Baking from Scratch: How a Tiny EM&V Study Disrupted the Status Quo in Utility Program Design

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ABSTRACT

Supporters and detractors often lament that evaluation studies scopes are too broad and delivered too late to matter in program design. What happens when a micro-scale evaluation study delivers on-the-fly, useful, actionable and impactful research for a fraction of the cost and proactively integrates Program Managers into the solution mix? Pacific Gas and Electric (PG&E) is further refining this 'disruptive approach' to launch its 2016 Embedded Data Center Program. This small study leverages a unique collaborative (Northwest Energy Efficiency Alliance, Lawrence Berkeley National Laboratories, City of Palo Alto, Silicon Valley Power) and the supply chain of embedded data center stakeholders from federal administrators to high-tech wizards to not only calculate savings estimates, but identify consumer needs and wants in this fast-paced industry. This approach integrates continuous monitoring and as-needed adjustments for changing market conditions. Unlike the previous PG&E program that served large, enterprise data centers in the Facebook and Google-sphere, the new focus is on server closets and rooms, embedded in commercial office spaces, where over 99.3% of the servers in the US reside consuming the equivalent of 26 medium-sized coal-fired power plants or 75 billion kilowatt-hours annually. Just like baking cookies, the approach is scalable to serve the needs of many and disruptive enough to challenge the convenient status quo.

Introduction

Large, enterprise data centers in the Facebook and Google-sphere, are the common face when one makes a reference to a "data center." Utility incentives for these larger scale data centers have historically been applied to new construction and custom projects. As this segment of energy efficiency applications advances, the new focus is turning to server closets and rooms, embedded in commercial office spaces. Over 99.3% of the servers in the US reside in embedded data centers (EDCs), consuming the equivalent of 26 medium-sized coal-fired power plants or 75 billion kilowatt-hours annually. It is estimated that there are over 4.9 million servers in EDCs, consuming 49% of the share of electricity consumed by data centers. This is the equivalent of 37.5 billion kWh/year (NRDC, 2014) in the United States alone.

The embedded data center (EDC) market segment lags in its adoption of energy efficiency measures due to several market barriers, including the presence of split incentives between facility and data center decision-makers and an extreme focus on data center uptime and performance. The embedded data center market includes server closets, server rooms and localized data centers co-located in commercial, institutional and industrial facilities. For the purposes of this study, Pacific Gas and Electric (PG&E) defined embedded data centers as demanding <50 kW and classifies them as 'hard-to-reach' because of the aforementioned reasons.

Embedded data centers are challenging markets to transform from an energy efficiency perspective. Data center equipment and operations are characterized by rapid and continuous change. EDCs are consolidating as rack density increases and information technology (IT) performance increases and have the general perception of becoming obsolete in the near future. However, as buildings become more intelligent and regulatory constraints require certain risk averse industries such as finance, government, healthcare and higher education, the reliance on EDCs will grow. Their importance will increase as less sensitive and routine and storage tasks migrate to the cloud. Meanwhile, physical data center footprints are shrinking and growing business demands are putting more pressure on data center managers to deliver more and with fewer resources. At the same time, decision-making related to energy efficiency is complex; decisions are made at the speed of business requirements, the level of sophistication in the market varies dramatically, and the subject matter is highly technical.

Can the embedded data center energy efficiency market achieve market transformation without utility incentives? It depends on who you ask. For a rapidly evolving and 'hard-to-reach' sector such as embedded data centers, designing utility incentives through the typical Evaluation Measurement and Verification (EM&V) study approach does not suffice. The typical approach to perform a market characterization is to execute a retrospective assessment of past EE measures including why measures are sunset and what is on the horizon for newer offerings through secondary market research. This is a helpful approach for markets that do not undergo rapid transformation, but not for the EDC market.

With this challenge in mind, PG&E and the Northwest Energy Efficiency Alliance (NEEA) initiated development of a Data Center Research Collaborative (Collaborative) in 2013 to better characterize the market and identify intervention options for increasing the adoption of utility energy efficiency measures in this hard-to-reach market. While the average cost of an Evaluation, Measurement and Verification (EM&V) market study in California for the 2010-12 and 2013-14 periods was $556,023 and $312,490, respectively, this study finished under its

$131,000 budget. The outcome was an actionable roadmap of product and program opportunities that are now being integrated into the PG&E Commercial Program team's Business Plan scheduled for submission to the CPUC in September of 2016. This paper details the process of the development of this study, the outcomes and provides suggestions for improvement on participatory evaluation design.

The Participatory Process

Utility programs are designed to respond to market needs within the constraints of regulatory requirements. A disruptive evaluation is one that is not based on the status quo one-way feedback evaluation where program managers wait for months or years before a study is finalized to integrate findings into their program offerings.

The design process must incorporate EM&V considerations before launching or risk the inability to adequately measure the impact of the program. Simple to complex measurements are required over a requisite period of time that demonstrate the efficacy of the EE intervention. Engagement with the program teams early in the design process was essential to designing a program that the market supply chain would embrace, adopt and leverage for EE gains.

This study was designed to leverage existing research, include a cross-section of utilities – both Independently Owned Utilities (IOUs) and municipally-owned utilities (SVP, COPA). Collaborative members contributed a variety of resources from source funding to subject matter expertise.

1. PG&E collaborated with the California Public Utilities Commission to obtain approval for the Embedded Data Center Market Characterization Study approved as an EM&V study using ratepayer funding. This is an annual process where the Independently Owned Utilities (Southern California Edison, Pacific Gas & Electric, San Diego Gas and Electric and Southern California Gas) EM&V teams propose new research to advance energy efficiency for the state of California. Funding is competitive and once approved, the average process to get a study approved and executed can take multiple years to complete. Only after the study is completed are the results integrated into program design.

2. Program Design teams objectives were integrated into the design of the characterization study research objectives during the study design.

3. Program Design teams and regulators were invited to kick off of the market characterization study.

4. Two collaborative workshops in the format of focus groups comprised of the entire embedded data center supply chain developed "draft" market interventions for the next generation of utility program incentives. The first occurred in July of 2014 with the Pacific Northwest Market Actor Collaborative Workshop. Sponsored and led by the Northwest Energy Efficiency Alliance (NEEA), two objectives were pursued:

- Build on the previously documented barriers to energy efficiency in order to gain a deeper understanding of the interaction among the "ecosystem" of market actors: data center managers, IT managers, CFOs, the owners and managers of commercial real estate and IT and HVAC vendors, distributors and resellers.

- Use the initial intervention list to build, customize and prioritize at least two to four intervention concepts that participants felt had highest potential to increase energy efficiency in embedded data centers.

The workshops were invitation-only working sessions and brought together Collaborative members, utility representatives, data center managers, IT managers, IT distributors and resellers, building/facilities managers, building owners, equipment OEM, and HVAC vendors.

5. The PG&E-funded Silicon Valley Workshop was held in October 2014 with two primary objectives:

- Outline operational plans for four energy efficiency program interventions, including how interventions would be delivered, the organization structure required for success, and the funding model.

- Identify the trends and impacts of data center applications moving to the cloud, including who is using the cloud, what applications are hosted in the cloud, and the fate of legacy data center hardware and applications post-migration to the cloud.

Similar to the Seattle workshop, this workshop was an invitation-only working session. In contrast to the Seattle session, the Silicon Valley workshop focused more extensively on data center managers, IT distributors and resellers, equipment manufacturers, and utility representatives. In total, forty-six (46) individuals participated in the workshop. Representatives from the Partnership Collaborative, specifically NEEA, PG&E, LBNL, Silicon Valley Power, and City of Palo Alto facilitated and helped document findings from the workshop.

Findings

The research findings helped to further refine the characterization of the "hard-to-reach" market in the embedded data center space. Multiple layers of decisions were identified with multiple outreach channels given the diversity of sophistication, attitudes and needs.

This process achieved several of the Collaborative's objectives including the (1) establishment of market connectivity (2) fostering long-term establishment of industry best practices and continuous energy improvement (3) facilitation of information sharing and (4) driving ongoing innovation.

Server virtualization is not industry standard practice in the EDC space.

A goal of the Collaborative was to identify approaches that would have the highest potential of adoption by both regulators and the entire supply chain. A total of seven recommendations were highlighted by the focus groups in Seattle and Silicon Valley. Three were selected as having the highest potential for adoption.

(1) Prescriptive measures
(2) A website clearinghouse
(3) Cloud migration

Prescriptive Measures

Prescriptive measures include efficient servers, virtualization and efficient uninterruptible power supplies (UPS). They are attractive incentives for both the customer and the utility as they are known for their predictability and promoting simplicity in market participation. The measures most frequently referenced as most relevant to speeding the uptake of energy efficiency in EDCs:

- Efficient servers
- Server virtualization
- Efficient UPS
- Efficient storage
- Efficient network equipment

Given the fast-paced nature of the IT market, annual value reassessments may be needed for data center prescriptive measures. There is also a need to convene regional leaders, develop multi-year roadmaps and engage the proper technical experts such as the California and Regional Technical Fora in the Pacific Northwest. A key to accelerate incentive adoption is determining where to appropriately place the incentive in the supply chain or to deliver it directly to the end user. A midstream approach where the Value Added Reseller (VARs) interacts with the data center manager or facilities manager was identified to be the most effective intervention point identified by the focus groups. Additionally, trade ally engagement is a key finding to improve incentive uptake/market transformation.

Website Clearinghouse

Designed to help overcome several key market barriers with its focus on bringing relevant resources, metrics and other information to market actors, a website clearinghouse is a targeted market intervention that could support or be leveraged into program services and solutions. A comprehensive website “clearinghouse” would serve as an impartial source of information on embedded data center technologies, equipment, best practices, vendors and service providers, trade allies, available utility financial incentives, reviews, blogs, original articles, and more. User logins are a core feature required to customize and enhance the user experience. In a more advanced version of the website, users could input specific information about their data center in order to calculate their PUE, compare their performance to similar data centers, and identify potential data center equipment or improvements.

A successful website clearinghouse would likely require collaborative governance and well-respected national and industry partners, such as The Green Grid, Lawrence Berkeley National Laboratory, Natural Resources Defense Council, or others.

Cloud Migration

Colocation and cloud facilities rent retail data center space, bandwidth, and consulting services to business customers. Typically more energy efficient than embedded data centers, these facilities are increasingly referenced as a viable solution to reducing energy use in embedded data centers. In cloud facilities, data centers move their applications from servers onsite to “cloud” based applications.

For IT managers, moving IT equipment into a colocation facility and shutting down the onsite data center can provide an attractive business case in comparison with maintaining and/or expanding an onsite data center. Colocation facilities offer flexibility and the ability to scale IT operations economically, and they offer increased redundancy and reliability. In short, IT departments can outsource the day-to-day cooling with their use of a colocation provider and receive a suite of energy and non-energy benefits in return.

A colocation or cloud-based program solution incentivizes an embedded data center manager to move the data center into a more efficient colocation and/or cloud environment. Energy savings resulting from the colocation or cloud facility must be verifiably more efficient than the embedded data center. The specific financial incentive may be awarded to either colocation facility or end user, or both. Additional elements to this concept may include a certification or PUE-validation program that results in deepening the pool of energy efficient colocation providers.

Improvements on Participatory Evaluation Design

For dynamic information technology incentive programs to increase their chances of adoption amongst customers, the participatory evaluation process is an obligatory approach. Without this, solution sets are obsolete within the timeframe that it takes to gain internal utility management support, regulatory approval and meet market demands. This ‘disruptive’ approach has many advantages and offer little downside. The advantages include galvanizing the supply chain of market actors to talk with each other more about possibilities and gather primary information to make informed decisions instead of relying on secondary information. The key to improving participatory evaluation design is communication and identifying and aligning market actors incentives to promote energy efficiency. This requires full participation at every level of the utility organization’s program design teams and external engagement of trade professionals, research organizations, supply chain market actors and regulatory bodies.

Conclusion

Market research conducted by PG&E and the Data Center Research Partnership Collaborative brings to light several program service and product solution concepts that are expected to overcome key market barriers and meet the needs of embedded data centers. These interventions place focus on different parts of the data center market actor ecosystem and vary in their focus relative to utility program readiness, market transformation, energy efficiency impact, cost, savings potential, and utility requirements.

Recently, a shift to further engage California energy efficiency stakeholders in the Independently Owned Utility Program has begun. Charrettes have been set up around the state to include consumer advocacy groups more directly in the program design process. This approach underscores the value of the 'disruptive' evaluation approach as stakeholders continue to demand that evaluation research translates into market-ready and cost-effective programs.

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