Energy Efficiency in the Forward Capacity Market: Evaluating the Business Case for Building Energy Efficiency as a Resource for the Electric Grid

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ABSTRACT

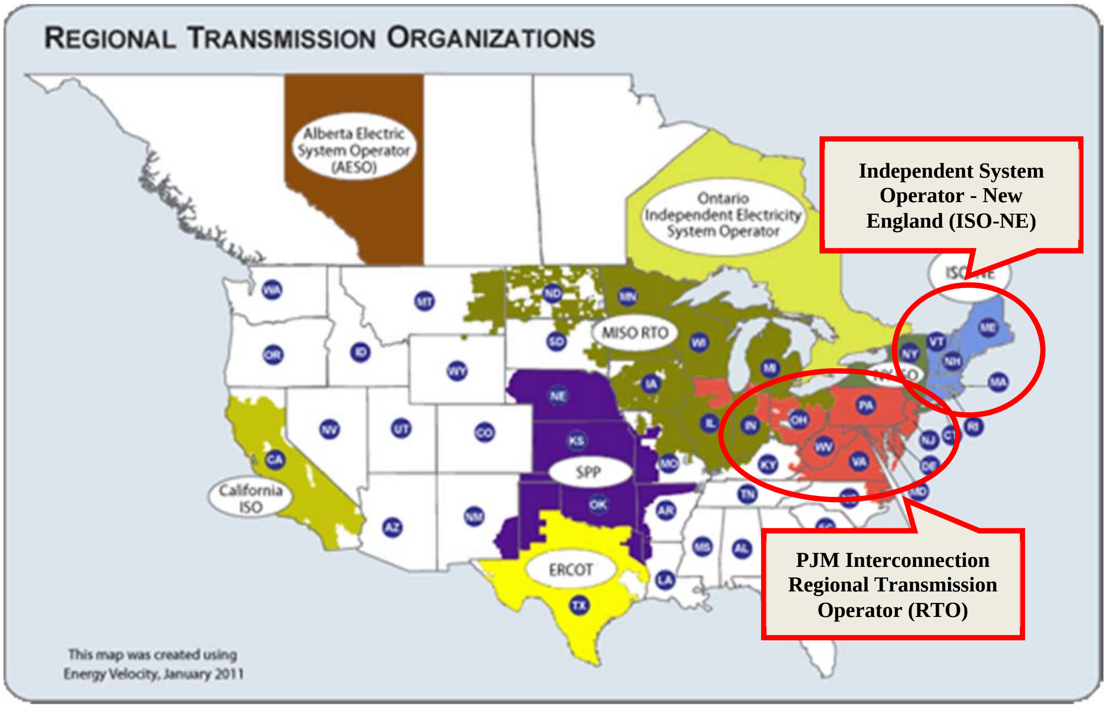
Two regional electricity grid operators – Independent System Operator-New England (ISO-NE) and PJM Interconnection Regional Transmission Organization (PJM) – use Forward Capacity Markets (FCMs) to induce the construction and maintenance of resources needed to satisfy future electricity demand. Increasingly, the meaning of 'capacity' has expanded from traditional wires-and-generators solutions to include greater levels of customer-sited resources, including energy efficiency. As with conventional merchant generators, the success of the FCM rests on whether it can send price signals to end-users powerful enough to mobilize investments in energy efficiency activities that otherwise would not take place.

This article uses a cash flow analysis to assess the revenue opportunities that these markets offer to owners and operators of commercial buildings. The analysis investigates whether the costs and revenues associated with supplying energy efficiency capacity in the newest EE FCM, operated by PJM, are likely to support a compelling value proposition for large commercial buildings. The results show that the overall revenues an owner or operator might expect increase project returns only slightly. It finds that the market players best positioned to compete in it those able aggregate large portfolios of efficiency measures which can be bid into the market in a manner that diminishes their relative transaction costs.

Introduction

In the last five years two major grid operators, the New England Independent System Operator (ISO-NE) and the PJM Interconnection Regional Transmission Organization (RTO) have opened their forward energy capacity markets (FCM) to energy efficiency (See Figure 1). This allows efficiency to compete against traditional energy generation assets in auctions designed to ensure future energy needs will be met. This development adds another plank to a platform of diverse policy initiatives that include implementation of rate-payer financed energy efficiency funds, dynamic pricing schemes, decoupling of utility revenues from electricity sales, and efficiency portfolio standards, all of which are intended to stimulate more efficient use of electricity.

Figure 1. Geographic location of Regional Transmission Organization



The opening of FCMs to efficiency resources is noteworthy because many market observers remain concerned that even with these efforts utilities remain ill-equipped to adapt to evolving pollution regulations. Carbon is of particular concern over the long term, but pollutants such as mercury, sulfur oxides, nitrogen oxides, and soot are problems now. All are at the focus of an evolving regulatory landscape that many market observers fear will harm utility profitability. Indeed, Moody's Investor Service said in 2009 that it was "struck by the [utility] industry's apparent lack of urgency regarding new, complex, and potentially costly carbon rules." (Moody's 2009) Certainly the fact that the US grid added 5.2 GW of coal-fired capacity in 2010 (EIA 2011) suggests that technically and economically viable non-polluting grid applications remain an aspiration.

It is for this reason that FCMs are a potentially powerful addition to electric market policy. They essentially seek to create a new category of grid asset by coopting each consumer into becoming a merchant generator of demand reductions or 'negawatts'. As with conventional merchant generators, the success of the FCM rests on whether it can send price signals to end-users powerful enough to mobilize investments in energy efficiency activities that otherwise would not take place.

Analysis suggests the business model is a challenging one. Cash flow modeling shows that FCMs do provide value to efficiency investments, but major challenges particular to the energy efficiency industry undercut the benefits: high transaction costs, expensive measurement and verification (M&V) of measure performance, and – not least – an abundance of inexpensive power plants. Indeed, study of the ISO-NE market operations indicates that successful use of the markets to date has centered largely on energy efficiency programs operated under public utility commission oversight. These can use a combination of scale and existing M&V activities to reduce administrative costs. Expanding use of the FCM to be a more significant force in regional power markets will require increasing their value to end users, through a combination of cost improvements and market design enhancements

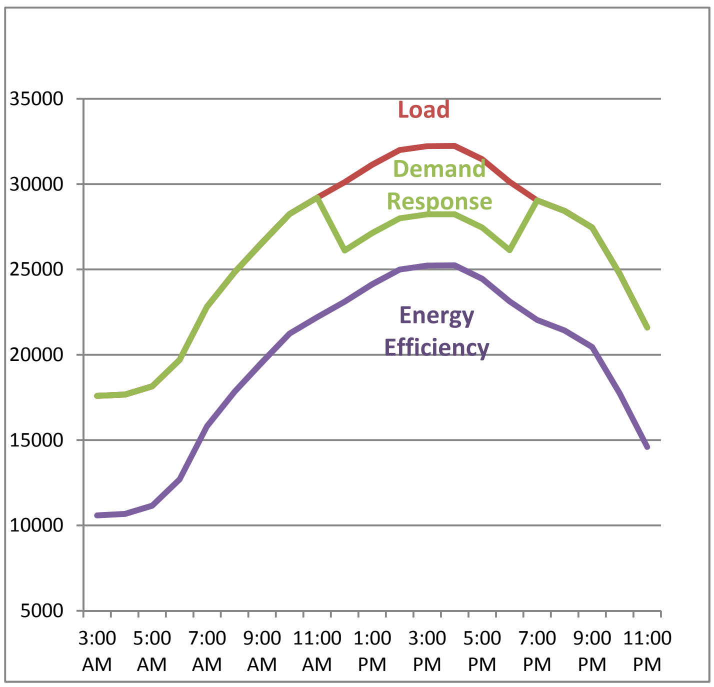
Overview of the Forward Capacity Market

A core function of ISOs and RTOs is to ensure the reliability of the electric grid at lowest cost to the consumers in the region that they serve. Energy capacity is capital intensive to build and involves long lead times for design, construction, and permitting. In order to ensure that capacity will be available when it is needed, the ISOs operate forward capacity markets. "Forward" refers to the procurement of resources today for use in the future, a reflection of the need to signal to the market that it will reward capital intensive investments with long construction, maintenance, and permitting time frames. Both PJM and ISO-NE conduct their planning windows three years in advance of delivery (Gottstein and Schwartz, 2011). It also bears mentioning that "capacity" refers to the assets that can be deployed to meet demand requirements; not the actual production or sale of electricity.

Energy Efficiency's role in the FCM

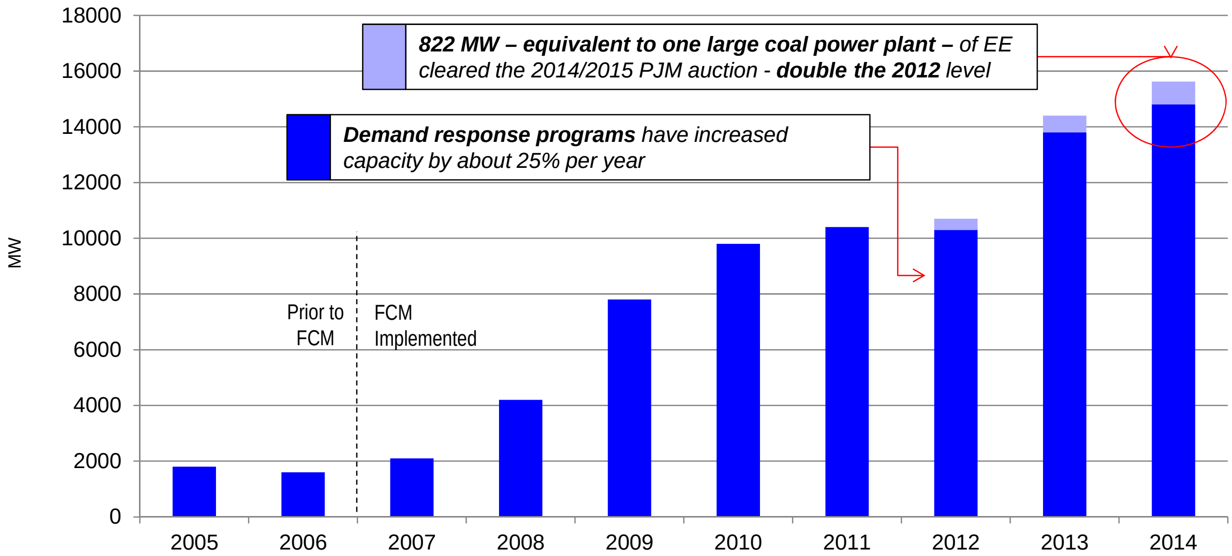
Capacity markets were designed largely around traditional central station generators (for example, the three-year planning horizon is intended to align broadly with the time needed to build a new peaking plant) but a movement toward more competitive wholesale electric markets has changed this dynamic. Demand response, in which the grid operator induces customers to temporarily reduce energy consumption (e.g. by turning off air conditioners; see Figure 2), is the first "negawatt" capacity resource used by system operators on a large scale.

Figure 2. Comparison of Demand Response and Energy Efficiency



Energy efficiency as a resource is a more recent development. Technically, it is distinguished by the fact that it involves permanent, continuous reductions in customer energy use that are not reflected in the system's forecast of peak load. It was pioneered by ISO-NE in 2006 as part of a settlement agreement with the Federal Energy Regulatory Commission (FERC), and the first "delivery" of energy efficiency took place in 2009. PJM followed suit in 2009, with initial delivery set for 2012. Use of both markets has increased rapidly, albeit off a small base (see Figure 3).

Figure 3. Growth in Demand Response and Energy Efficiency, PJM



Source: Energy Efficiency in PJM's Markets: Opportunities and Trends, Paul Sotkiewicz, PJM Interconnection, May 3, 2011
* See PJM 2012/2013 RPM Base Residual Auction Results, page 5

In addition to meeting load requirements without emitting carbon, energy efficiency markets offer a number of additional sources of value to the grid, particularly in densely populated areas that are also large electricity markets:

- **Speed of deployment:** Efficiency projects can be implemented over a period of months, without the uncertainties of extended siting, environmental, and regulatory analyses associated with generation and transmission projects.
- **High locational value:** Like urban highways, power lines that serve cities are often highly congested. And while cities also tend to be very difficult places to build major infrastructure projects, they rely critically on electricity to power service-oriented economies where the cost of down time is extremely high. They also rely on power to provide essential public services, such as water treatment. Amid these constraints, grid operators prize the ability to deliver power to a given location at a specific time.
- **Peak load reductions:** Utility grids are most vulnerable to outage at times of peak use – very hot days during the summer or very cold days during the winter. Some efficiency measures, such as improved Heating, Ventilation and Air Conditioning (HVAC) and building envelope improvements, support peak load reductions, avoiding the need to use the grid's most expensive generators.
- **Air quality:** Carbon emissions are a long-term concern, but emissions of other pollutants pose immediate health risks. Electricity power plants are leading sources of a wide range of pollutants, including chemicals that produce ground level ozone, as well as mercury, sulfur compounds, and particulate matter.
- **Lower wholesale prices:** Treatment of energy efficiency as a resource addresses both elements of the supply-demand equation that set prices: it introduces a new class of supply resource, and also lowers the volume of electricity needed to satisfy load.

That energy efficiency is a valuable and useful resource and that it should be used more widely has proven as easy to conclude in principle as it has been challenging to execute in practice. While the barriers to energy efficiency have been extensively catalogued, a few stand out with respect to their use in the utility grid:

- **Hard to count:** Planning the availability of resources, ensuring they deploy as agreed, and billing users appropriately are all fundamental responsibilities of the grid operator that rely critically on reliable data. Whereas the output of traditional energy resources are easily metered in real time, energy efficiency gains are not. Variations in weather, occupancy levels, facility use, management practices, and occupant behavior cloud precise accounting of efficiency gains. In addition, different types of energy efficiency measures use different types of monitoring and statistical verification methodologies.
- **Small individual transaction size:** A discernable impact on the market requires a large number of energy efficiency projects. A large commercial building such as a big box retailer could potentially offer the grid 100 kW in energy reductions (efficiency 'capacity'); it would take about 5,000 of these to equal the size of a typical power plant.
- **Not dispatchable:** Grid operators rely critically on the ability to increase the volume of electricity available to the grid by "dispatching" electric generators as needed. A passive resource, efficiency cannot be turned on or off as needed by the grid.
- **Complexity of market rules:** Suppliers of energy efficiency capacity must navigate a highly complex and often arcane set of processes, rules, and procedures to enroll in and then participate in ISO or RTO activities. These obstacles contribute to high project transaction costs and diminish returns.

The Value Proposition of the FCM as Seen by a Building Owner

Methodology

Our aim was to investigate **at an order of magnitude level** whether the FCM was an attractive option for a typical commercial building. To determine this, we conducted a standard cash flow scenario analysis to measure the potential effect of FCM revenue on an individual building conducting a retrofit. This cash flow analysis is based on a series of assumptions and variables to simulate an average commercial building conducting a standard retrofit in the PJM service area.

All variables are based on Energy Information Administration's (EIA) Commercial Buildings Energy Consumption Survey data, the Department of Energy's (DOE) Building Energy Data book, EIA electric sales data, and standard demand side management industry assumptions.

The minimum size for participation in the FCM market in both PJM and ISO-NE is 0.1MW peak reduction. Some of the variables were picked from a possible range to keep the calculations to round numbers and yield a 0.1 MW peak reduction. For example, from a possible range of 16-20 kWh/ ft^2/year for an office building, we picked 18.5 kWh/ ft^2/yr to represent a large office building so that we could work with a 150,000 ft^2 building that would yield 0.1MW peak savings when reducing electricity use by 15% at the typical 47% load factor for offices over a continuous annual operating profile.

We selected a large office building to represent the typical commercial building. The selection of an office building was based on CBECS data that shows that Office and Retail are the largest commercial sub-sectors in terms of energy consumption in US commercial buildings. Of these two, Offices are a more homogenous set both in terms of building characteristics and in organizational structures, and therefore a more likely sub-sector to be found in the FCM. We picked a large office rather than medium office, even though they have similar representation in terms of energy use, again because large offices are more likely to participate in FCM because of the level of effort involved and the size of returns. Healthcare would have been another likely candidate sub-sector because of the high potential for savings. However, it is also unusually energy intensive and comprised of relatively few installations, and therefore less indicative of the broader market opportunity.

Next, we assumed that the building would be seeking a reasonable but not necessarily aggressive savings target. Going by typical utility program offerings, we assumed a reasonable target of 15% savings. Because the source of the savings can vary by factors such as building vintage, system types and occupancy patterns, we assumed equal savings of 15% across electricity and gas use. We focused only on the electricity portion for the cash flow analysis.

To estimate the upgrade cost of the measures, we assumed initial project capital costs using a mix of 60% lighting and 40% HVAC upgrades, the average cost of which we obtained from the California Public Utilities Commission's Database for Energy Efficient Resources. Based on typical utility programs, we assumed a 25% incentive. We assumed a typical 55% of the incentive cost as administrative cost.

Monitoring and valuation is particularly critical to FCM activities, as it is the means by which the grid operator confirms that resources will be available when needed. The type and schedule of M&V activities used in the calculations are based on the PJM regulations, which are spelled out in PJM Manuals 18 and 18b. In terms of specific costs, the utility program incentive costs was used to derive the building M&V cost, which can range from 2-10% of program (incentive + administration) cost for a utility. For this exercise, considering the level of scrutiny in FCM markets, we assumed a 6% M&V cost. This was cross-checked with industry average M&V costs as this cost is typically being borne by the utility, but our analysis is from a commercial perspective. Our 6% assumption yields a cost of 5 cents/ft^2 for a 150,000 ft^2 building. This varies by size of the building and other factors, but is conservative compared to the 18-20 cents/ ft^2 that can be a typical cost for a commercial customer performing M&V on their own. Therefore, we rounded up these costs for the first year from the calculated range of $8,000 to $10,000 and assumed a fraction of that for follow-up.

We assumed that all measures would be financed on the building owner's balance sheet and did not ascribe financing costs, although a 10% discount rate was used to assess the future value of cash flows.

For electricity rates, we looked up the average commercial rate from EIA Short-term energy outlook, then found a similar commercial rate structure at PECO, a large utility serving mid-Atlantic markets and an important PJM participant, to get the various fixed and variable charges.

To build the model, we consolidated these assumptions for an average commercial office building, a standard 15% savings efficiency measure, and the PJM market (Table 1).

Table 1. Key Cash Flow Input Assumptions and Sources

Assumption Name	Value	Source
Building Characteristics		
Size	150,000 square feet	Assumption
Electricity Usage Intensity	18.5 kWh per square foot	Based on an inefficient building and the DOE CBI Commercial Reference Buildings (http://www1.eere.energy.gov/buildings/commercial_initiative/reference_buildings.html)
Building Load Factor	47%	Good Energy (http://www.goodenergy.com/electricity_consulting_products/aggregation.aspx)
Annual Operating Hours	8,760 hours per year	Assumption
Efficiency Measure		
Electricity Reduction	15%	Assumption
Cost	0.81 $ per kWh	DEER average
PJM Market		
Electricity Cost	9.54 cents per kWh	EIA Electric Sales, Retail and Average Price 2009
PJM FCM Efficiency Sale Price	172.67 $ per MW-Day	3-year average of PJM efficiency clearing price
Minimum Project Size	0.1 MW	PJM minimum requirement
M&V Plan (Pre-Sale)	$10,000	Authors expertise augmented by market research
M&V Plan (Subsequent)	$2,000	
M&V Report	$2,000	
M&V Verification (1st Year)	$1,000	
M&V Verification (Subsequent Years)	$ 500	

Results

The outputs of the cash flow analysis are annual energy savings, net present value, and payback period. We compared these outputs in two scenarios to analyze the effects of FCM payments on a building owner's decision to conduct a retrofit.

The cash flow model suggests that the hypothetical suite of energy efficiency upgrades would generate annual electricity savings of about 416,000 kWh on total annual pre-retrofit electricity consumption of 2,778,000 kWh. This translates to about $38,500 in savings on an annual electric bill of about $265,000.

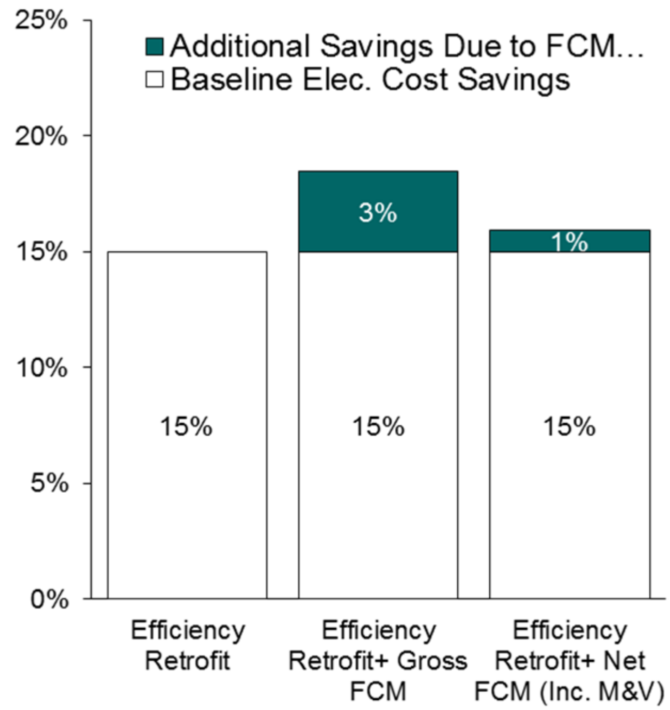
The project's contribution of 100 kW in 'capacity' to PJM's forward capacity market entitles the owner to receive $8,300 from the FCM for each of the four years that the project would be eligible to participate. This raises the gross project revenues to about $46,800 resulting in a return on the project's initial capital investment of about 18% (see Figure 4).

Factoring in the costs to participate in the FCM, however, diminish this figure substantially. Based on PJM M&V requirements, during the three year pre-delivery period project sponsors would need to front about $10,000 for the initial M&V plan, up to $2,000 to update the plan in each of the next two pre-delivery years, and $2,000 to perform an M&V report in the last pre-delivery year. This adds up to roughly two years' worth of revenues. Further, the discount factor applied to future cash flows means that each dollar of revenue received during the FCM delivery period is worth only 68 cents at the time the project is bid into the FCM.

M&V costs decline during the delivery years, allowing more revenue to be captured as profit, but continue to require about $1,000 annually in updates to the M&V report and $500 in verification costs. The total of effect of pre- and post-delivery transaction costs is to increase the project returns from 15% to 16%.

Qualitatively, several risk factors weigh further on the value of this additional 1% in revenues. These include the potential for the building to experience substantial changes in operating patterns, occupancy, equipment performance, or other factors that would result in savings forecasts deviating from initial estimates. Also, failure on the part of the building owner to deliver the level of savings expected by the ISO will trigger penalties. Finally, participants in ISO-NE must post financial assurance, essentially a bond against failure of the project to be "built" as planned but which essentially imposes an opportunity cost to the building owners' capital and must be considered an indirect cost.

Figure 4. Energy Efficiency Project Returns



Market activity to date has been dominated by efficiency programs

This analysis suggests a prominent role for both scale and minimizing transaction costs in widening the use of FCMs, and this appears to be elemental to the growth in the use of EE in them. The transaction costs of bidding energy efficiency capacity into the FCM can be optimized by aggregating portfolios of projects bid into the FCM under a single M&V plan, which both PJM and ISO-NE allow, by a specialized entity familiar with the workings of the capacity markets. Indeed, the ISO-NE FCM for EE, the only one to have accrued a substantial track record of energy efficiency resource participation to date, is dominated by rate-payer funded energy efficiency organizations and utility efficiency programs. These entities administer energy efficiency programs funded by system benefits charges (SBCs) pursuant to state mandates in New England, most of which require implementation of all cost-effective energy efficiency resources, and are operated under the purview of state public utilities commissions. A smaller set of entities seeks to assist energy users interfacing with the market.

The FCM for energy efficiency can represent a compelling value proposition to these aggregators, especially to utility program administrators. The experience of several SBC and utility program administrators interviewed for this paper holds that an investment of roughly $100,000 - $200,000 in staff salaries and consulting fees to participate in FCM can in turn generate $1 million or more in forward capacity market revenues. While approaches vary from organization to organization, these entities typically appoint a staff member to oversee FCM operations, and provide a budget for consulting services to maintain relations with the ISO, conduct M&V, and (in some cases) audit M&V results. Although programs are administered differently by states (whose PUC commissions regulate rates) and utilities (which serve defined territories), FCM proceeds have so far been mandated by the commissions to be channeled in one of two ways – either to augment the energy efficiency portfolio, or, in cases where energy efficiency is already mandated to be deployed at the maximum cost-effective levels, to lower customer surcharges. Three critical factors enable utility program administrators to harvest the value from FCM effectively:

- **Lower M&V costs.** Efficiency program administrators operating under PUC oversight already use M&V processes to measure and justify the benefits of their programming to the PUC, ratepayers and external stakeholders. With some modifications, they are often able to use the same M&V processes to fulfill the forward capacity market requirements.
- **Familiarity with the workings of the ISOs.** Utility companies are required to interface with the ISO as part of regular resource planning, procurement, and market settlement activities. They are institutionally established to work with policies, procedures, and practices employed by the ISO that would appear arcane to many outsiders. SBC fund administrators, in many cases, employ staff that have been active in the establishment of the FCM and are active participants in various ISO policy development activities.
- **Ability to offer portfolios into the FCM.** Programs operating under public utility commission oversight can develop large project pipelines through their ability to market programming directly to hundreds of thousands and – in some cases – millions, of customers. As a result, they are able to offer large portfolios of measures, often built around a common theme (e.g. office lighting or residential appliances). This ability is hard for non-utility market actors (such as energy service companies) to match.

Notwithstanding these considerable advantages, program administrators interviewed for this paper indicated a number of challenges with using the FCM. Capacity prices have been declining in ISO-NE, due in part to diminished demand associated with the recession. The administrative burden of participation is also significant, and requires investment of senior management time and resources, particularly in relation to meeting strict deadlines required by the ISO to maintain operations. M&V requirements have been a getting increasingly stringent, making the value of participation seem questionable to some participants. Finally, suppliers engage in a constant balancing act over how much of their portfolios to bid into the market; if they overbid they risk penalties for non-performance; if they underbid they lose a revenue opportunity.

Conclusion – Evolution of FCMs Can, Should, and Needs to Continue

The US utility grid is one of the nation's – and therefore the world's – principal sources of carbon emissions. This fact is unlikely to be impacted much by the inclusion of energy efficiency in FCM. However, when viewed in the context that energy markets have been designed over many decades with the express purpose of managing the central station utility model, it should hardly be surprising that they do not yet seamlessly integrate efficiency resources. In this context, the premise behind energy efficiency in forward capacity markets, which is that energy efficiency represents a resource for meeting energy requirements and can be delivered through competitive markets, is powerful. To date no other system offers the potential for large-scale integration of energy efficiency resources into the electric grid by any entity – utility, start-up company, non-profit entity, government agency, or otherwise – able to provide them competitively to the market. Evolution of these markets can and should continue, with focus in several areas:

- **Improve efficiency measurement & valuation systems.** Identifying the performance of energy efficiency investments on a timely, reliable, and cost-effective basis is an issue of fundamental importance. One promising avenue is the movement toward a system of deemed savings, rather than a project-by-project M&V approach, that gives the ISO confidence that savings bid into the system will materialize as scheduled. Expanded standardization and simplification of valuation systems would increase the potential for aggregation of portfolios.
- **Increase scale through leadership by organizations with building portfolios.** Diverse organizations that are already undertaking energy efficiency programming are likely leaving money on the table by not participating in forward capacity markets. These range from the Federal government, which is obligated by law to reduce, track, and report on energy use, to big box retailers, commercial property trusts, and other entities that manage large volumes of commercial real estate space. Lessons from virtually every market holds that increasing transaction volume supports routinization of individual transactions, decreases marginal costs, and enhances business processes. It also improves the financial performance of programs to which these organizations have committed.
- **Valuation of the environmental benefits of efficiency.** The cost of carbon emissions is not well reflected in many utility markets. And while the EPA has recently finalized new and more stringent rules governing other power plant emissions, the rules still allow substantial volumes of pollutants to be emitted into the atmosphere. The fact that that the FCM does not assign a financial value to the environmental benefits or costs associated with any given resource places clean energy efficiency at a notable competitive disadvantage.

- **A forum for Energy Efficiency market design.** Market design initiatives can deepen existing FCMs and support their development in other jurisdictions. With respect to the former, the fact that FCMs have been established should not obscure the fact that they are continuously evolving as a function of design imperfections, market needs, trends in regulation, and other market dynamics. Policy and market design features are under continuous evaluation within various market committees and other decision making bodies employed by the ISO, the outcomes of which can often have important effects on how valuable the markets are. In addition, to the extent operators of grids in other areas of the country may also be considering similar structures, the technical, economic, and operational experience of PJM and ISO-NE should be shared in order to facilitate the development of effective structures.

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