savings potential. It is straightforward to rank buildings from high energy use to low energy use within each NAICS subcode, but higher energy use does not necessarily mean higher opportunity, since energy use generally increases with building size. Instead, each building's energy use was normalized by energy use intensity (EUI) and compared to the average PG&E portfolio EUI.[2] An individual building was considered to have energy savings potential if its EUI was above the average EUI.

Next, EMI Consulting calculated the percent of buildings above and below the average PG&E EUI within each NAICS category. Program design should also take into consideration the number of customers within a target market, so there are enough buildings to target a program. Therefore, we defined high opportunity as those subsegments that have the most buildings with higher than average EUI that also have more than 100 buildings (considered to be a sufficient number of buildings to warrant action).[3] The results are shown in Figure 1, and Figure 2, and Figure 3 for the different fuel types.

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[1] A full list of the 4-digit NAICS codes kept in the analysis is shown in Appendix A1: Data Stratification Memo.
[2] The study assumed that a high EUI is correlated with higher energy savings potential. This concept is similar to other well-established benchmarking approaches, such as ENERGY STAR Portfolio Manager.
[3] A more detailed methodology, including the data limitations, was previously described in a memo to PG&E and can be found in Appendix A1: Data Stratification Memo.

EMI Consulting then discussed the EUI results and their relevance with the PG&E SAMs, program manager, and evaluation liaison in several discussions. The SAMs, program manager, and evaluation liaison used the analysis, these discussions, and industry knowledge to select biotech, real estate, telecom, and data center subsegments as areas of focus for the in-depth interviews.

Figure 1. Gas and Electric Customers Percent Above and Below PG&E Average EUI by NAICS

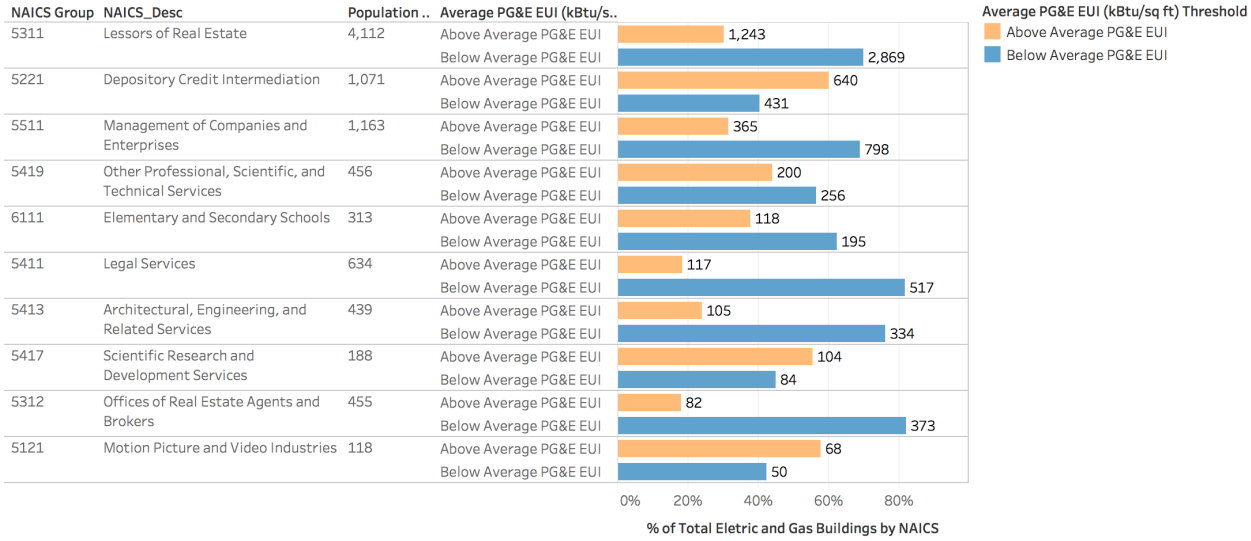


Figure 2. Electric Customers Percent Above and Below PG&E Average EUI by NAICS

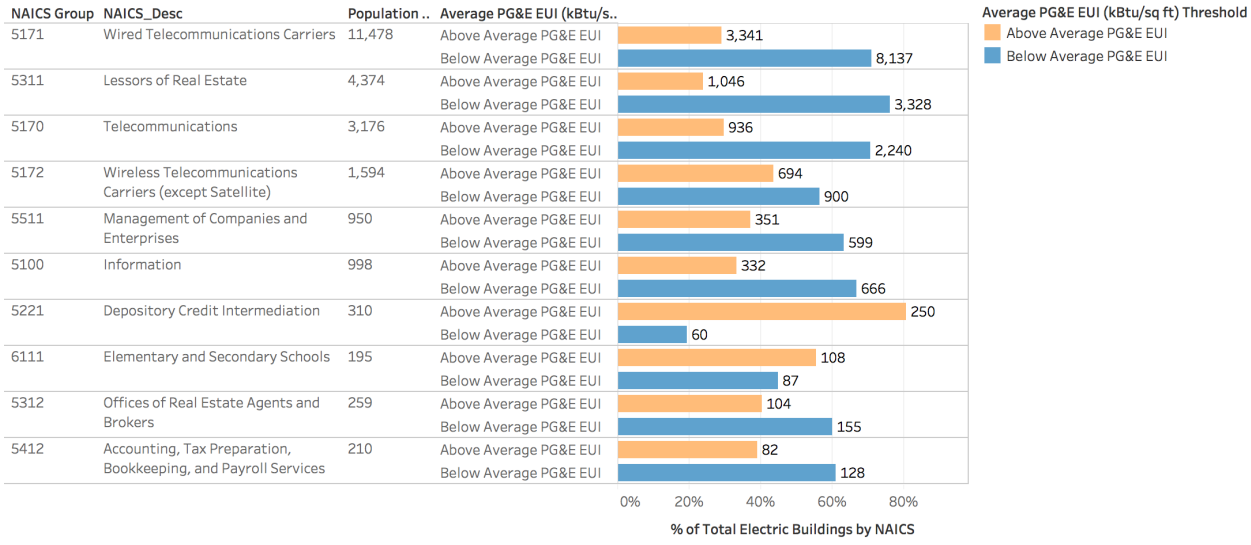
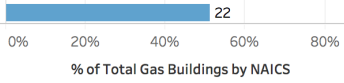


Figure 3. Gas Customers Percent Above and Below PG&E Average EUI by NAICS

NAICS Group	NAICS_Desc	Population ..	Average PG&E EUI (kBtu/s..
5311	Lessors of Real Estate	942	Above Average PG&E EUI
			Below Average PG&E EUI
5511	Management of Companies and Enterprises	459	Above Average PG&E EUI
			Below Average PG&E EUI
5221	Depository Credit Intermediation	283	Above Average PG&E EUI
			Below Average PG&E EUI
6111	Elementary and Secondary Schools	115	Above Average PG&E EUI
			Below Average PG&E EUI
5411	Legal Services	149	Above Average PG&E EUI
			Below Average PG&E EUI
5419	Other Professional, Scientific, and Technical Services	108	Above Average PG&E EUI
			Below Average PG&E EUI
5312	Offices of Real Estate Agents and Brokers	93	Above Average PG&E EUI
			Below Average PG&E EUI
5413	Architectural, Engineering, and Related Services	96	Above Average PG&E EUI
			Below Average PG&E EUI
5412	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	102	Above Average PG&E EUI
			Below Average PG&E EUI
5417	Scientific Research and Development Services	43	Above Average PG&E EUI
			Below Average PG&E EUI



3. KEY FINDINGS

The high tech, biotech, and office (HBO) market segment is comprised of a wide range of company types and sizes, and opportunities for equipment and energy efficiency improvements within each facility are as diverse as the companies that occupy them. These companies are in an extremely competitive marketplace in which information is not widely or regularly shared, resulting in limited industry associations (or none, for biotech) through which energy efficiency best practices can be defined and information can be distributed or where companies can come together to discuss barriers and opportunities. As such, EMI Consulting found that engaging the HBO market is a high-touch endeavor that relies heavily on in-person networking to develop trusted one-on-one relationships in order to identify opportunities, create custom projects, and move projects through customer business processes and PG&E programs.

It is not unusual for PG&E representatives to spend years developing these relationships and learning the business processes and decision-making criteria for each company. Diversity in business types, equipment, and decision-making criteria and the fact this market is driven by high-touch personal relationships are likely what have contributed to low program participation, despite the energy savings potential. Future program designs will need to account for, incorporate, and rely on existing personal relationships between customers and PG&E for recruitment, especially as programs move to third-party programs.

Program participation is also likely low due to three common barriers that were shared across all the HBO interviews:

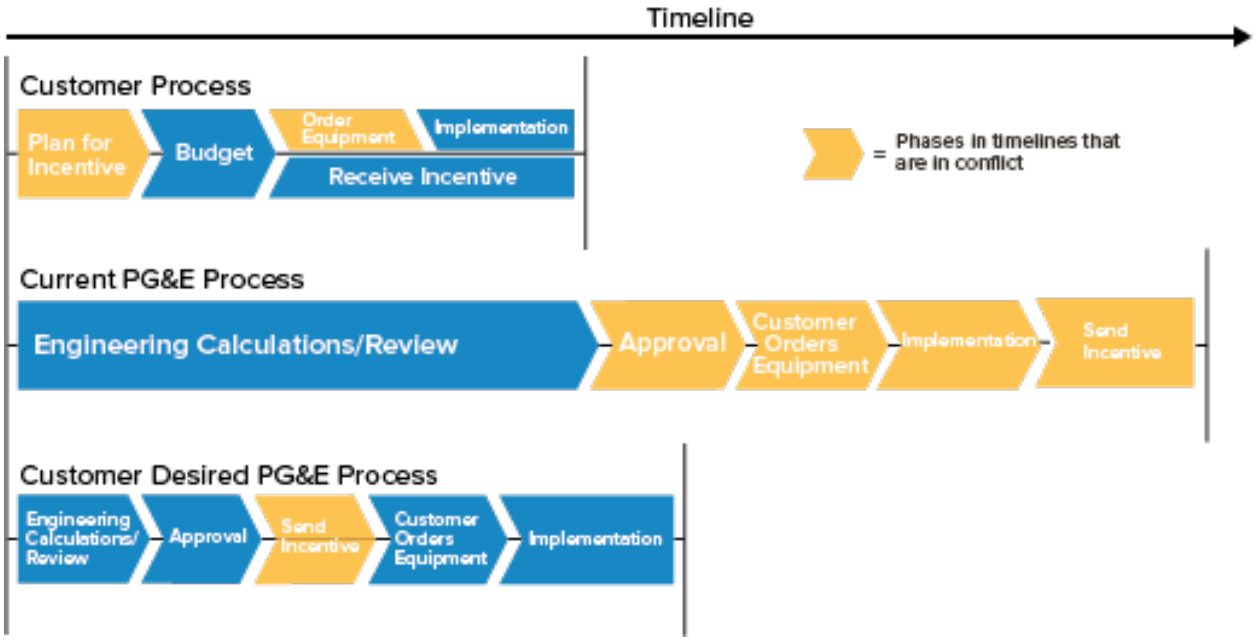
- **Reliability concerns**. Within the HBO market, reliability is paramount. Most of the interviewees discussed how reliability is the primary driver of business decisions. These buildings house critical infrastructure, such as 911 call centers or medical trial equipment, and can generate an enormous amount of revenue for the companies. These customers often see energy efficiency as risky as it might disrupt normal operations within the facility, especially as the benefits of efficiency are small compared to the potential cost of a disruption in service. In fact, the companies within the HBO market may favor less energy-efficient equipment to ensure equipment performance.
- **Project timeline misalignment.** Businesses in the HBO market have a fast timeline for budgeting, planning, and approving projects. Once funds are available, they have to be spent within a short timeframe or else the money is reallocated, and PG&E's custom program process is far too slow to meet the customer's timeline. Customers reported that budget decisions and funding allocation happens quarterly, while the PG&E program process can take six months to multiple years. Often customers have to order equipment while funding is available, but if equipment is ordered before the project is approved by PG&E they become ineligible for rebates[4]. This misalignment makes it difficult for customers to reserve funds for energy efficiency projects while awaiting approval from PG&E.

[4] Note there may be some discrepancies between actual program processes/requirements and interviewees' perception of the program processes/requirements. The findings discussed in this document reflect the discussion with interviewees. Discrepancy between interviewees' perceptions and actual program process/requirements, such as ordering long-lead time equipment while applications are under review, indicate an opportunity for improved communication as they may be a barrier to customer participation.

- **Impractical program requirements and low incentive levels.** HBO companies have very tight budgets, and efficiency projects tend to be large capital investments. As such, customers count on the incentives when budgeting, but PG&E's program requirements exclude measures if they're already budgeted. Furthermore, customers reported that PG&E's incentives, if received, are not high enough to justify participation. For example, one customer talked about a $1.3 million project for which a $100,000 incentive would barely pay for the loan. Multiple customers reported receiving far less money than was anticipated—one reported that a $1.5 million incentive on a $2 million project was cut to $60,000 after the project review took multiple years to approve and the CPUC changed the baseline in the interim. The incentive received was not enough to even pay the taxes on the project. Therefore, the level of incentive and the likelihood of receiving the promised incentive is another common barrier in the HBO market.

Figure 4 is a graphical representation of the second and third barriers—the misalignment between a customer's business timeline and PG&E's program timeline and the misalignment around the timing of the incentives and equipment orders. Customers and experts across the sectors reported that engineering calculations and review are driving the long timeline for PG&E and that simplifying the requirements for this aspect of the project could realign customer and PG&E project timelines.

Figure 4. Process and Timeline Misalignment



Across most of the market subsegments (except real estate), consolidation is a general trend for the next five years. For data centers, consolidation means a move to cloud computing and co-location facilities, for biotech consolidation means leased spaces, and for telecom consolidation means doing more within existing spaces. Customers reported that they expect this consolidation to increase their energy intensity and their energy costs, and customers and experts agreed that the ability to identify opportunities within this landscape will be key for future program designs. Efforts including benchmarking similar buildings, having visibility into which buildings perform well and which are energy hogs, and more robust analysis of which buildings to target before

engaging customers in the one-on-one relationships previously discussed could potentially increase program success.

The following four two-page briefs describe, for each subsegment, important five-year trends, barriers and opportunities, and the interviewees' expectations of PG&E, and the following section describes these findings in more detail.

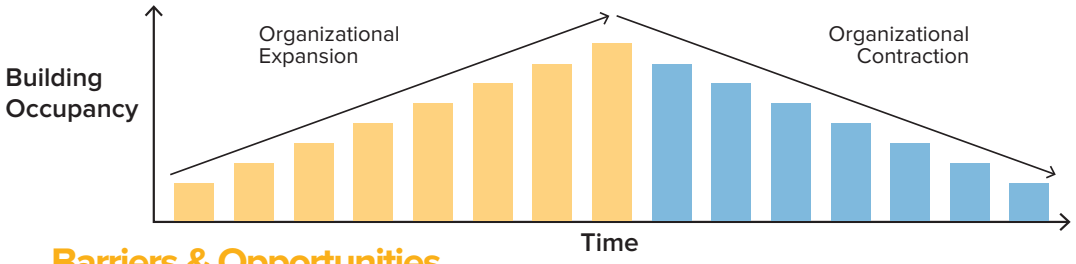
Biotech

Expand internal relationships, streamline processes and options

Current Trend

As of July 2017, approximately 362 biotech firms operate in PG&E territory. Biotech companies in the Bay Area are projected to grow at a rate of 10% for the next few years. Some firms are considering building substantial new lab spaces, while others consolidate space and retrofit existing structures. In addition to these developments, regulatory trends—such as stricter codes, AB802 implementation, and possible restrictions on drug costs—will likely influence energy efficiency opportunities in the next five years.

Due to the volatile nature of their business, biotech companies are prone to expand and contract rapidly depending on the stage of their research and the successes and failures of clinical trials or technology projects. They are like to pursue only measures that require moderate capital investments, have little disturbance on their business processes, and promise a quick return on investment.



Barriers & Opportunities

	Customer Instability	Highly Volatile Market	Misalignment of Processes
Barrier	• Biotech firms are subject to extreme highs and lows tied to successes and failures of developing new pharmaceutical drugs and technologies. • It is difficult to justify capital investments that disrupt business processes or can't promise short return on investment.	• It is difficult to make customers aware of opportunities and establish long-term relationships needed to execute bigger projects. • Turn-over among energy champions is to be expected due to the volatile nature of biotech business cycles.	• Customer budget must be spent within certain amount of time, but PG&E's approval and custom review processes take much longer. • If customers proactively approach PG&E about potential projects, then it is considered free-ridership and customers are no longer eligible for incentives. • Deemed measures underestimate savings because biotech firms operate more like 24/7 industrial facilities than 9-to-5 office buildings.
Opportunity	• Partner with building owners and operators as well as real estate developers to incorporate energy-efficient equipment and designs in their retrofit plans.	• Build on successful relationships with internal energy champion and expand network of contacts within a customer organization.	• Measure savings at the meter (via implementation of AB802) to help avoid measure-specific custom review process and accelerate approval process. • Design products and rebates that customers can count on being available during annual budget planning and remaining available for a defined period of time.

EMI CONSULTING

Biotech

Expand internal relationships, streamline processes and options

What Customers Want PG&E To Do

Technologies

- Low-temperature freezers (-80 degree and -20 degree)
- Water-cooled chillers
- Laboratories/clean rooms:
  - Ventilation fans: fume hood airflow setback, production ventilation optimization, insulation repairs, variable-frequency drive motors, fan-speed modulation
  - Air compressors
  - Specification designs for clean rooms
  - System optimization for purified water/water injection
- HVAC:
  - Air plenum design optimization to maintain air flow while reducing load on fans
  - Air handlers: variable-frequency drive motors, fan-speed modulation
  - Airflow rebalancing
  - Controls, schedule changes, set-point changes
  - Hydronic rebalancing
- Process boiler controls
- Steam traps
- Pneumatic controls
- Retrocomissioning
- LED lighting and controls

Savings

The implementation of AB802 may open opportunities to increase savings that have otherwise rarely been possible because of the mismatch between PG&E's reliance on measure-specific, calculated projects and biotech firms' need to make quick decisions about specialized, non-standardized equipment and processes.

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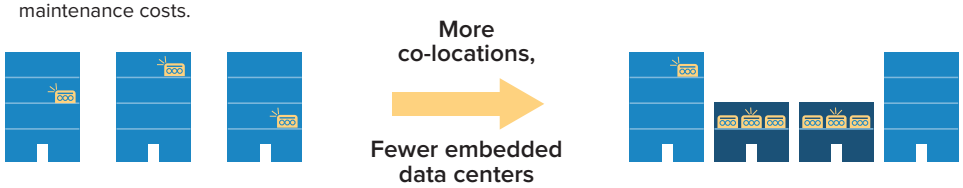
Data Centers

Build rapport, reduce requirements and timeline, offer partial incentives earlier

Current Trend

As of July 2017, approximately 100 data centers operate in PG&E territory. Companies are shifting from using embedded data centers spread across facilities to cloud computing and co-location data centers. Reasons include:

- **Reliability.** The risk of downtime is reduced. Embedded data centers typically do not have the n+1 or n+2 redundancy that larger facilities have and are operated by facility managers (who are not as familiar with data center equipment) as opposed to IT specialists.
- **Space.** Cloud options and co-locations provide more space for expanded servers. Many buildings are primarily office space where there is not the physical footprint to expand embedded data centers.
- **Economies of scale.** Merging embedded data centers achieves a significant reduction in operations and maintenance costs.



Hyperscale data centers are very focused on driving their power usage effectiveness (PUE) numbers as close to one as possible, making it difficult for utility programs to demonstrate influence on decision-making for evaluation of free-ridership. However, the industry is seeing the trend towards these hyperscale data centers slow down slightly compared to previous years, because the embedded data center is closer to the end user. Companies highly value speed, which is positively impacted by proximity to the data center.

The final trend discussed by interviewees was a demand for additional—or even 100%—renewable power. This is especially true for co-location or enterprise (companies that own their own data centers, such as banking, Google, etc.) data centers.

Barriers & Opportunities

	Small Data Centers	Program Timeline	Misalignment of Processes
Barrier	• It is difficult to identify embedded data centers.	• PG&E timeline for project review and approval is much longer than the customer timeline.	• Customers use PG&E incentive for budgeting projects, but if the measures are budgeted customers no longer qualify for incentive. • Customers have to order equipment when budget is available, but they can't order equipment until the project is approved by PG&E.
Opportunity	• Network and build trusted relationships with customers to learn about opportunities. • For large customers, allow customers to suggest applicable facilities for projects.	• Significantly shorten PG&E engineering calculation and review timeline by simplifying process. • Align engineering and program goals.	• Shorten PG&E review process to approve the project within the same timeframe as when the customer needs to use their budget.

EMI CONSULTING

Data Centers

Build rapport, reduce requirements and timeline, offer partial incentives earlier

What Customers Want PG&E To Do

Technologies

- Outside air cooling
- Power management
- HVAC
  - Evaporative cooling modifications for packaged units
  - Mist system
  - HVAC Armor
  - Water-side economizers
  - In-row coolers
- Measures for servers (such as submerged systems)

Savings

All data center interviewees mentioned how important accurate energy savings calculations are to their decision-making process, because budgets are set based on payback and return on investment. The application of the baseline (either Title 24 or “as found” conditions) is a key issue with data center customers as this can significantly impact claimed energy savings. Experts reported that “monster” potential exists with AB802 for measures, such as uninterrupted power supplies, that would have had only small savings under Title 24.

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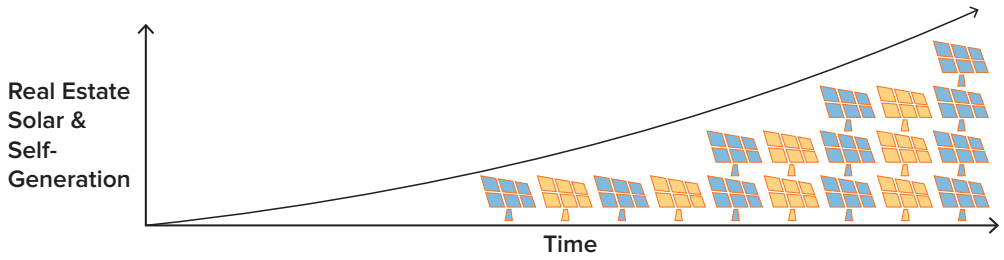
Real Estate

Build relationships, invest in energy and data management system

Current Trend

As of July 2017, approximately 670 real estate customers operate large buildings in PG&E territory. Real estate customers are technically savvy and desire the latest and greatest technologies to keep ahead of their competitors. These customers will likely increase their renewable energy (i.e. solar) and self-generation in the near future.

This market is also increasingly interested in real-time data at a very granular level—down to the per-floor or per-tenant level. Executives in this market are very aware of the tangible benefits (lower operating costs, rent premium, increased property values, etc.) and intangible benefits (enhanced ability to hire and retain employees/ tenants, increased sales, etc.) associated with energy efficiency projects. Some executives use these benefits to derive a competitive advantage, while others do not. Ownership turnover rate in this market will continue to have a significant impact on opportunities.



Barriers & Opportunities

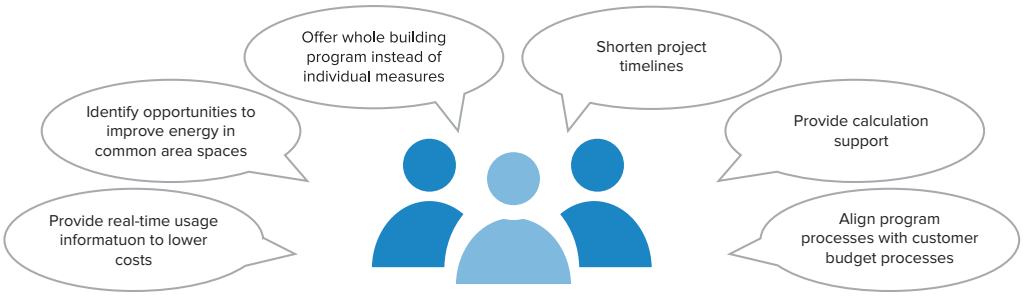
	Building Ownership Turnover	PG&E Data Availability	Decision-Making Structure
Barrier	• High building ownership turnover and long sales cycle of expensice efficiency measures make owners reluctant to pursue efficiency upgrades. • It is difficult to know when a building is going to be or has turned been over.	• When the property changes owner names, the data associated with that building, including energy usage and program participation, is archived and is extremely difficult to recover in a meaningful way.	• Investor-owned properties don't have a centralized decision-making structure, making it difficult to get approval for capital expenditure projects in these buildings.
Opportunity	• Establish strong relationships between the property manager and PG&E account managers to identify upcoming transfers. • Target buildings undergoing ownership transfer; the old owner may wish to do upgrades before they sell or the new owner may want to make upgrades.	• Use energy management and information systems (EMIS) to house historical meter data for a property and record the specific equipment in the building. • Use EMIS to offer analytics to customers and position PG&E as an energy advisor.	• Find a large tenant that occupies a majority of the building and build a strong enough ally to move a project forward. • Develop relationships with property management companies with a portfolio of buildings.

EMI CONSULTING

Real Estate

Build relationships, invest in energy and data management system

What Customers Want PG&E To Do



Technologies

- Energy management systems
  - Real-time energy usage information
  - Identification of efficiency upgrade opportunities
  - Maintaining/housing historical building data (energy usage, audit information, past program participation, etc.)
- Retrocommissioning
- Common area measures
  - Central plants
  - Chillers
  - Rooftop units
  - Common area lighting

Savings

AB802 is expected to have a positive effect on the real estate market. The ability to approach projects at the whole building level and to count savings at the meter should:

- Reduce the project timelines;
- Simplify calculations;
- Align the owner's vision of incentive levels (based on current equipment and building operations); with actual incentive levels (based on code);
- Open up higher amounts of project funding as owners are more apt to approve a larger pot of money over calculating individual metrics; and
- Help to renew motivation for energy efficiency participation in the real estate market.

EMI CONSULTING

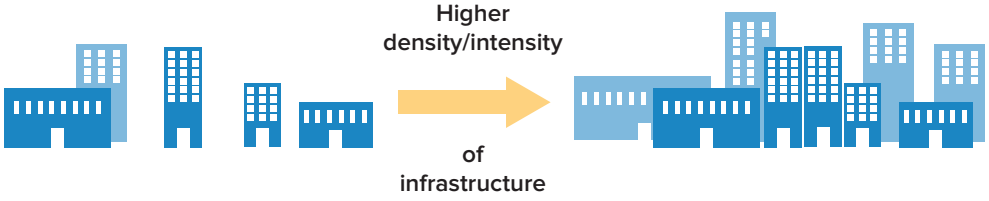
Telecom

Provide reliable infrastructure, offer more education and personalization

Current Trend

As of July 2017, approximately 190,000 telecom customers operate facilities in PG&E territory. Maintaining or increasing reliability is what guides business decisions, including investments in and willingness to make changes to facilities and equipment. Future growth will occur through higher density/intensity of infrastructure as telecom companies look to maintain or reduce their real estate. While the telecom industry will consolidate facilities like the data center market, telecom companies also need to have local facilities close to their customers.

Densification is expected to cause a large increase in energy consumption and a rapid increase in energy costs. Over the next few years they will be working to reduce their energy costs as they increase infrastructure development. Finally, interviewees reported that as the densification/intensity goes up, there is less you can do in the facilities as the increased consumption is from the additional IT equipment, such as network power consumption.



Barriers & Opportunities

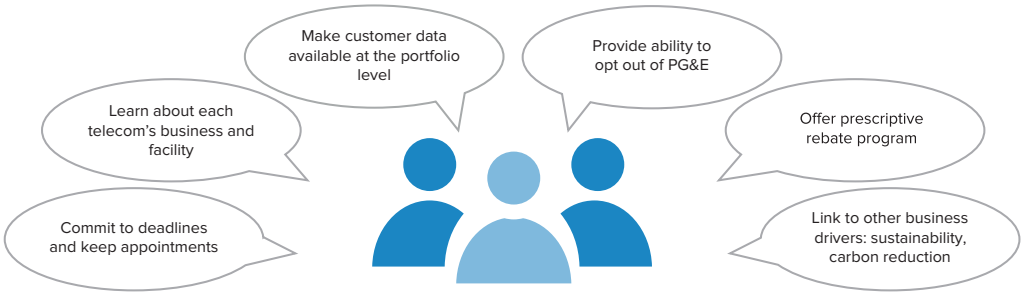
	Reliability	Tight Budgets	Customer Business Process
Barrier	• Energy efficiency is perceived as risky because there is a chance that energy measures might disrupt operations, which has high financial consequences. • EE benefits are dwarfed by revenue produced through business operations.	• PG&E incentives are not worth the time it would take to apply and go through the process. • Customers don't look at the overall amount of savings—both energy and financial—when considering efficiency projects.	• Run to fail operations don't prioritize improvements. • Companies lack a well-defined process for making decisions around energy efficiency projects.
Opportunity	• Promote switching to cloud servers, which is seen as less risky, to save energy and add capacity.	• Educate and communicate how energy efficiency can actually help save customers money or increase revenue over time. • Consider increased incentives.	• Quantify the costs of deferred maintenance. • Develop relationships with customers and work with them through the processes.

EMI CONSULTING

Telecom

Provide reliable infrastructure, offer more education and personalization

What Customers Want PG&E To Do



Technologies

- CRAC measures
- Variable frequency drives
- Air distribution
- Turbocore chillers or other chillers that are strong on part load
- Bigger filter banks for lower pressure drops
- More advanced air management
- Control schemes
  - No: measuring return temperature at inlet of CRAC unit
  - Yes: measuring temperature at inlet temp of servers
- Advanced lighting controls
  - Wireless mesh networks
- Rectifiers
- Uninterrupted power supply systems

Savings

The primary way telecom customers are looking to reduce costs is through investing in renewable generation and by investigating storage and independent utility districts. One interviewee reported "[my] boss would say the number one important thing is the increasing cost of energy. This has caused us to invest in solar." Another interviewee has installed fuel cells to provide redundancy (i.e., increase reliability), add capacity, and reduce energy costs. Many of these companies also have greenhouse gas reduction goals for 2020 that are driving their adoption of renewable technologies.

4. DETAILED FINDINGS BY SUBSEGMENT

Each section below provides additional detail related to the five-year outlook, key market actors, barriers and opportunities, and specific technologies that present potential energy efficiency opportunities given each subsegment's end uses and business environment.

4.1 Biotech

Five-Year Industry Outlook

According to PG&E strategic account managers, the biotech industry is expected to grow at a rate of 10% each year for the next few years. Due to the volatile nature of the sector, specialized equipment, and increased use of leased spaces, though, biotech companies in PG&E territory—heavily concentrated in the Bay Area—are more likely to limit their investment in energy efficiency measures to those that require moderate capital investments, do not significantly disturb of business processes, and promise a quick return on investment.

The biotech market is a highly speculative market marked by a lot of merger and acquisition activity. Biotech firms expand and contract rapidly depending on the stage of their research and the successes and failures of clinical trials. Such is the case for Amgen, which announced in March 2017 that it would lay-off, relocate to Florida, or reassign 500 of its 5,500 Thousand Oaks employees over the next year and a half.[5] Small and mid-sized biotech firms, such as OncoMed, Catalyst Biosciences, and Threshold Pharmaceuticals, are also subject to tumultuous business cycles. These firms may expand rapidly with venture capital funding, aspire to be bought-out by larger firms within a few years, or close down quickly if a project fails or takes an unexpected turn. As a result, companies are regularly constructing new spaces, retrofitting old spaces, expanding and contracting the use of existing spaces, and moving into "true mix-use buildings" that have smaller spaces with laboratories that are ready to use and can accommodate growth, such as The Cove in South San Francisco. This presents a strong opportunity to work with biotech firms during the concept design phase of new construction projects to include energy efficiency measures and practices. The challenge lies in moving quickly enough to approve projects that align with these fast-paced companies' budgeting, planning, and building timelines.

Despite the volatility of the market, the Bay Area will continue to be a biotech hotspot, along with San Diego, Boston, and New Jersey (for manufacturing). The Bay Area features several hubs for biotech (including South San Francisco/Mid-Peninsula, Santa Clara County, East Bay including Oakland, Emeryville, Hayward, and Hercules, as well as North Bay cities: Novato, Benicia, and Santa Rosa). Some firms are considering building substantial new lab spaces while space consolidation and retrofitting of existing structures is also a strong trend. Some mid-sized biotech firms have begun leasing less expensive spaces in Santa Clara, and this latest trend may drive some companies out of PG&E territory, to locations including Alameda and Santa Clara.

[5] Pacific Gas and Electric Company. *Energy Efficiency Business Plan 2018-2025*. Retrieved from https://docs.wixstatic.com/ugd/0c9650_cbeb1d9e14cf4575845e8d5cd6bce57f.pdf.

In addition to trends in facility acquisition and repurposing, regulatory trends such as stricter codes, AB802 implementation, and possible restrictions on drug costs will likely influence energy efficiency opportunities in the next five years. For example, fans currently offer strong potential for increased energy efficiency, but stricter code requirements for variable frequency drives (VFDs) and variable speed drives (VSDs) may reduce the above-code savings potential associated with fan efficiency measures. On the other hand, the implementation of AB802 may open opportunities to increase savings that have otherwise rarely been possible because of biotech firms' specialized, non-standardized equipment and processes and PG&E's reliance on measure-specific, calculated projects. Currently, biotech customers are wary of pursuing projects that may be allowable under AB802 due to the uncertainty around the establishment of baselines, the absence of clear guidance on its implementation, and concerns about being considered "free riders." Regarding pharmaceutical industry regulation, the possibility of federal or state legislation restricting the amount of money biotech companies can charge for drugs is also likely to influence biotech companies' willingness to make capital improvements.

Key Market Actors

There are a handful of very large life sciences leaders that are fueling a prolonged boom for the Bay Area's world-leading firms, including Roche / Genentech, Bayer, Amgen, Bristol-Meyers Squibb (BMS), Gilead Sciences, AbbVie Theraputics, BioMarin, ThermoFisher Scientific, Novartis, and Boehringer Ingelheim. There are also many small- to medium-sized biotech companies have facilities in PG&E territory.

When working with large biotech companies, the main stakeholders who influence decisions about energy-efficient equipment and operational improvements include the energy manager, who likely also oversees water management. This person closely collaborates with laboratory, research, facilities, and plant engineering managers or directors. When planning to install energy-efficient equipment, laboratory and production managers need to be involved in setting timeline and installation criteria to ensure that laboratory procedures are not disrupted in a way that interferes with the research or production quality. The finance department may also be involved in decisions regarding large capital expenditures.

Smaller biotech firms are often less interested in investing in energy efficiency improvements due to their short-term leasing arrangements and project volatility. That said, there might be opportunities to work with smaller biotech firms by coordinating directly with the building owner/operator (such as HCP) in addition to the biotech customer. In this situation, the biotech firm's facilities manager may serve as the main point of contact and then work with the laboratory and/or research or production manager to consider upgrades.

Figure 5. Energy Efficiency Decision-Makers at Large Biotech Firms

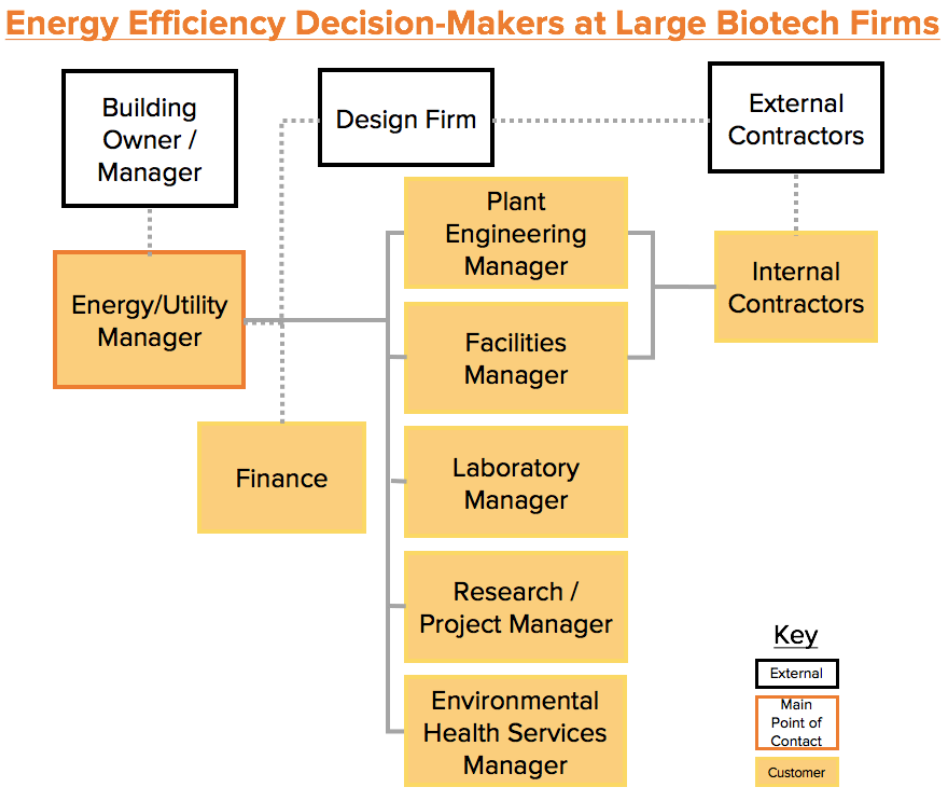
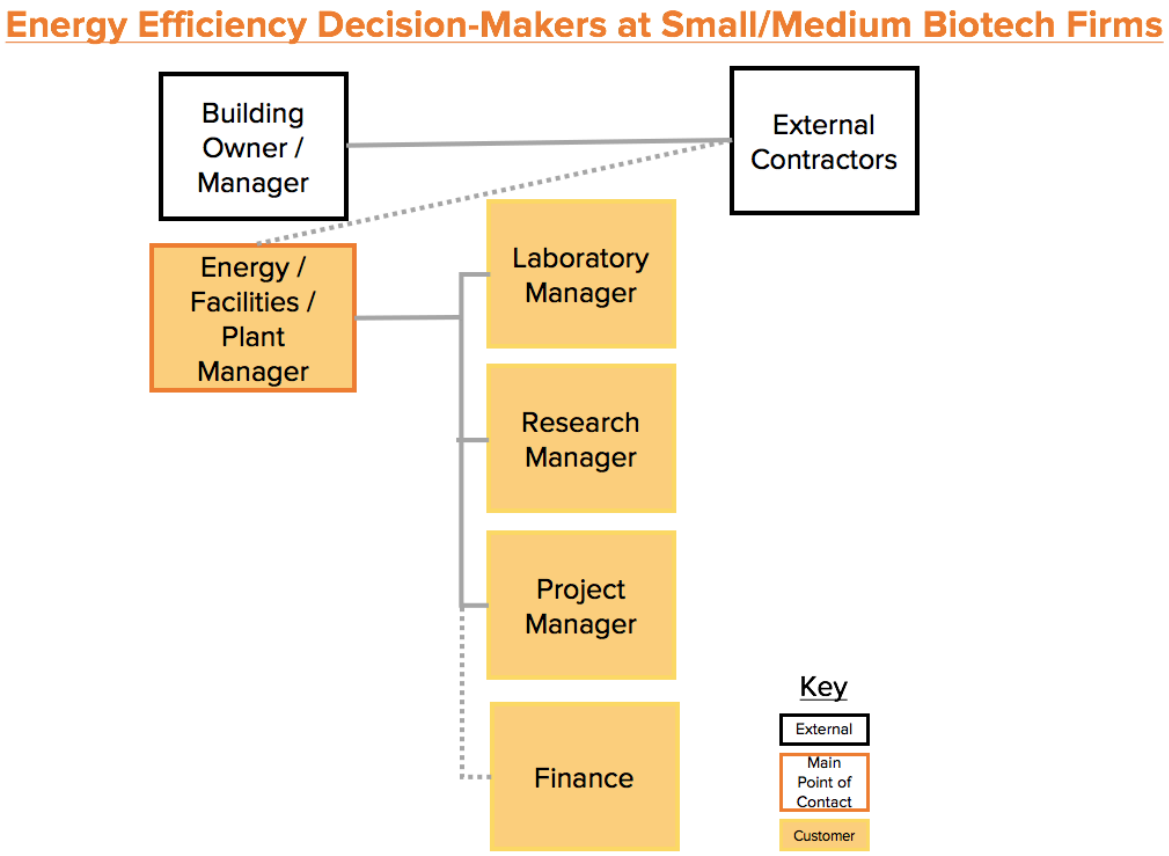


Figure 6. Energy Efficiency Decision-Makers at Small/Medium Biotech Firms



In addition to the biotech firms, key biotech market actors include:

- Real estate developers that build or retrofit structures for biotech research, development, and production
- Real estate lessors of biotech facilities
- Designers and contractors that work with the biotech companies to design facilities and install specialized equipment

Barriers and Opportunities

The biotech sector is characterized by the following barriers for increasing energy savings through energy efficiency:

- Market instability suppresses willingness to make capital investments or prioritize energy efficiency.
- A highly competitive, volatile market fosters high turnover and low information sharing.
- The PG&E custom review process is completely misaligned with biotech firm business cycles.

As described above, biotech firms are subject to the extreme highs and lows tied to R&D cycles, clinical trials, and mergers and acquisitions. It is difficult for biotech firms—especially small- to medium-sized firms—to justify capital investments that disrupt business processes or that cannot

promise a short return on investment. Furthermore, the permitting process may double project cost and be highly disruptive to the project. Regarding energy use, biotech customers are primarily interested in issues that affect reliability, such as outages, and in the services PG&E provides. Energy savings is not typically a top priority, and in fact, biotech companies may favor spending more on less energy-efficient equipment to ensure equipment performance and avoid upgrades. This can be especially true among start-up biotech firms that aspire to be purchased by larger firms within 24 months.

A low saturation rate of installed measures and high potential for new construction and retrocommissioning projects among the biotech subsegment also present opportunities, and a high-level look at program participation rates shows energy savings potential. In 2015, the biotech industry represented 3% of PG&E's commercial electric consumption and 4% of its commercial gas consumption.[6] Among PG&E's commercial biotech customers, roughly 5% participated in electric-savings programs and roughly 9% participated in gas-savings programs. The biotech sector was only recently identified as a subsegment in January 2016. Acknowledging the many barriers to participation discussed in this report, it is important to keep in mind that at least 90% of the biotech companies in PG&E territory have yet to engage with the energy efficiency programs.

In terms of new construction opportunities, large biotech firms like Genentech partner with real estate developers like HCP that specialize in biotech, as well as Lawrence Berkeley National Laboratory (LBNL), to design and build large new facilities in PG&E territory using techniques that allow buildings to consume 35% less energy than the national standard.[7] Working through programs like Savings By Design, large biotech firms can ensure they exceed code and cost-effectively introduce more energy efficiency measures into their plans. By contrast, small- to medium-sized biotech firms rarely reach out to PG&E for reasons other than outage management. Their primary interests are reliability and ensuring their work can move along quickly and efficiently. Given that (1) many small- to medium-sized companies lease space and do not necessarily expect to remain in one space for extended periods of time, and (2) developers and building owner/operators specializing in biotech are retrofitting existing office spaces for biotech firms, there may still be opportunities at the concept design stage to partner with building owners and operators, as well as real estate developers like HCP, to incorporate energy-efficient equipment and designs in their retrofitting designs.

The second barrier is the highly competitive, volatile nature of the biotech market. It is difficult to make customers aware of opportunities and to establish the long-term relationships needed to execute bigger projects. There is no local biotech industry association event where PG&E can quickly and efficiently distribute information about energy savings opportunities for biotech firms, raise their credibility by touting past project successes, or help define energy efficiency "best practices." Biotech companies are extremely competitive with each other, so information sharing does not regularly occur among the firms.

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[6] Pacific Gas and Electric Company. *Energy Efficiency Business Plan 2018-2025*. Retrieved from https://docs.wixstatic.com/ugd/0c9650_cbeb1d9e14cf4575845e8d5cd6bce57f.pdf.

[7] Leuty, R. (2015, May 21). Genentech's big experiment: Biotech goes green, thanks to Berkeley lab. *San Francisco Business Times.* Retrieved from https://www.bizjournals.com/sanfrancisco/blog/biotech/2015/05/genentech-lawrence-berkeley-building-35.html.

PG&E has spent years developing trusting, one-on-one relationships with large biotech customers. A PG&E strategic account manager may work for a year or more to help a large biotech customer design a custom project. Disturbing the research laboratory or production line is a more complex endeavor than working on, for example, common area upgrades, and upgrades in secure, regulated environments require a larger number of stakeholders to make decisions about appropriate adjustments. Specific security levels and access must be approved before work can begin. As such, it is important for the company to have an internal "energy champion" who commands respect within the organization, understands how to navigate the regulatory, security, and facility needs, and can influence other lines of business. This person is motivated to stay engaged and can work towards energy efficiency goals as part of their job. Once the trust and relationship is gained, however, the stakeholders can change quickly due to volatile market conditions, such as layoffs that drastically reduce energy consumption and, potentially, the loss of energy management champions. The scope and priority of the project can also change quickly depending on internal needs; for example, the approval or rejection of a clinical trial can radically alter the need to upgrade laboratory equipment.

The related opportunity lies in using existing relationships as a foundation and expanding the network of contacts within a customer organization. After PG&E completes one successful project with a large biotech customer, it is more likely that they can accomplish additional energy savings projects within that company. As biotech firms branch into projects that include electric vehicle infrastructure and on-site generation, having a trusting relationship and a good experience conducting an energy efficiency project enables PG&E to engage the customer in broader conversations about the role of energy efficiency in distributed energy resources plans. While a strong relationship with an energy champion is important, having connections with others involved in energy-related decisions can help move projects forward. In a large biotech firm, for example, the regional office members may have sway over energy efficiency project decisions but may also need approval from those who manage the finances out of a headquarters office in Boston or New Jersey. When getting to know a customer, a quick scan of LinkedIn can help connect the dots to determine which types of decision-makers are in which offices.

The third barrier refers to the difficulties with navigating PG&E's internal processes and custom review requirements. Like other sectors, large capital investments go through a project lifecycle consisting of project initiation, concept design, detailed design, bid, construction, measurement and verification, and commissioning. Decision-makers determine whether or not to pursue a rebate at the concept design stage when budgeting, schedule, and resource allocation decisions are made. In terms of operations, biotech customers are more similar to industrial customers than commercial customers. The measures installed are almost always custom measures, which require additional review. The ex-ante review process impedes PG&E's ability to sell and implement projects in a timely enough fashion to meet customer needs. The review process takes, at minimum, three to six months to complete, which far exceeds biotech companies' timelines for making decisions about how to allocate funds, and customers often have access to funds for limited amounts of time before they must reallocate it to other projects. This misalignment makes it difficult for customers to reserve funds for energy efficiency projects while awaiting approval from PG&E. If customers are proactive and approach PG&E about potential projects, then it is considered free-ridership and those projects are not eligible for incentives. Customers are also not allowed to pilot the installation in one location and then implement the measure campus-wide because campus-wide implementation is then considered "industry standard practice," regardless of the fact that it may not be cost-effective to install the equipment without incentives.

For those projects that overcome the planning and resource allocation barriers, the likelihood of receiving the promised incentive presents yet another barrier. A project may progress through the program, then after the review process is completed the customer may find that the anticipated incentive amount was significantly reduced. For example, a customer recently applied for a large chiller project that required custom calculations. After spending substantial time preparing and submitting an application for PG&E's review and working through the custom review process, a CPUC disposition used deemed hours for biotech processes instead of custom calculated hours for the chiller and, as a result, the CPUC reduced the expected $1.5 million incentive to $60,000 on a $2 million project. According to the customer, this incentive was not enough to pay for the taxes on the project.

The implementation of AB802 may present the best opportunity to work around these barriers. Measuring savings at the meter may allow customers to avoid a custom measure review process and to accelerate the approval process. The anticipated guidance on AB802 implementation will likely include an interpretation of how to establish baseline calculations, which will in turn affect how projects are planned, implemented, and approved. One large biotech customer anticipates that implementing AB802 will help them make lighting and HVAC upgrades that are currently on hold due to a lack of sufficient incentives to make the projects cost-effective (i.e. using an existing equipment baseline as opposed to code baseline would increase savings potentially making projects cost effective). On a related note, the customer also expects that changes in on-peak, mid-peak, and off-peak hours will alter the way they manage and use energy, including their HVAC hours of operation.

How PG&E Can Improve Biotech Services

According to strategic account managers and one large biotech customer, PG&E has an opportunity to improve biotech services in a few ways. PG&E could:

- Do more to identify where older equipment exists that could be upgraded
- Streamline PG&E processes to encourage participation at the concept design stage
- Clarify and simplify the program structure, because the number of programs available leads to customer confusion
- Provide higher incentives for customers with minimal to no program participation

As noted above, very few biotech customers have participated in programs, and there is likely a substantial amount of equipment that could be upgraded. PG&E could do more to help customers identify equipment eligible for upgrade.

A common theme across the sectors is that PG&E needs to refine internal processes to speed up approval processes. When strategic account managers work for years to establish relationships with biotech firms, a project is designed, and then the customer waits two years to find out that it is not going to be approved, PG&E loses credibility with the customer and misses opportunities to improve energy efficiency with its largest energy consumers. It is possible for PG&E to increase likelihood of approved projects by submitting a work paper (e.g., develop deemed savings for biotech facilities that operate 24/7), but the work paper development and approval process takes longer than customers may be able to wait. While much of the delay revolves around the custom review process, there are other areas in which PG&E can improve their processes. For example, PG&E could improve participation in finance programs by processing loan approvals more

quickly and increasing financing amounts. A customer can have a custom project approved, paying contractors on standby, and end up waiting up to two months for a loan document to be approved. The longer the customer has to wait for a loan approval, the more precipitously the customer loses potential savings from the project. This erodes willingness to participate in the program.

Loan amounts can also be too small for large customers to benefit. Small- to medium-sized customers operating at a $250,000 revenue level can benefit from $100,000 loans, but when large biotech firms want to pursue a $1.3 million air compressor project, $100,000 barely pays for the loan itself.

Finally, customers need a simpler, easier way to interact with PG&E's programs. They need clarity on program eligibility requirements, timelines, and approval processes.

Promising Technologies

PG&E strategic account managers and a large biotech customer identified the following equipment and support as providing the best opportunities to increase energy efficiency among biotech firms:

- Low-temperature freezers (-80 degree and -20 degree)
- Water-cooled chillers
- Laboratories/clean rooms:
    - Ventilation fans: fume hood airflow setback, production ventilation optimization, insulation repairs, variable-frequency drive motors, fan-speed modulation
    - Air compressors (not currently a measure due to Title 24 restrictions)
    - Specification designs for clean rooms
    - System optimization for purified water/water injection
- HVAC:
    - Air plenum design optimization to maintain air flow while reducing load on fans
    - Air handlers: variable-frequency drive motors, fan-speed modulation
    - Airflow rebalancing
    - Controls, schedule changes, set-point changes
    - Hydronic rebalancing
- Process boiler controls
- Steam traps (expires as a program measure in January 2018)
- Pneumatic controls (not currently offered as an incentive)
- Retrocommissioning
- LED lighting and controls

4.2 Data Centers

Five-Year Industry Outlook

The largest trend that will affect the data center industry over the next five years is companies moving away from using their own equipment in embedded data centers[8] spread across their facilities. For example, one customer said they used to have three server rooms in three separate buildings at one campus but in the last year two of those rooms have been closed. This trend is driven by three factors:

- **Reliability.** This is the number one factor that drives all decisions in data centers. Embedded data centers typically do not have the n+1 or n+2 redundancy that larger facilities have and are operated by facility managers (who are not as familiar with data center equipment) as opposed to IT specialists. As such, moving away from embedded data centers reduces the risk of downtime, as downtime even in embedded data centers is unacceptable. Additionally, within PG&E territory some companies are moving data center operations out of state where there is lower risk for natural disasters.
- **Space.** Companies now need massive amounts of data to conduct business, so space is becoming a premium. Many buildings are primarily office space where there is not the physical footprint to expand embedded data centers.
- **Economies of Scale.** Merging embedded data centers achieves a significant reduction in operations and maintenance costs.

As companies move away from embedded data centers, they are shifting to cloud computing and co-location data centers. The massive amounts of data companies like Google and Facebook require are resulting in hyperscale data centers that are built at a few discrete locations around the world. This shift to larger data centers impacts energy efficiency programs in that more capital is likely to be spent on measures oriented to larger scales, such as water-side economizers, in-row coolers, and containment on air systems. Hyperscale data centers also pose a problem for energy efficiency programs in that they are very focused on driving their power usage effectiveness (PUE) numbers as close to one as possible, making it difficult for utility programs to demonstrate influence on decision-making for evaluation of free-ridership. In fact, some of the companies that own hyperscale data centers compete with one another to see how little energy they consume.

While larger cloud and co-location facilities reduce operations and maintenance costs and minimize some risks, they do introduce other risks, such as a higher risk for cyber-terrorism. The industry is seeing the trend towards hyperscale data centers slow down slightly compared to previous years because the embedded data center is closer to the end user, playing an important role in “connectivity and how the information is routed.” Companies highly value speed, which is positively impacted by proximity to the data center. As such, even the large companies, such as Microsoft, have smaller data centers close to their customers. While some companies have policies of shifting loads out of the Bay Area due to PG&E’s high rates, experts agree the embedded data centers are not going away because of the proximity to customers factor. The one remaining embedded data center of the customer mentioned previously in this section houses customer-facing systems.

[8] For the purposes of this report, embedded data centers are defined as small data rooms or data closets that are housed within buildings whose primary use is not data centers (i.e. office buildings, banking centers, etc.).

The fact that embedded data centers won't go away entirely is a significant finding given embedded data centers are the primary type of data centers in PG&E territory. Unfortunately, embedded data centers do not have the scale or the profile to make pursuing efficiency easy, since it is cost-prohibitive (per square foot) to drive the PUE as low as in the larger data centers, especially as the companies behind them are hesitant to make major investments in embedded data centers.

All of the data center interviewees talked about how accurate energy savings calculations are important to their decision-making process since budgets are set based on payback and return on investment. The application of the baseline (either Title 24 or "as found" conditions) is a key issue with data center customers as this can significantly impact claimed energy savings. Experts reported that there is "monster" potential with AB802 for measures such as uninterrupted power supplies that would have small savings under Title 24.

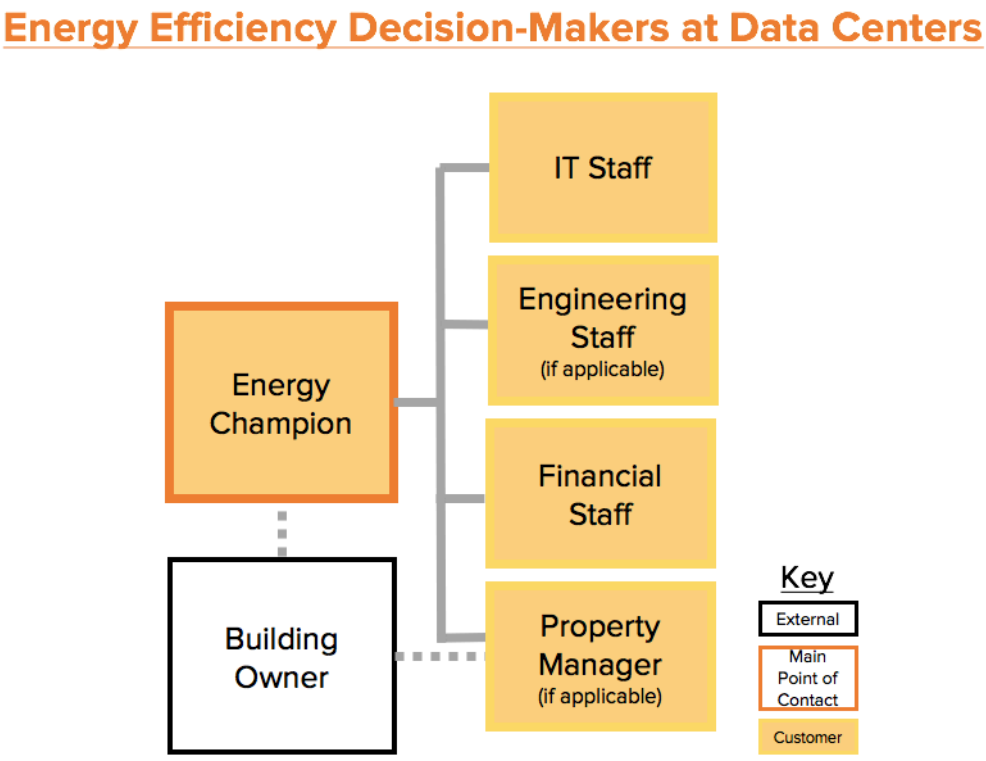
The final trend discussed by interviewees is a demand for additional, or even 100% renewable power. This is especially true for co-location or enterprise (companies that own their own data centers, such as banking, Google, etc.) data centers.

Key Market Actors

As discussed previously, most of the data centers within PG&E territory are embedded data centers. In addition to the data center firms, projects might also interface with contractors or manufacturers.

The primary stakeholder in data centers is the "energy champion," who influences decisions about energy efficiency equipment and operational improvements. This person may be a sustainability manager, a facility manager, or another person who commands respect within the organization, understands how to navigate the regulatory, security and facility needs, and can influence other lines of business. This champion could reside within the data center company or within a property management company, such as CBRE. The energy champion interfaces internally with other roles (primarily IT and finance staff) to budget, approve, and implement efficiency projects.

Figure 7. Energy Efficiency Decision-Makers at Data Centers



Barriers and Opportunities

Expert and customer interviews revealed two main barriers for PG&E to implement data center energy efficiency programs:

- Most data centers in PG&E service territory are small embedded data centers.
- PG&E program processes and timeline do not align with customer business processes and timelines.

The first issue with small embedded data centers is identifying them. There are likely hundreds in downtown San Francisco alone, but PG&E doesn't have any data to identify where they're located. To date, data-driven methods such as searching for office buildings with above average energy use or trying to use their load profile to identify embedded data centers have not been overly successful. PG&E reports that the signal doesn't register and that, at best, you can only guess whether a building may have an embedded data center. Asking customers which facilities contain embedded data centers has not proven any more successful, as companies are resistant to sharing this type of information for security purposes. As one expert suggested, "none of the current avenues [to finding embedded data centers] seem particularly attractive." Both customers and experts agreed, the best route is likely networking and relying on trusted relationships to collect this information, which would take a significant time investment. Another option may be for PG&E to approach large accounts with multiple locations, offering them a general program and allowing them to suggest embedded data centers they think might be good candidates.

After identifying embedded data centers, it is important to craft messaging that fits the particular customer. For instance, it's hard to get approval for embedded data center efficiency projects

from large companies such as Microsoft or Google because the per-square-foot investment is too high, especially in comparison to their large or hyperscale data centers. These larger companies also don't really care about energy efficiency in embedded data centers. In this case, programs that can reduce cost and streamline participation, such as using deemed savings, can make it more attractive for customers to participate. Smaller companies with embedded data centers aren't aware they consume too much energy. Additionally, many of these facilities are run by an IT manager whose primary goal is reliability and up-time, and who may view any potential environmental changes as too risky. In these cases, engagement may focus on building understanding.

The second barrier in this subsegment is the misalignment between the PG&E program process and timeline and the customer business process and timeline, as illustrated in Figure 4. There are three main disconnects within the processes and timelines:

- PG&E incentive process and customer budget cycles
- Timeline for PG&E project approval and timeline for customer budget availability
- Calculation rigor

These are complex issues that are highly intertwined with each other.

First, interviewees discussed how customers have tight capital expenditure budgets and generally have troubles getting approval for projects that have longer than a two-year payback. Therefore, they reported that including the incentive payment in the budgeting process is essential for reducing projects' payback and getting project approval. However, the current rebate process mandates that if a customer has already budgeted a project they are no longer eligible to receive an incentive. This requirement serves the utility's need to demonstrate influence (i.e., the project would not move forward without the incentive) and their need to demonstrate awareness (i.e., the customer learned of the measure because of the program). This misalignment creates a chicken and egg problem between the customer and PG&E with respect to the timing of the incentive payment and is illustrated in Figure 4. The incentive is at the beginning of the customer process, but at the end of the PG&E process.

The second misalignment concerns project approval timelines. In the case of small embedded data centers, both of the utility's conditions for evaluation can be met (customers wouldn't have done the project without the incentive and they learned of the measure from the utility) but there is also a timing misalignment between customers' budgeting cycle and PG&E's review cycle. Interviewees reported that customers have a discreet timeframe during which the budget is available and money has to be spent, otherwise it is reallocated to other projects. Therefore customers have a short window in which to order equipment. However, within PG&E's process the project has to be approved before the customer can order the equipment. For data center projects, which fall into the custom project process, interviewees reported that it can take 6 to 12 months for project review and approval. This is two to three times longer than the interviewees' reported customer business cycle. As illustrated in Figure 4, the customer process is often completed before PG&E engineering calculations are completed. Interviewees reported that the length of the engineering calculations and project review put projects at risk. The time required for engineering calculations and review also results in lost opportunities when customers have excess budget they want to put towards energy efficiency, but don't because approval can't be received before the money has to be spent. Customers may also receive sudden internal funding for a project, which current PG&E processes cannot accommodate.

The third misalignment in this subsegment resides in the calculation requirements. Detailed trend data is required to accurately calculate energy savings for incentives. The trend data can either come from PG&E through a "complicated request" that could take three to six months for PG&E to complete, or the customer can provide the needed data if they already have it. However, customers might have to hire a vendor to access the data, requiring customer investment for a project that may or may not come to fruition. Interviewees also discussed how the many layers of engineering review is the primary driver behind the extended timelines. They discussed how "three different internal reviews" are required for tasks such as developing calculations, reviewing calculations, reviewing the project, and inspections. One interviewee said there "are so many layers of engineers it doesn't make any sense." The interviewees stated that a PE stamp on a calculation should be good enough and only a cursory review should be needed. Additionally, the engineers' goals don't align well with program goals. Third party implementers are paid based on performance estimates—if they don't meet their savings goals, their payments are reduced. In-house PG&E engineers' goals are to match the third-party calculations. By the end of this long process of trying to match savings calculations the engineers have met their goals, but the customer does not have project approval. The goal of the program, however, is to have approved projects.

Aligning engineering and program goals and reducing engineering calculation times are major opportunities for this subsegment, along with providing calculation support for customers. As discussed, interviewees reported that it can be difficult for customers for allocate time for project assessment unless they have some sense of potential energy savings and incentive amounts. Market experts emphasized that this initial step of giving customers an idea of savings and incentive amounts is one of the most important steps in a data center project and that offering calculation assistance could help solve some of the chicken and the egg dilemma discussed above.

Both the experts and the customers interviewed reported that most issues would be resolved if the PG&E engineering calculation and review process could be significantly shortened—as low as 10 business days—as illustrated by the "Customer Desired PG&E Process" line on the bottom of Figure 4. If shortening the timeline were possible, the misalignment between the timing and use of incentive would also be resolved as the PG&E process would the fit within the customer process. Thus, all interviewees reported this as the most significant action PG&E could take to improve their programs.

Outside the process and timeline discrepancies, all interviewees also reported that the regulatory process required to participate in PG&E programs is a major barrier. When customers assess the amount of information required, the complexity of the process, and the timeline for approval along with current incentive rates (especially compared to prior years), they often "don't want to bother with the program."

The final barrier discussed by interviewees is the requirement that data center programs can't pay the incentive until the load materializes on the system. This poses a hurdle in new construction and major retrofit projects as this requirement stretches out the payment by three to four years. As discussed, one of the major trends in the data center market is the shift to co-location facilities, so this barrier is expected to become more significant in the future. Interviewees expressed an interest in the ability to receive a partial incentive based on load and

efficiency for the first year of operation, second year of operation, etc. This would better align incentives with project capital expenditures and facility loads.

How PG&E can Improve Data Center Services

As a part of the discussions, interviewees discussed four areas for improvement in PG&E data center programs:

- **Marketing of third-party programs**. Customers reported they were very knowledgeable about internal programs, but know virtually nothing about third-party programs. The customers reported learning about third-party programs through their personal networks, not from PG&E account managers or third-party implementers. Customers want to know about all the programs and measures available to them, ideally from their account managers.
- **Identifying opportunities**. Interviewees believed that PG&E can conduct more robust data analysis to identify buildings to target as poor performers. PG&E can then provide a scoping audit to identify specific measures and guide the customer to appropriate opportunities.
- **Linking energy efficiency to other business drivers**. Data center customers are continuously requesting energy usage for calculating carbon footprint. These requests could be leveraged into measures that can increase energy efficiency and reduce carbon footprint.
- **Consider offering a consolidation incentive**. While the industry trend is going to co-location facilities, doing so is costly. One interviewee suggested that a consolidation incentive would benefit both parties—customers would save considerable operations and maintenance costs in the long run, the singular room could have modern and highly efficient equipment, and PG&E could potentially save on service costs.

Promising Technologies

When considering the best energy efficiency opportunities within the data center market, hyperscale, large, and embedded data centers must be considered separately as the technologies and opportunities within them are different.

Large and hyperscale data centers are well managed and interviewees agreed that there is not a lot of remaining opportunity. One expert interviewed reported they are approaching a PUE of 1.0. Another customer has done hot/cold aisle separation, VFDs, air conditioning, LED lamps, lighting controls, and R-rated servers. The interviewee said he “doesn’t know what is left to do—it seems like free outside cooling is the only thing left to do,” but that is expensive to do in retrofits. Experts also said that outside air will be their primary consideration in the future, especially in new construction.

There are more opportunities for energy efficiency within smaller embedded data centers. In this market, companies with tight budgets and no in-house expertise focus on cheap but effective opportunities. They need measure packages that do not require significant levels of technical work or understanding. Instead, they simply need a guarantee or assurance from PG&E that it will work and pay off.

According to both expert and customer interviews, the biggest opportunity is power management, which allows equipment to be turned off. Power management should also be the

first step in any efficiency project as it allows for the implementation and control of subsequent measures. This was confirmed by one customer interviewee who said "everyone wants to monitor the load. . . and give them a monthly report down to the rack level." PG&E's *Energy Efficiency Business Plan* also calls out improved power management software as one of the contributing factors to an only modest increase in energy consumption in enterprise-level data centers (4% increase instead of a previously seen 24% increase).

After power management, the next opportunity is more efficient HVAC systems. Most embedded data centers have small direct expansion systems, and potential opportunities with these systems include making evaporative cooling modifications to packaged units and using a mist system instead of air for cooling. Another product that shows promise is HVAC Armor, a coating that is applied to condenser coils and is designed to help keep the coils cleaner, thus improving heat transfer. Interviewees also discussed water-side economizers and in-row coolers.

There is also significant discussion within the industry about the energy consumption of the servers themselves, and many believe this is the next big step for efficiency in data centers. Decreased heat output from servers means decreased needs for infrastructure to cool them, which means energy savings with the servers also leads to energy savings with uninterrupted power supplies, air distribution, HVAC, etc. However, one expert noted that it could be a significant amount of time before cutting-edge technologies like submerged systems are included in utility programs.

Additional Considerations

Interviewees discussed how data center customers have other priorities that drive their business, and having regular contact and rapport with customers is essential. PG&E should continually discuss what is going on in customers' facilities, assess opportunities, and probe how they could support customers in order to successfully influence their decisions and participate in energy efficiency programs.

4.3 Real Estate

EMI Consulting interviewed one expert within the real estate market and no customers. We present the information from the single interview in this section, but note that the findings may not be representative of others' opinions and are not comprehensive.

The real estate subsegment is a diverse market in which there are three primary ownership structures:

- Corporate accounts are owned and occupied by a single company such as Google, AT&T, PG&E, Facebook, etc. They have corporate teams whose responsibility is sustainability. The Vice President of this team has budget and decision-making authority. This is the easiest ownership structure in which to do capital intensive or whole building projects, as tenants are employees and the company owns the building.
- Investor-owned is where a fund, such as a pension fund, owns the building, the building is third-party managed, and it has multiple tenants. In this case there is not a single decision-maker who owns the property and can make investment decisions. These buildings are typically LEED rated and close to 100% occupied, and investments are typically only for aesthetics.

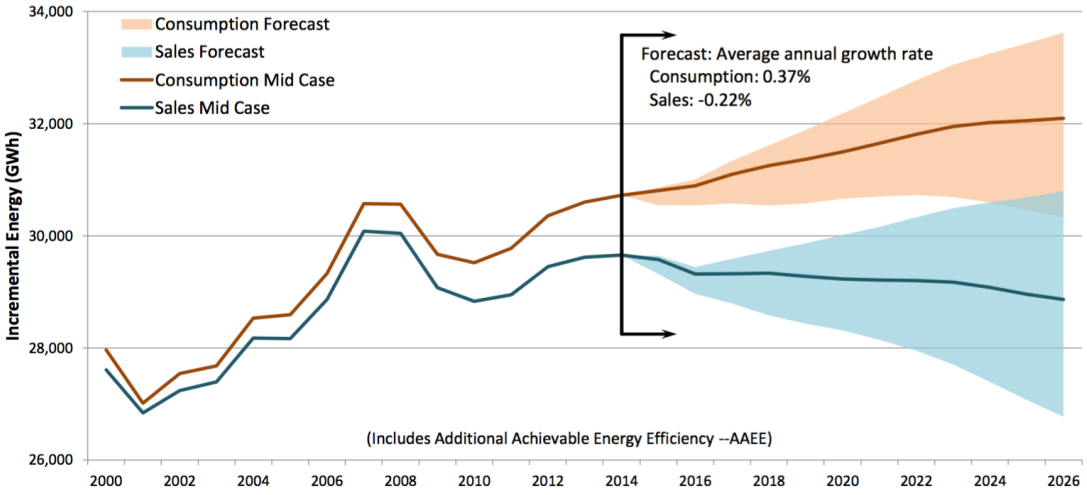
- Real Estate Investment Trusts (REITs) are individually owned by a company and modeled after mutual funds, where the ownership company is looking for a regular income stream as well as long-term capital appreciation. Similar to corporate accounts, REITs may have a Vice President of Sustainability who makes energy efficiency decisions for a region or the company's portfolio of facilities, but like investor-owned properties they have multiple tenants, which makes whole building projects challenging.

Ownership structure has a significant impact on PG&E's ability to engage any particular building, the decision-making process regarding how investment dollars are spent, what motivates participation in efficiency programs, and the opportunities and barriers within the facilities. The sections below discuss these aspects of the market and delineate differences due to ownership structure where they were found.

Five-Year Industry Outlook

The real estate market, in particular large commercial offices, is a technically savvy group that desires the latest and greatest technologies so they can keep ahead of their competitors. Both the expert interview and PG&E's *Energy Efficiency Business Plan* highlight that this market will be increasing renewable energy use (i.e. solar) and self-generation into the future, as depicted in Figure 8.

Figure 8. Commercial Consumption and Sales Forecast[9]



This market is also increasingly interested in real-time data at a very granular level—down to the per-floor or per-tenant level.

Executives in this market are very aware of the tangible (lower operating costs, rent premium, increased property values, etc.) and intangible benefits (enhanced ability to hire and retain employees/tenants, increased sales, etc.) associated with energy efficiency projects and some use these benefits to derive a competitive advantage. For REITs, the cost reductions achieved by energy efficiency projects go directly back to shareholders. However, for some Class A spaces

[9] Pacific Gas and Electric Company. *Energy Efficiency Business Plan 2018-2025*. Retrieved from https://docs.wixstatic.com/ugd/0c9650_cbeb1d9e14cf4575845e8d5cd6bce57f.pdf.

that have 100% occupancy, there is little motivation to do efficiency projects despite the known benefits.

On the other hand, there is significant ownership turnover in this market that is expected to continue. This turnover has significant impact on the opportunities and barriers in this market, discussed in detail below.

AB802 is expected to have a positive effect on the real estate market. The ability to approach projects at the whole building level and count savings at the meter should:

- Reduce the project timelines
- Simplify calculations
- Align owner's vision of incentive levels (based on current equipment and building operations) with actual incentive levels (based on code)
- Open up higher amounts of project funding as owners are more apt to approve a larger pot of money over calculating individual metrics

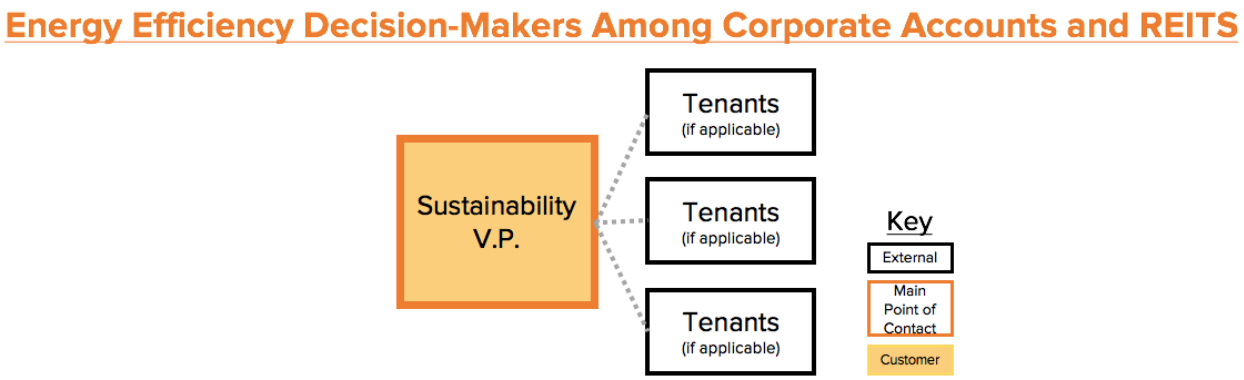
It is believed these benefits of AB802 enactment will help to renew motivation for energy efficiency participation in the real estate market.

Key Market Actors

PG&E's *Energy Efficiency Business Plan* accurately reflects the real estate market key actors when it describes them as a "messy matrix of inputs." Often there are multiple levels of decision-makers, each with their own values and priorities. This makes it somewhat difficult to identify common decision-makers, decision-making criteria, and processes, all of which are critical for PG&E to understand in order to engage the right actors at the correct time with the appropriate information.

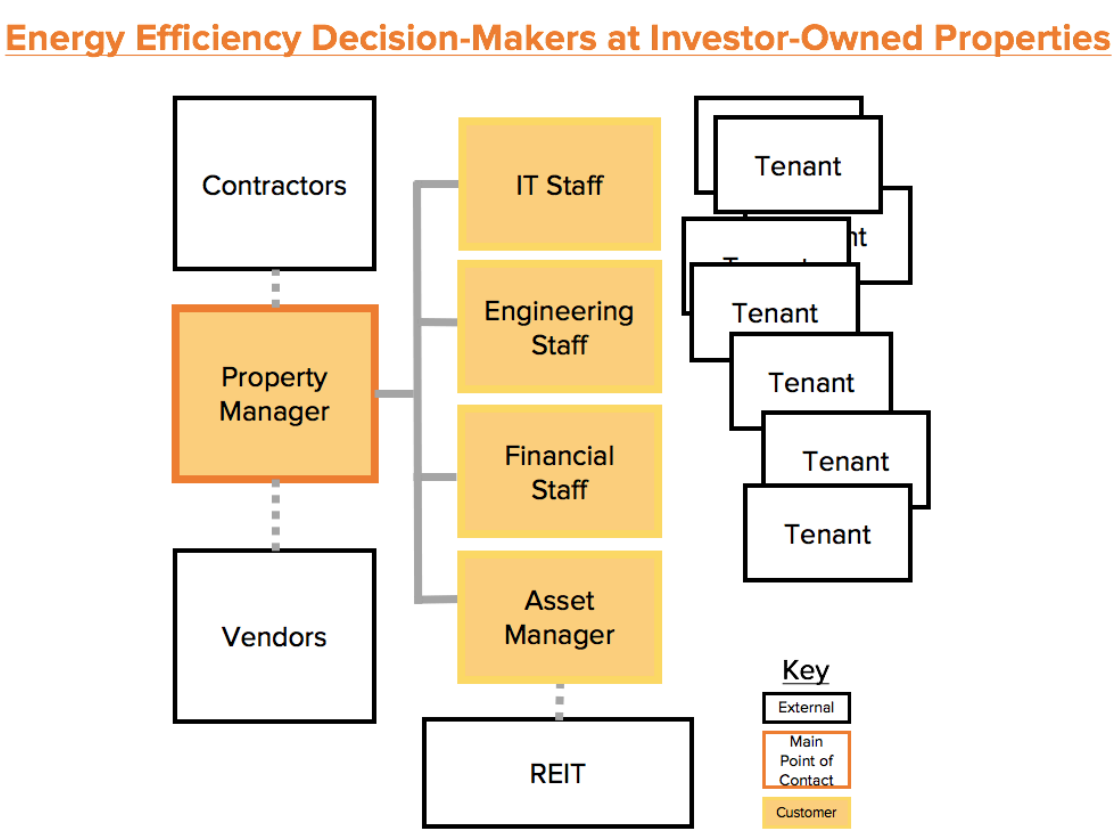
Corporate accounts and REITs are easier ownership structures to characterize. For corporate accounts the decision-maker is generally a single person, such as the VP of Sustainability. That person needs a proposal from PG&E that lays out the project, the incentives, and the expected return on investment. In turn, PG&E needs the energy savings calculations approved by the CPUC. These projects can be large—even whole building projects—and the decision-maker has the authority to approve projects for their portfolio. REITS are similar to corporate accounts but their tenants have long-term leases, making whole building projects challenging.

Figure 9. Energy Efficiency Decision-Makers Among Corporate Accounts and REITS



Investor-owned properties do not have a single person who can approve efficiency projects. Instead, motivating the property manager with the potential of efficiency projects is the key in these buildings. Potential projects are presented to the property manager, who takes the opportunity to the asset manager, who represents the owner. In some cases, property managers have a small expense funds they can use on small projects, but capital projects must go to the asset managers for approval from the fund. In these buildings, projects are often done piecemeal, instead of at the whole building level like with REITs. The decision-making process is also compounded by the fact that these buildings are usually occupied by many tenants, in which case the split-incentive dilemma may come into play when considering energy efficiency projects. While not including investor-owned buildings in efficiency programs may seem the easiest course, they comprise roughly 35% of the real estate market in PG&E territory. It is desirable to develop relationships with property management companies who have portfolios of buildings within their purview.

Figure 10. Energy Efficiency Decision-Makers at Investor-Owned Properties



Barriers and Opportunities

The interviewee discussed three primary barriers within the real estate subsegment:

- Building ownership turnover
- PG&E data availability
- Investor-owned buildings' decision-making structure

The turnover of class A office spaces in PG&E territory is quite high—it's believed a large proportion of buildings change hands every few years. Combined with the fact efficiency measures with large capital expenditures have long sales cycles, this poses a significant barrier to energy efficiency programs as owners are reluctant to spend money in the short timeframe they own the buildings. However, changes in ownership also represent an opportunity. The interviewee reported that building transfer is the best time to propose energy efficiency upgrades as the old owner may wish to complete upgrades before they sell or the new owner may have a different outlook and want to make efficiency upgrades. That said, it is difficult to identify when a building will change ownership. Industry resources such as BOMA have not been extremely useful. Instead, the relationship between property managers and PG&E account managers have been the most successful in identifying upcoming transfers.

Ownership change of a building poses a data barrier for PG&E, because when the property changes owner names, the data associated with that building (including energy usage and program participation) is archived. While the data is not completely gone, it is extremely difficult to recover in a meaningful way. After "digging and conducting research," the resulting data could be missing large amounts of information and could include incorrect information or information from another customer. The following example was provided: "Company A has Property 1 for two years and sells to Company B. Company A buys Property 2 and owns that for three years. If PG&E pulls a data query for Company A it may include Company A's Property 1 data and Property 2's data, instead of Property 1's data for the last five years." As discussed with the interviewee, energy management and information systems offer a potential solution to this barrier in that they can house historical meter data for a property, offer analytics to make it easier to understand energy use, record the specific equipment in the building, and use this information to identify opportunities. There is an opportunity for PG&E to use these data analytics to help their customers as an energy advisor.

The final barrier has already been discussed above, and that is the fact that investor-owned properties do not have a centralized decision-making structure. As such, it is extremely difficult to get approval for capital expenditure projects in these buildings. In these cases, it was discussed that efficiency programs may be a service offering, especially as the historical savings in these projects have been extremely low. Alternatively, if PG&E can find a large tenant that occupies a majority of the building, they may act as a strong ally in moving a project forward. Developing relationships with property management companies who have a portfolio of buildings is another possibility.

Two other opportunities were mentioned by the interviewee: the potential for savings at the meter as a result of AB802, and using positive marketing to create additional project value. If AB802 allows the program to measure existing conditions as a baseline, even if it is below code, it could save a lot of time and effort and the interviewee thinks it might increase customers' motivation to participate in programs. They believe customers are more apt to give PG&E a larger amount of money for a whole building program than to calculate metrics for a series of individual measures. Additionally, Class A offices like to have labels on their buildings or other things that are visible to the public, and the interviewee suggested that the program could include a competition to see who could reduce the most or implement the most measures, with significant fanfare around the winner. The interviewee discussed how PG&E could give buildings a flat screen in the lobby, and how thousands of people from different companies go through those

lobbies and could take that information about what the building is doing to their corporations or their home.

Promising Technologies

The largest opportunity identified by the interviewee is the use of energy management systems (such as Retroficiency, FirstFuel, Pulse, Lucid, etc.) to give property managers real-time usage information so they identify potential measures and practices to help their buildings run well. These systems can also be used to reward people (i.e., tenants) who want to see and reduce their energy use. Lastly, PG&E would like these tools to be used by third-party implementers to identify and bring PG&E opportunities within this segment. Recommendations need to be actionable and urgent in this market.

There is a lot of hype in the commercial office market right now around whole building programs, such as retrocommissioning. However, these types of programs can be challenging in buildings where there are many tenants with different drivers, including some tenants that do not want any interruptions. In these cases, measures around central plants, chillers, rooftop units, or common area lighting are more appropriate than measures within tenant spaces.

Additional Considerations

The only additional item discussed during the interview is how difficult it is to distinguish opportunities in this segment, as the end uses can be varied depending on whether the building houses retail, banking, offices, embedded data centers, etc. Using energy use intensity as a means for identifying potential equipment or opportunity has not worked well in the past. Instead, looking at square footage and kW is another possible path.

4.4 Telecom

Five-Year Industry Outlook

Reliability is the highest priority within the telecom market. Maintaining or increasing reliability is what guides business decisions, including investments and willingness to make changes to facilities and equipment. Telecom companies are also in a highly competitive market where they strive to be bigger, faster, and even more reliable. This requires significant infrastructure improvements and interviewees reported that future growth will consist of higher density/intensity of infrastructure. This will be accomplished by installing many micro and mini sites, boosters, and increased infrastructure into existing buildings as telecom companies are looking to maintain or reduce their real estate. One interviewee discussed how they are “trying to use the real estate we already have” to grow their infrastructure and another discussed how they are “right-sizing their traditional real estate” by consolidating lab space, data centers, and condensing office spaces.

The result will be a large increase in energy consumption in this market—one interviewee is expecting to double their energy use. As an example of how densification can significantly increase energy use, one interviewee said, “there is a lot of network and telecom gear they could sneak in a 12kW rack of equipment within a very small footprint that requires tons of cooling in a little spot.” However, interviewees responded that as the density/intensity goes up, there is less you can do in the facilities as the increased consumption is from the additional IT equipment.

One interviewee reported that today, before densification, 50% of the consumption is on the facility side—the rest is from network power consumption.

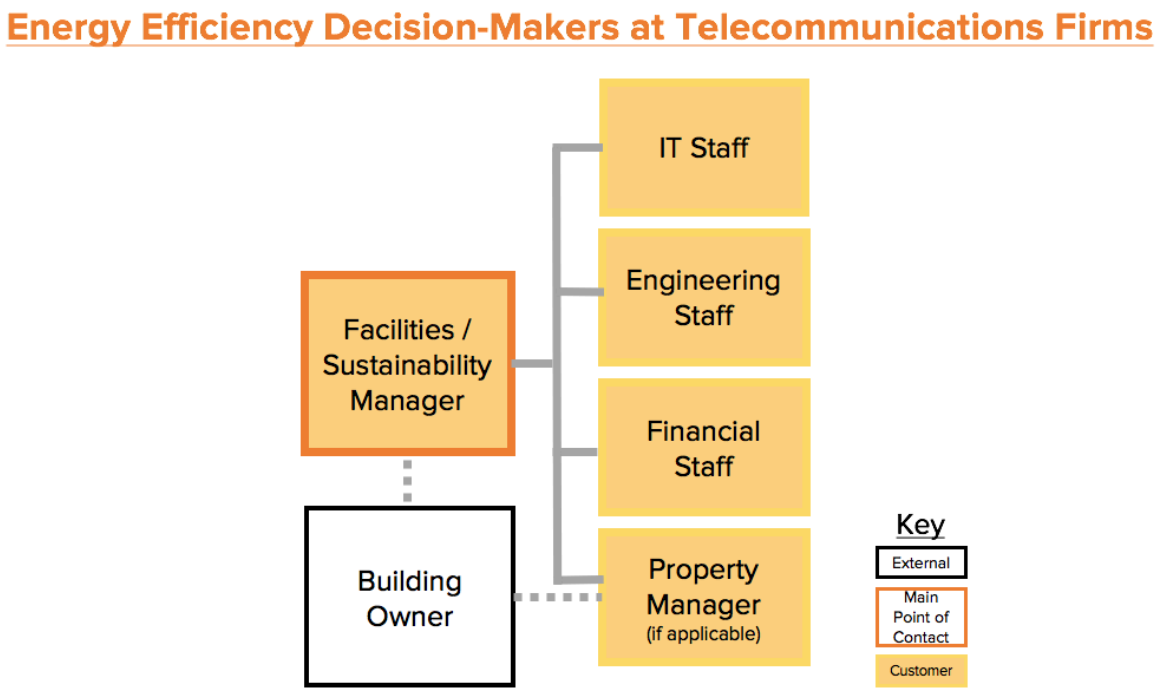
The interviewees are also expecting their energy costs to rapidly increase. Over the coming few years they will be working to reduce their energy costs as they are increasing infrastructure. One interviewee reported their team's goal is to "avoid additional costs and keep costs as low as possible." The primary way telecom customers are looking to reduce costs is through investing in renewable generation and by investigating storage and independent utility districts. One interviewee reported "[my] boss would say the number one important thing is the increasing cost of energy. This has caused us to invest in solar." Another interviewee has installed fuel cells to provide redundancy (i.e., increase reliability), add capacity, and reduce energy costs. Many of these companies also have greenhouse gas reduction goals for 2020 that are driving their adoption of renewable technologies.

The cost to do business in California is expensive and is reported by interviewees to be the second highest cost in the country. As such, companies are assessing their facilities and locations to see where condensing or moving facilities could cut energy costs. While the telecom industry consolidates facilities like the data center market, it is also important to have local facilities close to customers. Telecom companies see buildings as a part of the network, and having "hubs and nubs" in big cities would make it difficult to move out of PG&E territory completely.

Key Market Actors

The primary stakeholder in the telecom subsegment who influences decisions about energy efficiency equipment and operational improvements is the Facilities Manager. The facilities manager interfaces internally with other roles, primarily IT and Finance staff to budget, approve, and implement efficiency projects.

Figure 11. Energy Efficiency Decision-Makers at Telecommunications Firms



Barriers and Opportunities

The interviewees discussed six barriers within the telecom market:

- Reliability
- Tight budgets
- Challenges with customer business processes
- Regulatory environment
- PG&E's program process being too slow
- Data availability

As discussed in the previous section, reliability is the highest priority within the telecom market. Maintaining or increasing reliability is what guides business decisions, including investments and the willingness to make facility and equipment changes. Concerns about reliability makes it challenging to make changes in telecom facilities. Many telecom companies have customers with 24/7 operations, such as 911 call centers, that cannot have any downtime. Energy efficiency is perceived as risky because there is a chance that energy measures might disrupt operations, which would have high financial consequences. One interviewee discussed how energy savings are "dwarfed" in comparison to the revenue a building is making through the network. They discussed how "an average building in PG&E territory may gross $20 million—so when the energy people come in and tell them they can save $100,000 in energy the network guys don't care." Another interviewee gave the example that if a network building loses a server card it could cost the company $60,000 in revenue, almost cancelling out the entire project savings with one down card. While making changes to the HVAC, lighting, or other facility equipment is seen as risky, switching to cloud servers is known, saves energy, and also adds capacity.

Telecom interviewees all reported operating within tight budgets with very strict payback metrics for expenditures. One interviewee said their company only invests capital in things that make

them money or expands their capabilities. This same customer also said they want to pick and choose those things they are interested in doing. A second customer operates in a "run to fail mode," where even if a project makes sense in the long run the capital expenditure budget available to fund a project does not exist. This customer finds it hard to fund a project with a three-year payback, as they have a hard line as to whether projects are "worth it or not." Both customers reported that "participating in PG&E programs isn't even worth it," because the incentives are too low. One provided the example of an HVAC project where installing the more efficient system would cost $250,000 but the incentive was only $5,000; going after that $5,000 was not worth the time it would take to apply and go through the process. Experts in this market agree customers don't look at the overall amount of savings—both energy and financial—when considering efficiency projects. In this case, it is the thinking that needs to be changed. PG&E can help overcome some of these barriers by better communicating how energy efficiency can actually help save them money or increase revenue over time. For example, one customer asked for help to quantify the costs of deferred maintenance.

In addition to tight budgets, telecom customers reported that their own business processes are not conducive to PG&E's calendar, timeline, and requirements to participate in programs. One customer discussed how their company does not have a well-defined process for making decisions around energy efficiency projects. They provided the example of moving into additional floor space: first, they create a scope of work that includes items such as functional requirements for the lights and HVAC and where they want the electricity brought into the facility. Then, they bring in a variety of contractors to put together a bid. Those bids do not include anything related to energy efficiency because their company pays the contractors a price to do the specified work, which does not include efficient equipment. Based on the bids, the company chooses a contractor and has the work done. Internally, this customer has been challenging the company's engineering department to ask the contractors to offer them more efficient equipment that qualifies for a PG&E incentive, but this means increased costs and the concept has not been supported. Additionally, they reported contractors are not good partners for energy-efficient products because incorporating them takes more time and money. Another customer said they "haven't participated in PG&E's programs because of [their company's] business operations (i.e., run-to-fail operation)."

All interviewees identified the regulatory environment as a major barrier for telecom customers. They discussed how the amount of regulation in California is a big problem for business and how expensive it is to do business in California. They specifically cited the issue is the "CPUC system in California and the way utilities are run." As a result, telecom customers interviewed believe deregulated markets will be better for California businesses and are tracking the independent utility districts being formed across the state. They believe these are cities' attempt to provide a different utility experience to their customers and keep costs down. One customer said they "just don't want to do work with PG&E and they've applied to the lottery to opt out of PG&E." Another said "across the country PG&E is the hardest utility to work with and get things done with. PG&E doesn't have the ability to be flexible with what businesses need."

While customers reported their own business processes are a barrier for program participation, they also said that once a project is approved and on their books PG&E is too slow with their program process, likely as a result of the regulatory environment. Similar to data center customers, once telecom customers get funding they have to use it right away or the funding is used for something else. If a customer turns in a custom application and orders the equipment before PG&E approves the project, the project is ineligible for incentives. These customers

operate on a calendar year and would like to have projects start and finish within the same year, but the incentive process is slow—up to three to four years. Additionally, when the incentives do arrive they can be significantly lower than anticipated because of baseline changes. This has a profound effect on PG&E's credibility and customers' motivation and willingness to participate in their programs. Experts discussed that a potential solution to this barrier would be to provide the telecom industry a prescriptive rebate program, wherein companies could pick and choose what measures they would like to implement, have clear guidance on how much incentive they would receive, and have the freedom to do their installation when their funding is available and apply for the rebate as opposed to waiting for project approval from PG&E.

The final barrier interviewees discussed revolves around data availability. Telecom customers are regional and national companies and often decisions are made at that level. As such, corporate offices want visibility into energy use across their portfolios in order to identify which buildings are performing well and which ones are energy hogs. However, getting "even basic" usage data out of PG&E is difficult. One customer discussed how they could call their account manager and get 12 months of usage data within an hour for buildings in their territory, but if corporate wants access statewide data it is very difficult. They reported other utilities they work with can do this really quickly. A second customer, based in the Bay Area, discussed an example where they were doing a walkthrough in Monterrey looking at expanding a transformer. They called their account manager for the Bay Area and couldn't receive an answer because PG&E's business is broken into regions and Monterrey wasn't within that account manager's region. Customers want information for their locations and properties connected by customer, not by PG&E's regions. Finally, customers have also tried to use the automated account with Energy Star and found it "clunky and too hard to keep up."

The largest opportunity identified by interviewees within the telecom market is to incorporate energy efficiency upgrades into other corporate goals such as carbon reduction or sustainability. All companies interviewed have corporate sustainability goals as well as renewable energy goals, and together with driving down energy costs these goals are what drive these companies to adopt solar and fuel cell technologies. Recognizing a project-by-project approach was not working, one company reported a new holistic corporate-wide initiative to look at all of their sites (>1,000) nationally with a whole building approach to bring forward a seven year contract with off-balance sheet approach to funding efficiency projects. They reported that having a company vision and corporate sustainability goal is a key difference. On the other side of the coin, unfortunately, another customer reported they are not doing energy efficiency projects before renewable projects. They are completing renewable projects on a fixed contract, which makes it very difficult to get energy efficiency measures through post-installation.

How PG&E can Improve Telecom Services

As a part of the discussions, interviewees discussed three areas where PG&E can improve their telecom programs:

- **Commit to deadlines and keep appointments**. One customer reported that their engineers struggle to get inspections and other tasks completed by PG&E. They would like to make an appointment with PG&E and have confidence that it is not going to get cancelled or missed.
- **Learn about each telecom's business and facility**. As noted earlier, each customer and each of their facilities are different. To successfully reach this market, PG&E and third-

party implementers need to know about each telecom's business drivers. It is important to visit a site and see what can be offered.

- **Educate customers through conversations**. If a prescriptive program is developed, representatives should take advantage of site walkthroughs to talk about what equipment they see in use and what PG&E can offer. Opportunities may include specific measures or a whole building approach, depending on what they learn from previous steps in the process. The conversation should also include dialogue around what the customer is working on and what products they are considering.

Promising Technologies

Overall, interviewees agreed that PG&E does not currently have a great product for telecom customers. While it is desirable to create a program or measures specific to this subsegment and their equipment (versus data centers), there is not consensus as to what the market-specific offer should be. Not only did each customer want something different, but customers also discussed how within a company different sites need different things. Overall, experts said that PG&E needs to provide flexibility where representatives can understand each customer and what might work for them.

All customers agreed that there are HVAC, lighting, and IT equipment opportunities in their facilities. Specific technologies customers are thinking about installing include:

- CRAC measures
- Variable frequency drives
- Air distribution
- Turbocore chillers or other chillers that are strong on part load
- Bigger filter banks for lower pressure drops
- More advanced air management
- Control schemes that get away from the measuring return temp back at inlet of CRAC unit and get the temp measurement out at the inlet of the servers
- Advanced lighting controls (wireless mesh networks)
- Rectifiers
- Uninterrupted power supply systems

As previously discussed, all customers interviewed are looking at alternative energy—in particular solar, fuel cells, and energy storage. Tesla and Lockheed Martin are companies that were mentioned.

Two customers would prefer a whole building approach, such as retrocommissioning, because it's easier for them to move forward with more measures at one time. One explained that the desire for whole building approaches stems from difficulty in property managers keeping up with smaller incentives for multiple measures. A second customer stated that many of their facilities are aged, and that whole building approaches allow for upgrades like building management systems in those facilities. The third customer, however, did not want to look at the whole building. They cited using PG&E as a consultant in the past, and felt the project was not successful because PG&E looked at the whole building instead of equipment.

Only one customer talked about a cutting-edge technology—a cell tower dimming technology. Currently cell towers consume the same amount of energy 24/7 irrespective of how many customers are on the line, and this dimming technology would modify the equipment to turn down the energy use so it more accurately matches the traffic. Similarly, one expert mentioned the possibility to develop a DR program for cable sites.

Additional Considerations

Two of the three customer interviewees talked about how they would like PG&E to support them in getting permits quickly. If telecoms grow and gain customers through densification they will have additional funding available to complete facilities and equipment upgrades, so PG&E support in getting permits faster could help with efficiency efforts.

APPENDICES

Appendix A1: Data Stratification Memo

To: Priscilla Johnson, Pacific Gas & Electric

From: Kara Crohn, EMI Consulting
Joan Effinger, EMI Consulting
Julie Scrivner, EMI Consulting

cc: Jeremy Kraft, EMI Consulting

Date: August 10, 2017

RE: Pacific Gas & Electric High-tech, Biotech, and Office Building Research: Data Stratification

Introduction

The objective of this study is to identify trends, market actors, primary end uses and expected 5-year trends that will impact energy consumption for the Office, Biotech, and High Tech commercial markets. Multi-tenant and owner-tenant issues in offices are a well-known barrier to energy efficiency and will not be emphasized in this memo. The results of this study will help inform future program design on how to effectively segment the commercial market to access untapped energy savings potential. It will also be actionable and allow the Commercial Programs Team to shape a Request for Proposal (RFP) for future program delivery. The study has five main components:

- Customer data analysis
- Interviews with customers and industry experts
- AB802 Analysis
- Analysis
- Reporting and regulatory support

The purpose of this memo is to deliver the results of the first component, customer data analysis, for review by PG&E program staff. In this memo, we describe the data cleaning, analysis methods, data limitations, results, potential additional analysis, and recommendations and next steps. Given the limitations of the customer data analysis, it is important for PG&E staff to review this memo with the following questions in mind:

- Do these results make sense given your knowledge of your customers' and their industries?
- Is there anything that stands out as odd or interesting in the results?
- Are these results actionable?

We will work with PG&E staff to decide on the five to six subsectors that will be the focus of the remainder of the study. This memo will serve as an important source of data to make that decision.

Data Cleaning

We received two datasets from PG&E:

- *CoStar and geocoded customer data* which included premise ID, 2016 energy usage (kWh and/or therms), NAICS, year built, square footage, number of stories, address, and property description for 39,157 buildings. This data was acquired through a costar query which was joined to two geocoded tables of customer data.

- *Program participation data* which included premise ID, address, installed measures (code and description), and annual energy savings (kWh, therms) for 1,393 buildings that participated from 2012-2017.

The two datasets were merged based on the premise ID. As such, we removed records where the premise ID was empty or had words instead of numbers. Where records had the same address and square footage, we rolled the premise IDs up into a building ID.[10] To get total energy use for each building, we then added the electric and gas energy use for each building ID. For all buildings, we converted kWh and therms to kBTU according to Equation 1. If gas or electricity data were not present, the associated kWh or therm value was zero in Equation 1.

Equation 1. Calculating kBTU for all buildings

$$kBTU = sum(kWh) * 3.412 + sum(therm) * 100$$

Next, we assigned a NAICS value to the building ID based on the NAICS code for the premise ID with the highest kBTU. We then stratified the buildings based on the six-digit NAICS codes. We then eliminated the NAICS codes that were not associated with the HBO market. We kept the two digit codes from the SOW (51, 52, 53, 54, 55, 56, 61, 81, 92) plus additional codes that appeared to fit within the HBO market based on their description. Some examples of additional NAICS kept in the analysis are “Space Research and Technology” and “Semiconductor Manufacturing.” Lastly, we rolled up the NAICS values to the four-digit level to allow for a sufficient number of buildings within each code for analysis. A full list of the four-digit NAICS codes that were kept in the analysis are shown in the Appendix.

Analysis Methods

The overarching goal of the study is to provide PG&E with a stratified list of buildings within five to six different NAICS sub segments based on energy savings potential. In this section, we describe the series of steps we took to create the stratified list. Figure provides a visual representation of the steps taken to create the list of buildings included in the stratification analysis, including the number of customer records at each step in the process.

It is straightforward to rank buildings from high energy use to low energy use within each NAICS sub-code, but this does not necessarily mean those with higher energy use have higher opportunity as energy use generally increases as the building gets larger. Instead, a normalization factor is needed to be able to differentiate which buildings and which sub sectors

[10] We assumed different premise IDs represented multiple units within the same building.

may have more opportunity than others. EMI Consulting chose Energy Use Intensity (EUI) for this normalization factor, as shown in Equation 2.

Equation 2. Energy Use Intensity

$$Energy\ Use\ Intensity = \frac{total\ energy\ use\ (kBTU)}{square\ footage}$$

Therefore, buildings were removed from the analysis if they did not have square footage information or if their square footage was less than 1,000 square feet.[11] This resulted in 47947 buildings for which an EUI could be calculated (of the CoStar data).

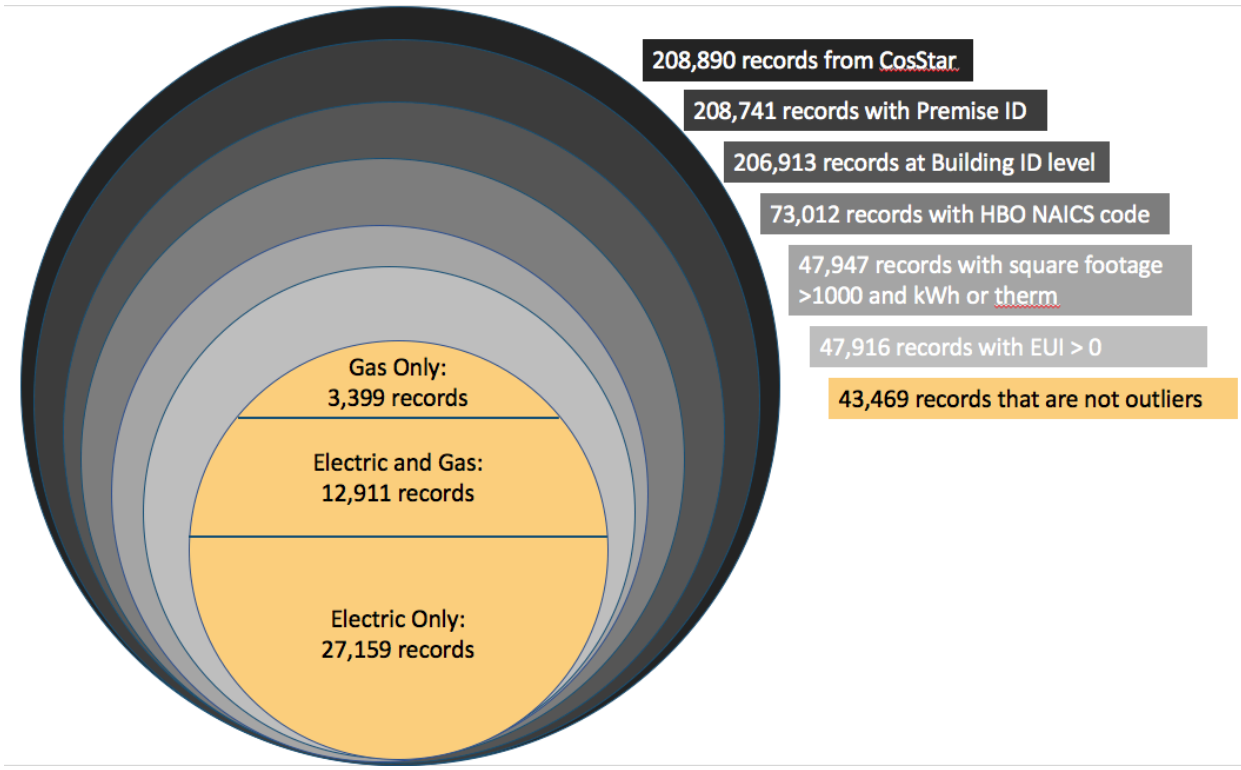


Figure 1. Steps taken to create list of buildings included in the stratification analysis

Next, we eliminated buildings if they had negative EUI as we assumed these customers have on-site generation, such as solar, and their motivations will be different than the general population. This resulted in 47,916 in the analysis set.

EMI Consulting then created three types of customer groups; those with electric and gas usage (14,249) those with electric-only (29,892) and those with gas-only (3,775),[12] all represented in kBTU.

[11] Without accurate square footage data, an EUI cannot be calculated. However, the results could potentially be extrapolated to these buildings if they have similar vintage, number of stories, or NAICS codes as those shown to potentially have more opportunity.

Then we eliminated high and low outliers, defined as the top and bottom 5th percentiles. This resulted in the final set of buildings to be included in the analysis: those with electric and gas usage (12,911), those with electric-only (27,159), and those with gas-only (3,399),[13] all represented in kBTU.

These groups were chosen to allow for differences between electric and gas programs, their targets, and what may motivate customers. Within each fuel type we calculated the average EUI across all NAICS codes. For each fuel type, we then compared the EUI of each building to the:

- Average PG&E portfolio EUI by NAICS
- Vintage[14]
- Number of stories[15]

An individual building was considered to have an energy savings potential if its EUI was above the average EUI within a specific subgroup (by fuel type, NAICS, etc.). Because there were no available compatible external benchmarks, this analysis could not assess whether an entire sector had an above average EUI and therefore had energy savings potential.[16] Thus, average EUIs had to be calculated within the dataset as a point of comparison for individual buildings. Further, it is possible that a building has an above average EUI due to external factors that do not necessarily indicate a potential for energy savings, such as a large data center. Lastly, this method is biased toward identifying smaller sub-segments (i.e., sub-segments with fewer buildings) as having energy savings potential, since the mean is driven by the sub-segments with the greatest number of buildings. The results are shown in the results section below.

Data Limitations

As the EMI Consulting team has discussed with PG&E, there are many limitations to using the data. The biggest limitations we've identified in the data are:

- Premise ID does not represent an individual building – EMI Consulting rolled up premise IDs based on address, but this method may not result in entirely accurate results as we don't know for certain if we have every space within a building. Therefore, we may be missing energy use data and/or square footage data within any individual building, especially as we eliminated records where the premise ID was blank.
- A number of premise IDs with different addresses have identical kWh usage. We've treated these as different individual buildings, but that may not be accurate.
- There are a number of buildings with gas-only data. We presume those buildings get their electricity supplied from another entity. Therefore, these buildings' EUIs are very low and may not be accurate.

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[12] EMI Consulting assumed these customers may be Marin Clean Energy (MCE) accounts and treated them as gas-only customers in the analysis
[13] EMI Consulting assumed these customers may be MCE accounts and treated them as gas-only customers in the analysis
[14] Only 40.1% of the records in the analysis set had building vintage available
[15] Only 51.46% of the records had number of stories available
[16] EMI Consulting attempted to use ENERGY STAR average EUIs, CBECS regional average EUIs, and RECS regional average EUIs as benchmarks. However, due to the very low EUIs calculated using available data, the calculated EUI values were not comparable to the benchmarks.

- The calculated EUIs are low, likely driven by the potential issues with rolling premise IDs into building IDs based on address (i.e. first two bullets above).
- The distribution of gas-only and electric-only EUIs are very similar, further suggesting there is missing data.

The intent of this analysis is to help narrow the list of high-tech, biotech, and office building sub-sectors down to a list of five to six sub-sectors with the highest potential energy savings opportunities. However, this decision should not be informed by this analysis alone; PG&E staff familiar with the customers' industries and program participation patterns should be consulted.

Results

The results presented in this section include:

- EUI vs. number of stories by fuel type
- EUI vs. building vintage by fuel type
- Percent above average PG&E EUI for each HBO NAICS code.

Figure 2 and Figure show the EUI by the number of stories for each building in the analysis dataset. We stratified the EUI by number of stories as a method to visualize the customer data, but it was not used to select which segments to target. The plot includes a box and whisker for each number of stories – the bottom of the box represents the lower quartile, the middle of the box the median, and the top of the box the upper quartile. Also presented is a horizontal line that is the average EUI in the dataset for the particular fuel type. When looking at this plot we are looking for the number of stories where the box plot is above or mostly above the horizontal line – meaning three-quarters of the buildings have an EUI above the PG&E average. For example, electric customers' buildings with 12, 16, 17, 22, 24, 25, and 31 stories have a higher than average EUI.

Program design should also take into consideration the number of customers within a target market. While buildings with 12, 16, 17, 22, 24, 25, and 31 stories have a higher than average EUI, there might not be enough buildings within these categories to target a program. Figure 3 zooms in on buildings under 10 stories which have a larger number of buildings. Figure 2 shows the percentage of buildings with an EUI above and below the average by number of stories.

For the purposes of this data analysis, we define high opportunity as those categories that have the most buildings with higher than average EUI that also have more than 100 buildings (considered to be a sufficient number of buildings to warrant action). Customers in one- and two-story buildings may present the highest opportunity as measured by above-average EUI:

- Gas and electric: 1,963 one-story and 737 two-story buildings
- Electric-only customers: 5251 one-story and 1258 two-story buildings
- Gas-only customers: 589 one-story and 240 two-story buildings

Across all the fuel types, one- and two-story buildings appear to have more opportunity than buildings with more stories.

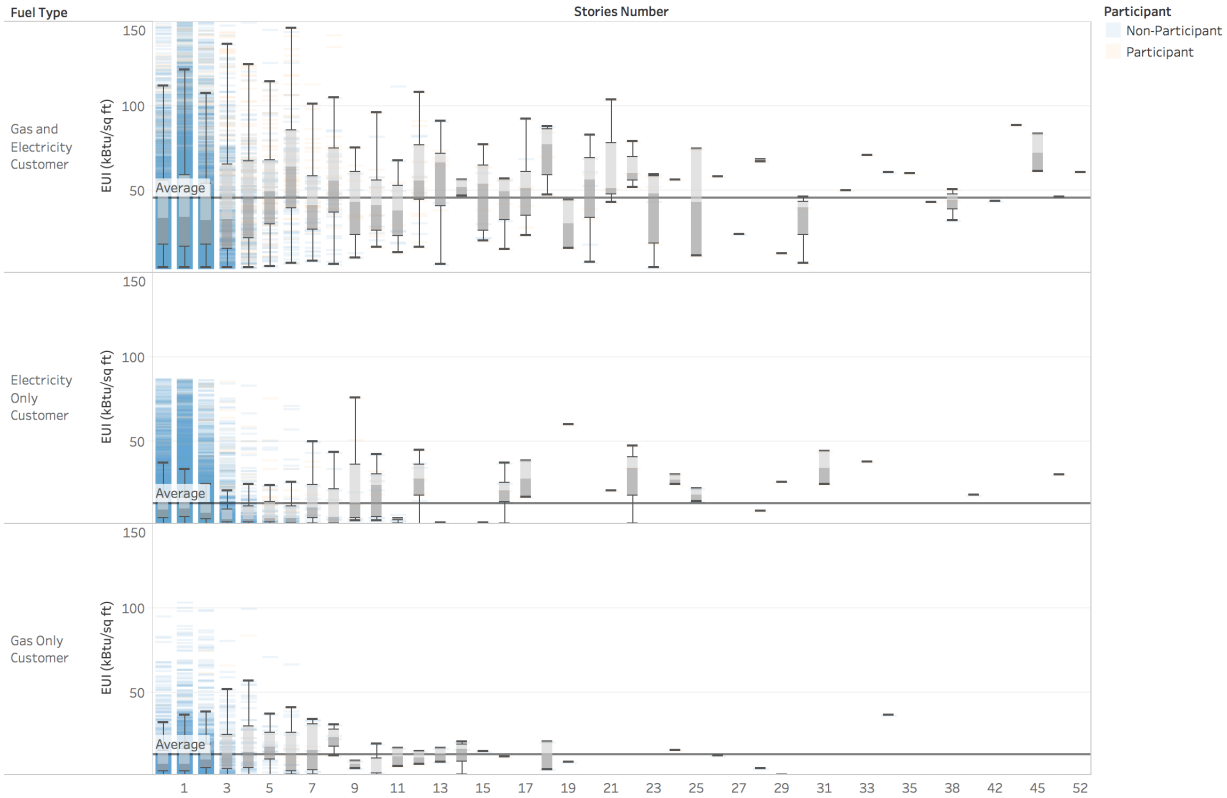

Figure 2. EUI vs. number of stories for each fuel type.

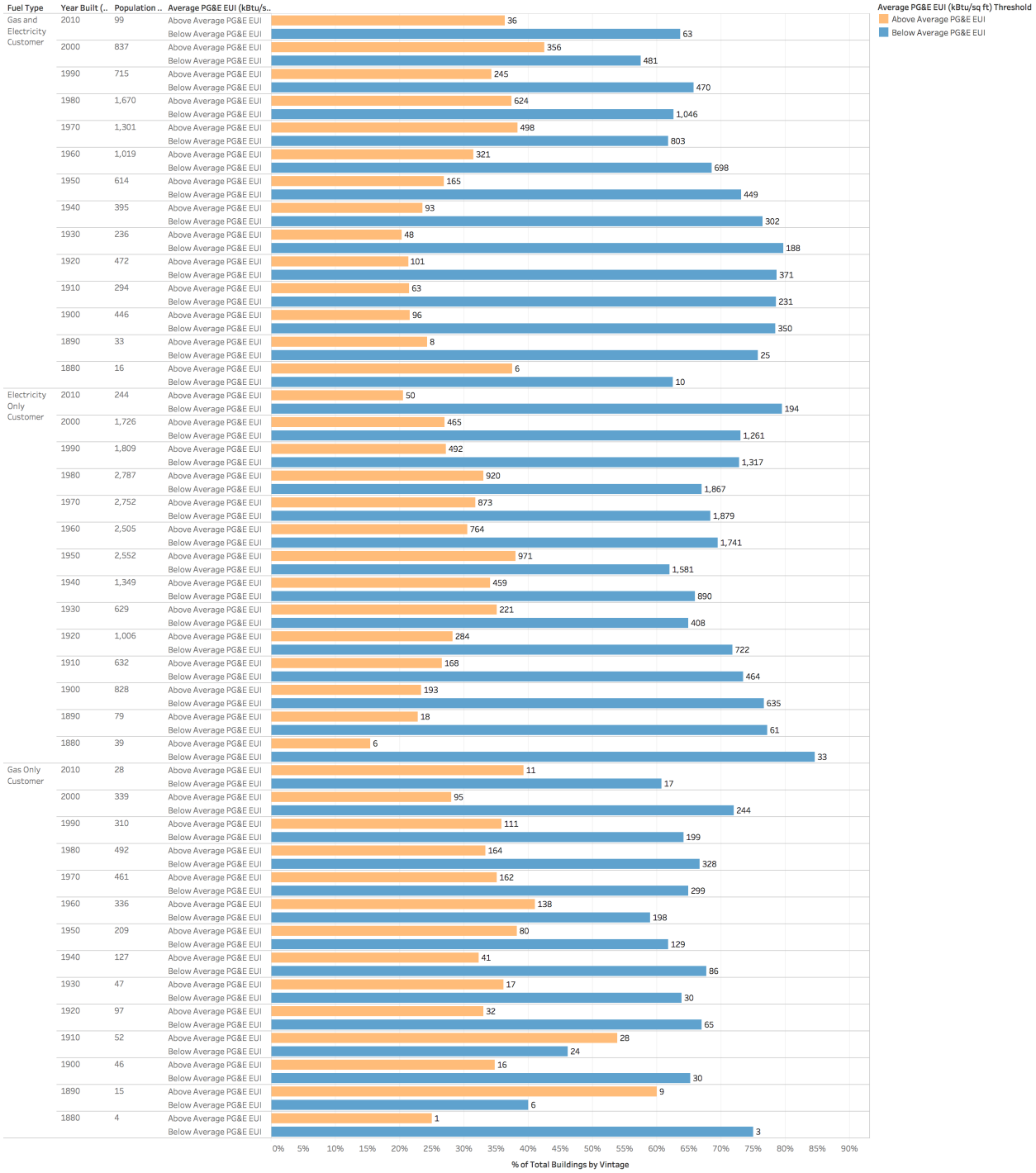

Figure 3. EUI vs. number of stories for each fuel type, under 10 stories.

Figure and Figure illustrate the EUI by building vintage. We stratified the EUI by building vintage as a method to visualize the customer data, but it was not used to select which segments to target. The customer data does not include major retrofit and upgrade information and therefore we determined it was not a good predictor of opportunity, which is reflected in our analysis results below.

There are not any vintages where three-quarters of the buildings use more energy than the average building in PG&E territory (i.e. there are no vintages where the box is above the average line). In general, buildings built in the 1960s, 1970s, and 1980s may have slightly more opportunity than other vintages but the difference is minimal. Interestingly, for electric and gas customers the newest buildings may also have opportunity.

For customers with both gas and electric, buildings built in the 1980s and 1970s may have the most opportunity as they have 720 and 569 buildings above average, respectively. For electric-only customers, buildings built in the 1980s and 1950s may have the most opportunity as they have 980 and 1,068 above average, respectively. For gas-only customers, buildings built in the 1970s and 1960s may have the most opportunity as they have 165 and 138 above average, respectively.

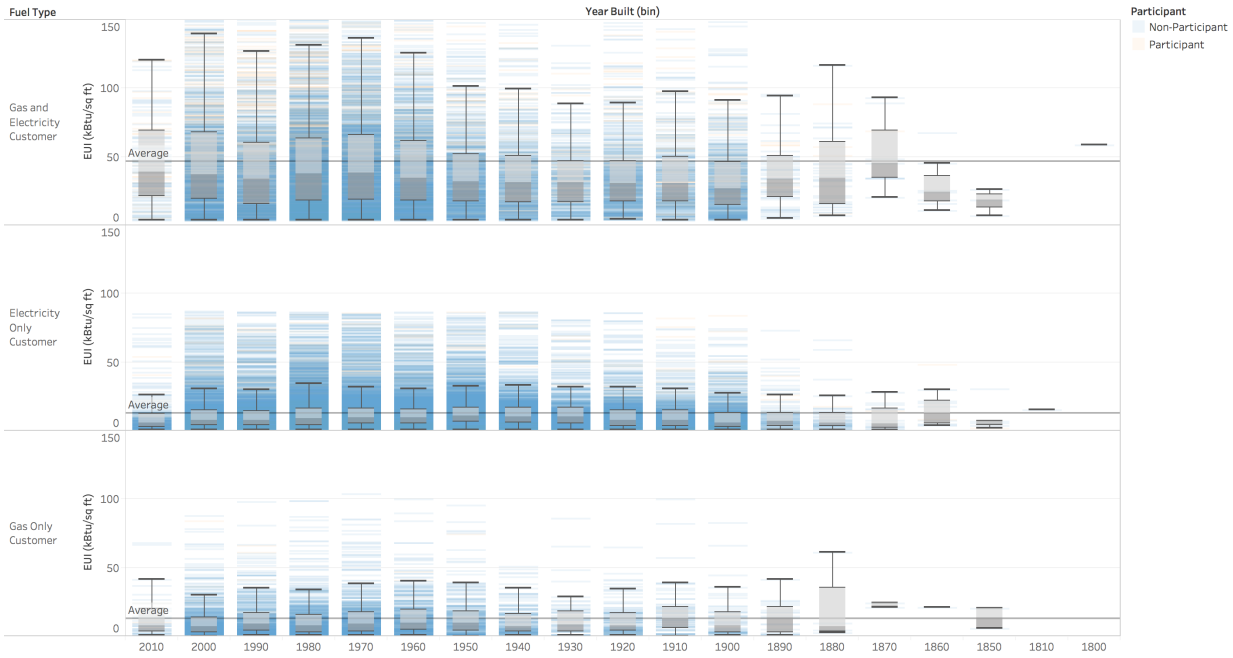

Figure 4. EUI vs. vintage for each fuel type.

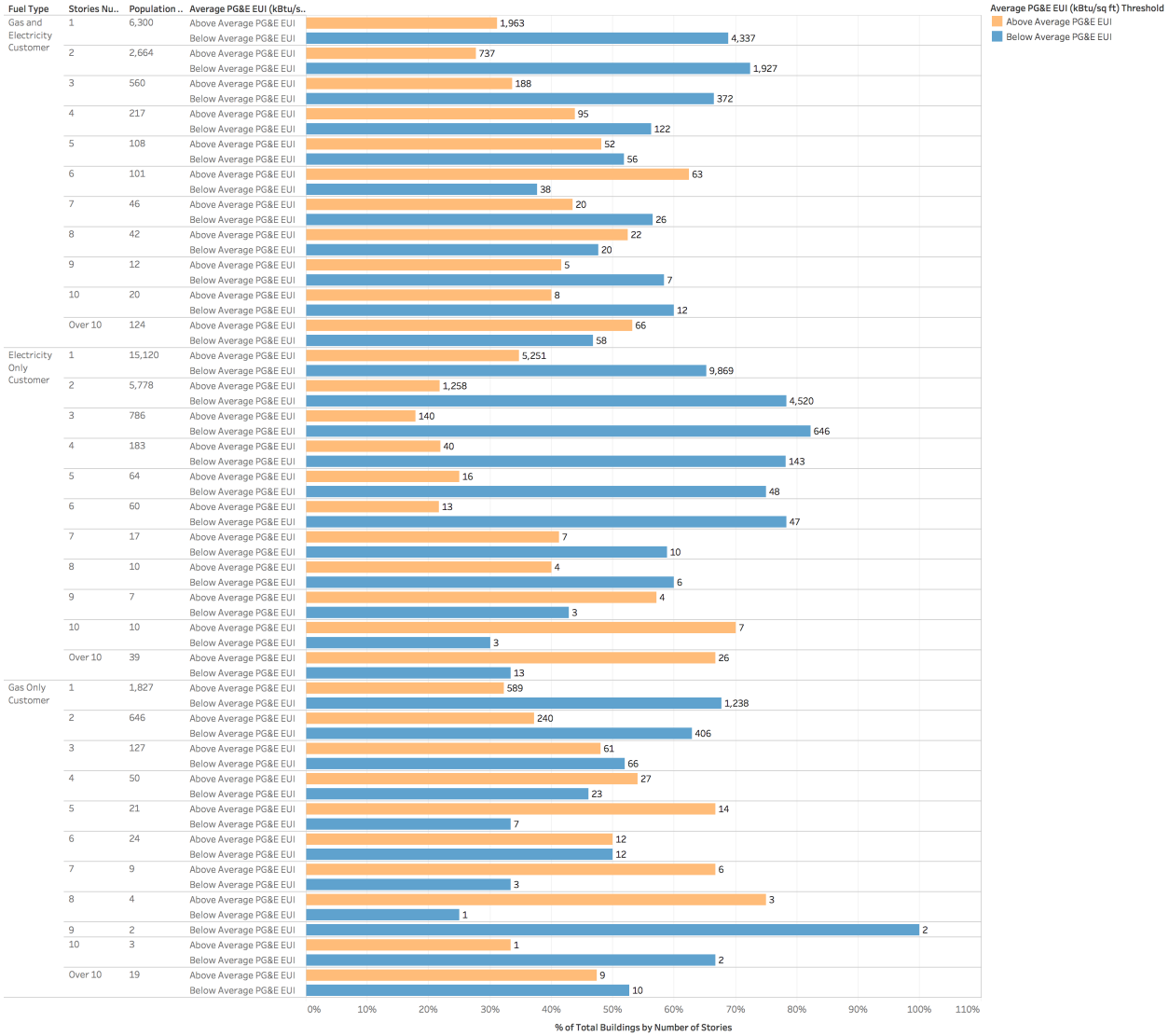

Figure 5. EUI vs. vintage for each fuel type, after 1980.

To investigate which NAICS codes may present a higher energy savings opportunity, we calculated the percent of buildings above and below the average PG&E EUI within each NAICS sub-category. The results are shown in Figure 6, 7, and 8. Similar to the number of stories and vintage, a combination of the percent of buildings above the average and the population size should be used when determining a target market for a potential program. Therefore, NAICS codes 5311, 5221, 5511, 5419, 6111, 5411 may have the highest opportunity for electric and gas customers, NAICS codes 5171, 5311, 5170, 5172, 5511, 5100 may have the highest opportunity for electric-only customers, and NAICS codes 5311, 5511, 5221, 6111, 5411, 5419 may have the highest opportunity for gas-only customers. Across all the fuel types buildings with the NAICS codes 5311, 5511, 5221, and 6111 appear to have more opportunity than others, using the definition and method defined in this memo.

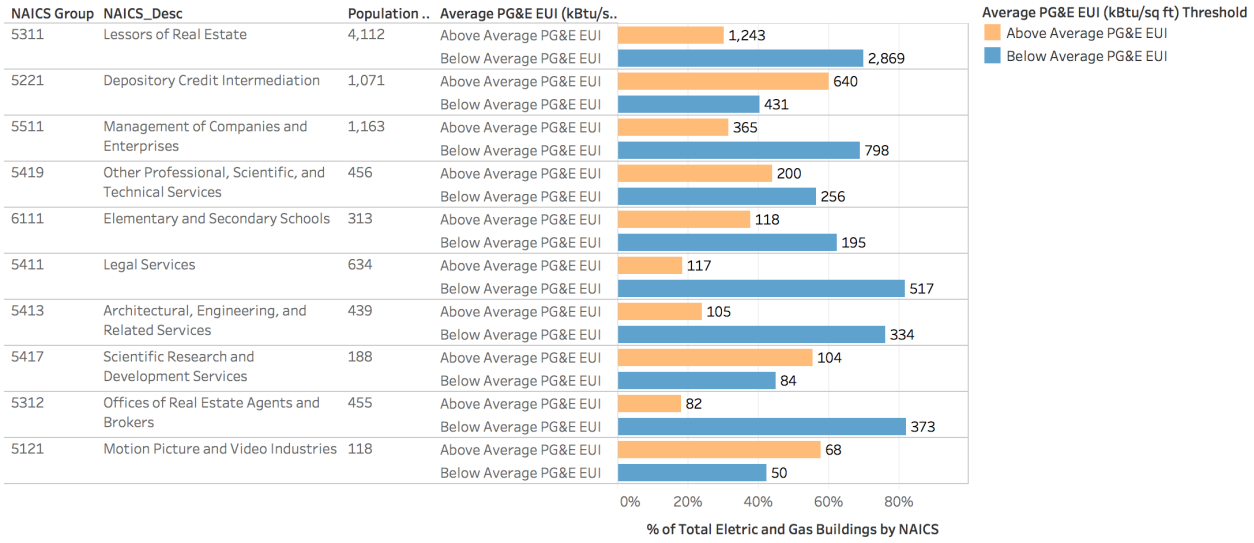

Figure 6. Gas and Electric Customers percent above and below PG&E average EUI by NAICS.

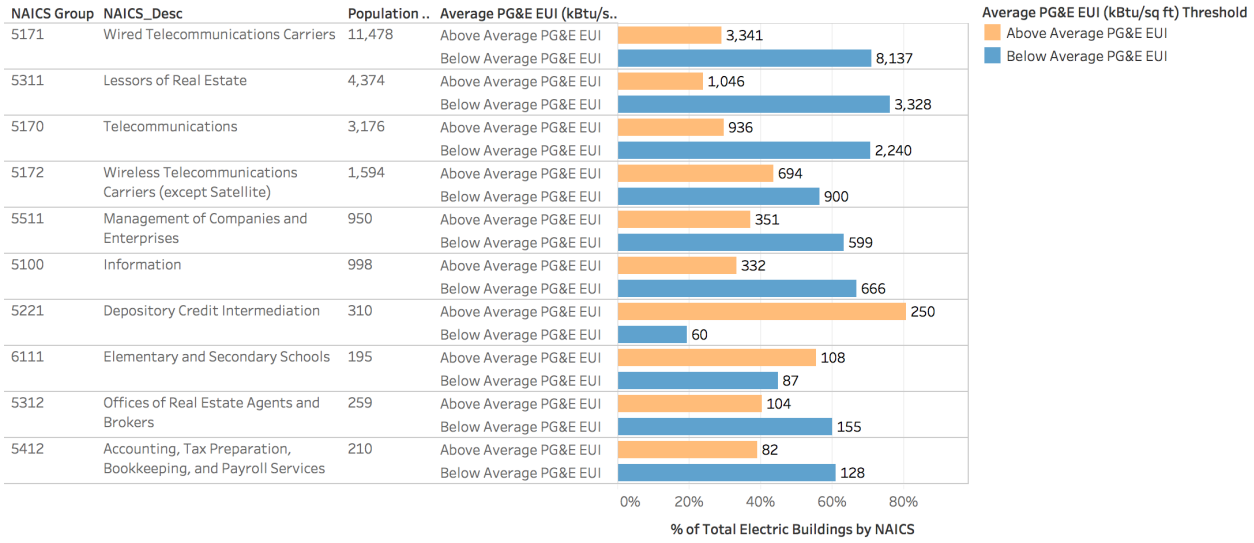

Figure 7. Electric Customers percent above and below PG&E average EUI by NAICS.

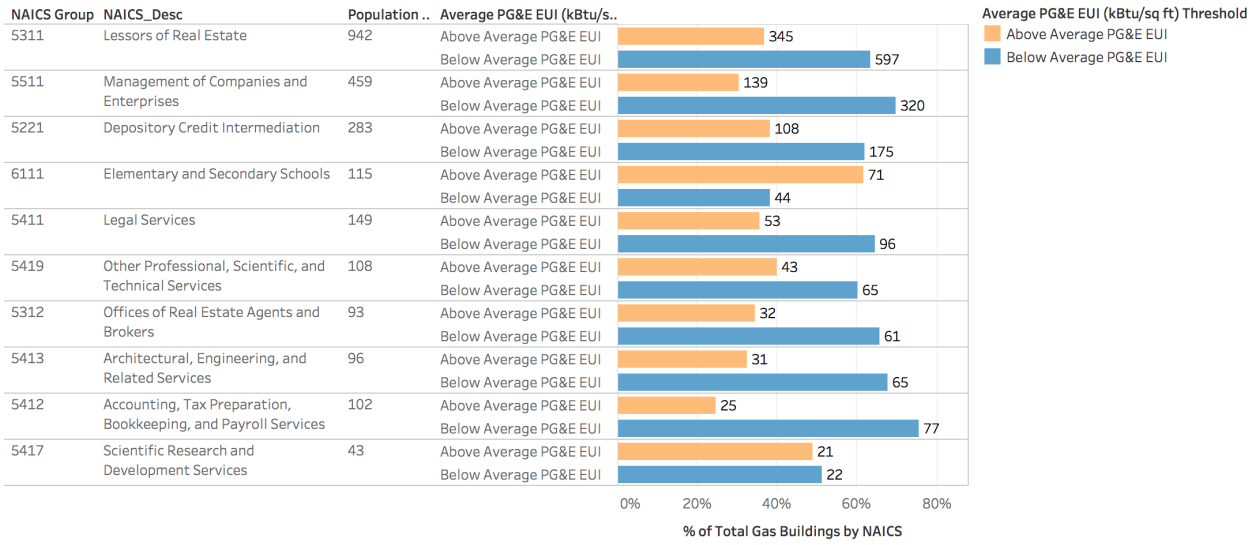

Figure 8. Gas Customers percent above and below PG&E average EUI by NAICS.

Potential Additional Analysis

The Scope of Work and the data analysis discussed in this memo are high-level and were intended to indicate which sub-segments may have more opportunity than others, but were not intended to be a rigorous quantitative analysis of opportunity or savings potential. If some of the data limitations discussed above could be overcome (mainly ensuring all the energy use/spaces are accounted for within and individual building), further analysis could be conducted on the data to provide additional insights. Examples include:

- Analysis using an alternative definition of energy savings potential; for example, a sub-segment with high variance in EUI from the sub-sector EUI mean might be considered to have greater energy savings potential than a sub-segment with lower variance
- Modeling (e.g., regression or non-parametric models) to quantitatively examine the relationship between NAICS code, vintage, and number of stories including interactive effects between them
- Analysis of participation data for the highest opportunity NAICS codes, vintages, and number of stories that examines what measures previous participants have installed, what comprises typical savings, or what new measures could be offered within those markets

These types of analysis were not within EMI Consulting's original scope, but are the types of analysis that we could do in the future if deemed valuable or useful by PG&E.

Recommendations and Next Steps

This data analysis revealed some trends of which NAICS codes, building vintage, and number of stories may have more opportunity than others. Although we used building vintage and number of stories to present the data, the final selection of NAICS fields is based on the analysis of customers above the average PG&E EUI by NAICS code. To select the five to six sub-sectors that will be the focus of the remainder of the study, we recommend using one of two approaches:

- Select the top six NAICS codes for gas and electric customers above the average PG&E EUI: 5311, 5221, 5511, 5419, 6111, 5411
  - Pros: Given that the EUIs are very low for single-fuel customers and likely are affected by missing data, the duel-fuel customer data may represent a more accurate depiction of energy savings opportunities
  - Cons: Representation of biotech companies and data centers will likely be limited
- Select the four NAICS codes that appeared in the top 10 NAICS codes for electric-only, gas-only, and gas and electric customers above the average PG&E EUI: 5311, 5511, 5221, 6111. Select one additional high-potential NAICS codes that has a large number of customers, such as the telecom subsectors 5171, 5170, and 5172. Select the NAICS code 5417 to ensure representation of the biotech services.
  - Pros: The approach provides a way to ensure representation of telecom and biotech firms
  - Cons: The number of NAICS code 6111 buildings (elementary and secondary schools) represents a smaller number of customers than other sub-sectors with high potential

Next steps:

1) EMI Consulting and PG&E staff will finalize list of sub-sectors that will be used to select customer and expert interviewees and narrow the scope of the AB802 literature review
2) PG&E staff will help identify key customers and industry experts from the selected NAICS codes to interview
3) EMI Consulting will revise interview guides as needed and conduct interviews with key customers and industry experts
4) EMI Consulting will complete the review of AB802-related literature (evaluation reports, policy briefs, media) on opportunities relevant to selected NAICS code sub-sectors

5) EMI Consulting will review and analyze all study components to create a presentation and final report outlining the characteristics of sub-segments with the most energy savings opportunity

Appendix A2: NAICS Groups

NAICS_Group	NAICS_Desc	NAICS_INCLUDED
5100	Information	y
5111	Newspaper, Periodical, Book, and Directory Publishers	y
5121	Motion Picture and Video Industries	y
5151	Radio and Television Broadcasting	y
5170	Telecommunications	y
5171	Wired Telecommunications Carriers	y
5172	Wireless Telecommunications Carriers (except Satellite)	y
5182	Data Processing, Hosting, and Related Services	y
5191	Other Information Services	y
5221	Depository Credit Intermediation	y
5222	Non-depository Credit Intermediation	y
5223	Activities Related to Credit Intermediation	y
5230	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	y
5231	Securities and Commodity Contracts Intermediation and Brokerage	y
5241	Insurance Carriers	y
5242	Agencies, Brokerages, and Other Insurance Related Activities	Y
5310	Real Estate	Y
5311	Lessors of Real Estate	y
5312	Offices of Real Estate Agents and Brokers	y
5313	Activities Related to Real Estate	Y
5322	Consumer Goods Rental	y
5323	General Rental Centers	y
5410	Professional, Scientific, and Technical Services	y
5411	Legal Services	y
5412	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	y
5413	Architectural, Engineering, and Related Services	y
5414	Specialized Design Services	y
5415	Computer Systems Design and Related Services	y
5417	Scientific Research and Development Services	y
5418	Advertising, Public Relations, and Related Services	y
5419	Other Professional, Scientific, and Technical Services	y
5511	Management of Companies and Enterprises	y
5613	Employment Services	y

5614	Business Support Services	y
5615	Travel Arrangement and Reservation Services	y
5616	Investigation and Security Services	y
5617	Services to Buildings and Dwellings	y
5619	Other Support Services	y
5620	Waste Management and Remediation Services	y
5622	Waste Treatment and Disposal	y
5629	Remediation and Other Waste Management Services	y
6110	Educational Services	y
6111	Elementary and Secondary Schools	y
6112	Junior Colleges	y
6115	Technical and Trade Schools	y
6116	Other Schools and Instruction	y
8111	Automotive Repair and Maintenance	n
8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	n
8114	Personal and Household Goods Repair and Maintenance	n
8121	Personal Care Services	n
8122	Death Care Services	n
8123	Dry-cleaning and Laundry Services	n
8129	Other Personal Services	n
8131	Religious Organizations	n
8133	Social Advocacy Organizations	n
8134	Civic and Social Organizations	n
8139	Business, Professional, Labor, Political, and Similar Organizations	n
9211	Executive, Legislative, and Other General Government Support	n
9225	Justice, Public Order, and Safety Activities	n
9226	Justice, Public Order, and Safety Activities	n
9228	Justice, Public Order, and Safety Activities	n
9231	Administration of Human Resource Programs	y
9241	Administration of Environmental Quality Programs	y
9261	Administration of Economic Program	y