# 19. Revise Capacity Market Practices and Policies

## 1. Profile

In some parts of the United States, "capacity markets" have been established as a mechanism for promoting competition in the electric power sector while ensuring reliable electric service. This chapter explains what capacity markets are, where they have been instituted, and – most importantly – how capacity market rules can have an impact on greenhouse gas (GHG) emissions.

Air pollution regulators should understand at the outset that the existence of a capacity market does not by itself imply reduced GHG emissions, and establishing a capacity market is not necessarily a policy tool for reducing emissions. However, where capacity markets exist, the specific practices and policies (i.e., market rules) can and do affect GHG emissions, so it is legitimate to consider capacity market rule reforms as a tool for supporting and enhancing other GHG emissions reduction strategies. This chapter identifies some capacity market rules that support emissions reductions, as well as some market rules that can inhibit emissions reductions. But at the outset, it is necessary to understand why capacity markets exist, and that requires an explanation of the concepts of "resource adequacy" and "competitive wholesale electricity markets."

### Resource Adequacy

In industrialized societies, power system reliability is treated as a public good, requiring that customers' collective demand for electricity is met when they turn on their appliances and electric heating or cooling systems, subject to a socially acceptable standard for involuntary service interruptions (i.e., "blackouts"). Energy regulators therefore set reliability standards that apply to the system. In the United States, reliability standards require adequate resources sufficient to provide reliable supply 99.7 percent of the time.[1] This high standard of reliability reflects the unique "serve all, or serve none" nature of the electric system: if it falls short in meeting even one customer's power needs, all customers relying on that electric circuit are literally left "sitting in the dark."

To meet these strict reliability requirements, load-serving entities (LSEs) are required to have a certain amount of generation capacity in reserve to be called upon when needed.[2] This "resource adequacy" requirement is an essential component of reliability, but is not by itself sufficient to ensure reliability. Other features of system reliability are collectively referred to as system quality, and address questions about whether the right mix of resource *capabilities* is available to ensure that in every moment supply can be balanced with demand.

How LSEs meet resource adequacy requirements varies widely across the US capacity market. Capacity markets, the subject of this chapter, are one option that has been employed within the context of competitive wholesale electricity markets.

### Competitive Wholesale Electricity Markets

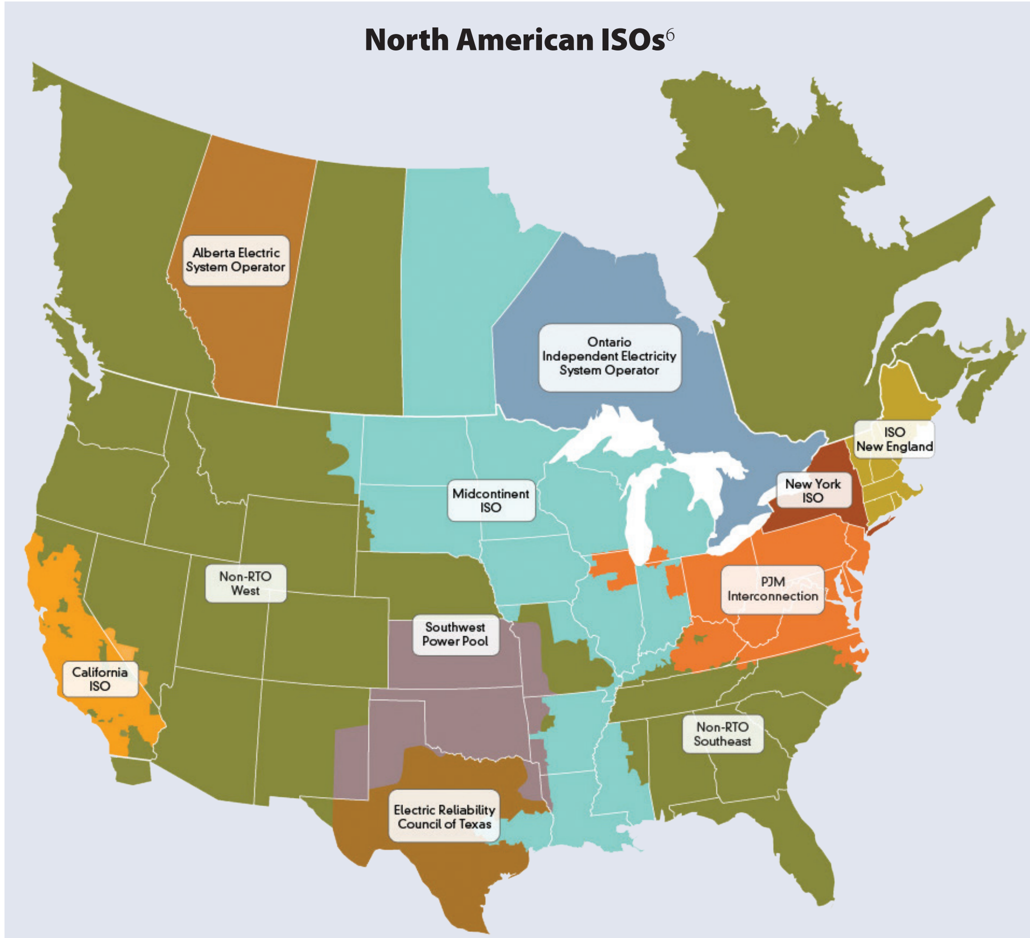
Historically, utilities throughout the United States were responsible for generation, transmission, and distribution of power to retail customers. These utilities were "vertically

1 North American Electric Reliability Council. (2015, March 3). *Glossary of Terms Used in Reliability Standards.* Available at: http://www.nerc.com/pa/Stand/Glossary%20of%20Terms/Glossary_of_Terms.pdf. Put another way, "resource adequacy" means having sufficient electric supply resources in place to maintain a "loss of load expectation" of no more than one day in 10 years. See, for example: ISO-NE. *Market Rule 1, Section III.12.1.* Available at http://www.iso-ne.com/participate/rules-procedures/tariff/market-rule-1

2 Some states have implemented "retail choice," that is, a policy allowing customers to choose their power supplier and rates from a variety of competitive offers by non-utility businesses. Regardless of the choice of supplier, power is still delivered to the customer via a utility's distribution system. The customer pays the power supplier for power and pays the utility for distribution services. The term "load-serving entities" is a catch-all phrase that includes competitive suppliers in retail choice states, as well as utilities in states that don't allow retail choice.

integrated," and they owned some or all of the generation and transmission assets needed to meet their customers' needs, as well as the local distribution system. But in the 1990s, many parts of the United States decided to restructure their power sectors so that different entities would be responsible for generation, transmission, and distribution services. Competitive wholesale electricity markets were an offshoot of this industry restructuring, born on the premise that competitive markets would be better than regulators at revealing the costs of generating and transmitting energy at different hours of the day and in different seasons.[3]

*Figure 19-1*




Today, two-thirds of the population of the United States and more than one-half of Canada's population are served by competitive wholesale electricity markets run by Regional Transmission Organizations or Independent System Operators (ISOs).[4] Currently seven ISOs operate in the United States, as shown in Figure 19-1: PJM Interconnection (PJM), Midcontinent ISO (MISO), Electric Reliability Council of Texas (ERCOT), California ISO (CAISO), Southwest Power Pool, New York ISO (NYISO), and ISO New England (ISO-NE).[5] Within these ISO regions, generators compete to sell wholesale power to LSEs. Some states allow vertically integrated utilities to continue to own generation assets, but the ISO now controls when those generators are dispatched. Outside of the ISO regions, vertically integrated utilities can still own and control their generation, transmission, and distribution system assets.

3 As noted in footnote 2, some states also opted for retail competition. Although the differences between wholesale competition and retail competition are often misconstrued or ignored, the existence or absence of retail competition is not relevant to the wholesale capacity markets that are the focus of this chapter. For more information on restructuring in the United States, see: Moskovitz, D., Bradford, P., & Shirley, W. (2000). *Best Practices Guide: Implementing Power Sector Reform.* Montpelier, Vermont: The Regulatory Assistance Project. Available at: http://www.raponline.org/document/download/id/9; and Lazar, J. (2011). *Electricity Regulation in the US: A Guide.* Montpelier, VT: The Regulatory Assistance Project. Available at: http://www.raponline.org/document/download/id/645

4 The distinction between Regional Transmission Organizations and ISOs is subtle and, for the purposes of this chapter, not particularly relevant. For simplicity, the remainder of this chapter will refer to either type of organization as an ISO.

5 Federal Energy Regulatory Commission. (2012). *Energy Primer: A Handbook of Energy Market Basics.* Available at: http://www.ferc.gov/market-oversight/guide/energy-primer.pdf

6 Sustainable Federal Energy Regulatory Commission Project. Available at: http://sustainableferc.org/iso-rto-operating-regions/

ISO operations encompass multiple services at the wholesale level that are needed to provide reliable and economically efficient electric service to retail customers. Each of these services has its own parameters and pricing. The ISOs use competitive markets to determine the providers and prices for many of these services. These markets include day-ahead energy markets (sometimes called a Day 2 market), real-time energy markets (sometimes called a Day 1 or balancing market), capacity markets (designed to ensure resource adequacy), ancillary services markets (designed to ensure system quality), financial transmission rights (contracts for hedging the cost of limited transmission capability), and virtual trading (financial instruments to create price convergence in the day-ahead and real-time markets). Not all of these markets are available in each of the ISOs listed previously, and they function differently in each ISO depending on the design decisions each ISO made.

## Capacity Markets

Energy and the capacity to generate energy are treated differently by ISOs, and both are important to maintaining the electrical system in different ways. A power plant generates electricity that is used instantaneously in a home, factory, or office building — and the generator needs to be paid for that electricity. This payment happens in the energy markets, such as the day-ahead or real-time markets noted previously. In these markets, electricity is like any other commodity, bought wholesale by LSEs and resold to consumers at retail prices.

LSEs are also required to maintain adequate reserves to ensure that sufficient capacity will be available to meet future peak loads and reliability requirements. LSEs have traditionally satisfied their reserve obligations with generation they already own, or bilateral contracts with other suppliers. Today, however, some ISOs run a capacity market to allow LSEs within their region a different way to satisfy their reserve obligations. Those ISOs have created mechanisms to competitively procure capacity commitments on behalf of LSEs. These mechanisms, such as capacity auctions and capacity payments, can supplement or supplant the traditional LSE approach to resource adequacy.

For a capacity auction, the ISO will calculate how much capacity needs to be procured to meet the resource adequacy requirements of all the LSEs on the system.[7] The ISO will then accept competitive bids from potential suppliers of capacity through one of several possible price-setting mechanisms. Although the nature of these mechanisms varies, what they all produce is a way for the ISO to identify the least expensive bids that will collectively meet the resource adequacy requirements of all the LSEs on the system. Another common feature of capacity auction mechanisms implemented to date is that all accepted bids are paid the same price, the auction "clearing price."[8]

Capacity markets cover short-term capacity, such as a month, season, or year. In addition, PJM and ISO-NE run forward capacity auctions to procure commitments up to three years before the capacity is needed. The near-term focus of these markets is consistent with providing payments to existing generation, or generation such as combustion turbines that can be sited and built within three years.[9] This is important, as power plants are expensive and can take a long time to build; adding the additional risk that they may not even be used can obviously discourage investment.[10] Capacity mechanisms are intended to provide a price signal in today's market to incentivize new capacity to be built and available to meet future needs.

## Impact of Capacity Markets on Greenhouse Gas Emissions

The design and rules of a capacity market can strongly influence the amount and types of resources that are used to meet future electric demand. This, in turn, can positively or negatively affect power sector GHG emissions. The main

7 This calculation accounts for capacity that has already been procured by LSEs through "self-supplied" resources and through bilateral contracts. Bilateral contract prices are not impacted by auction prices.

8 For a more thorough discussion of how capacity market auctions work, refer to: Gottstein, M., & Schwartz, L. *The Role of Forward Capacity Markets in Increasing Demand-Side and Other Low-Carbon Resources: Experience and Prospects.* Montpelier, VT: The Regulatory Assistance Project. Available at: www.raponline.org/docs/RAP_Gottstein_Schwartz_RoleofFCM_ExperienceandProspects2_2010_05_04.pdf

9 Based on: Supra footnote 5.

10 Based on: James, A. (2013). *How a Capacity Market Works.* The Energy Collective. Available at: http://theenergycollective.com/adamjames/237496/energy-nerd-lunch-break-how-capacity-market-works-and-why-it-matters

factors at play include all of the following:

- Some capacity markets allow energy efficiency and demand response (DR) to be bid into the market as capacity resources if they can reduce demand below the amount the ISO is projecting. This creates the possibility that providers of these resources will receive capacity market payments, which, when added to the other benefits of energy efficiency and DR can make implementation more cost-effective and attractive for customers. Energy efficiency and DR can indirectly facilitate emissions reductions by reducing electric demand and helping to integrate high penetrations of zero-emission, variable energy resources (VERs)[11] like wind and solar.[12] Rules that permit energy efficiency and DR participation in capacity markets can help to reduce GHG emissions by contributing to increased energy efficiency and DR deployment.
- In some markets, backup generators may be eligible for capacity market payments as a generation resource. In addition, some customers may be offering to participate in a DR program for capacity payments, but with the expectation that they will run a backup generator if they are called to reduce demand.[13] In either circumstance, diesel-fired backup generators can potentially *increase* GHG and other air pollutant emissions, relative to other capacity resources that might be deployed if the diesel generators are not accepted in the market. Rules that permit diesel generators and other high-emitting customer-sited generation to participate as DR without recognizing the costs being imposed by these dirty resources can increase GHG emissions.
- Because of the near-term (three years or less) focus of existing capacity markets, electric generating units (EGUs) that take a long time to construct would have to begin construction without any certainty about future capacity payments. This arguably disadvantages such resources, compared to EGUs that can be built more quickly, even if they might be cheaper capacity resources in the long term. This is relevant to emissions because of the long lead-time needed to construct nuclear and hydro units, and fossil EGUs with carbon capture systems. However, this same near-term focus may work to the advantage of other low-emissions resources that can be deployed relatively quickly, such as energy efficiency, DR, and small-scale renewables. Forward capacity markets (FCMs) should be designed with due consideration of how the selection of a time horizon will affect different resources.
- The argument is often made that capacity markets can prop up older EGUs that are less thermally efficient than an average EGU, and have higher-than-average emissions and operating costs. In the context of competitive wholesale energy markets, EGUs that are costly to operate tend to be dispatched less often than average EGUs, which means they get paid less often. In some cases, these energy market revenues may not be enough to cover all of the EGU's fixed and variable costs. In the absence of other revenue streams, the continued operation of such an EGU is not economically sustainable and the unit may be retired.[14] However, where a capacity market exists, an inefficient EGU that is usually too expensive to operate might still qualify as a capacity resource and receive capacity market payments – perhaps even enough to forestall retirement. This can discourage the construction of new, lower-emitting resources that might otherwise be built to meet capacity

11 "Variable" as used in this chapter refers to any source of electricity production in which the availability to produce electricity is largely beyond the direct control of operators. It can be simply variable – changing production independently of changes in demand, or variable and uncertain – variable and, in relevant timeframes, unpredictable. Another term for this latter category of sources is "intermittent." The challenge and opportunities for integrating VERs is discussed in more detail in Chapter 20.

12 For more information on how these resources indirectly affect emissions, refer to Chapters 11 to 15 for energy efficiency and Chapter 23 for DR.

13 For example, in the PJM market, backup generators have been estimated to comprise 30 to 50 percent of the total DR resource. Verified data are not yet available to test these estimates.

14 Chapter 8 includes a more thorough discussion of the factors that influence a decision to retire an EGU.

needs.[15] Capacity market design that props up old, inefficient EGUs at the expense of more efficient EGUs can increase GHG emissions.

- Distributed generators (DG), combined heat and power (CHP), and electricity storage units may not be able to fairly compete in capacity markets, despite the fact that they are interconnected to the system and have a generating capacity. Renewable DG technologies and all types of CHP resources can reduce GHG emissions, as explained in Chapter 17 (DG) and Chapters 2 and 3 (CHP). Storage units can help with the integration of VERs, as explained in Chapter 20. Because these resources are sited on the customer's side of the electric meter, the ISO may assert that they are features of customer demand that are already included in its projections of future demand, and thus not available to serve unmet capacity needs. But capacity market rules that permit renewable DG, CHP, and storage to compete in capacity markets can promote greater deployment of these resources that will help to reduce GHG emissions.
- Capacity market rules will include a standard discounting of the capacity value of VERs like wind and solar. This is a way of acknowledging that a 100-megawatt (MW) VER has some capacity value, but is not always capable of providing 100 MW of capacity. The discount factor applied to VERs can significantly affect the payments that are received, and those payments of course influence the cost-effectiveness and competitiveness of VERs relative to higher-emitting fossil EGUs. Rules that fairly establish the capacity contribution of VERs can reduce GHG emissions relative to rules that give no or inadequate capacity value to VERs.

Finally, the existence of capacity markets and the rules of those markets can encourage or discourage procurement of capacity resources that have different *capabilities* that affect system quality. This is especially relevant to the topic of integrating zero-emission VERs like wind and solar (treated in more depth in Chapter 20). "Traditional" capacity mechanisms focus only on a simple version of resource capacity, ensuring there are enough firm, dispatchable[16] energy resources available to meet peak demand during a relatively limited number of hours in the year, irrespective of their operating capabilities in other hours. These traditional capacity mechanisms have historically resulted in the construction of new baseload power plants, usually coal or natural gas. However, the changing nature of power generation sources is straining this traditional model. The reliability challenges of the power system are changing with a growing share of VERs, requiring that the capabilities of physical capacity change. These traditional mechanisms are not designed to elicit the operation of or investment in capacity with the flexible capabilities that will be required with increasing frequency, and at multiple times of the day or year, as the share of VERs in the power mix increases.

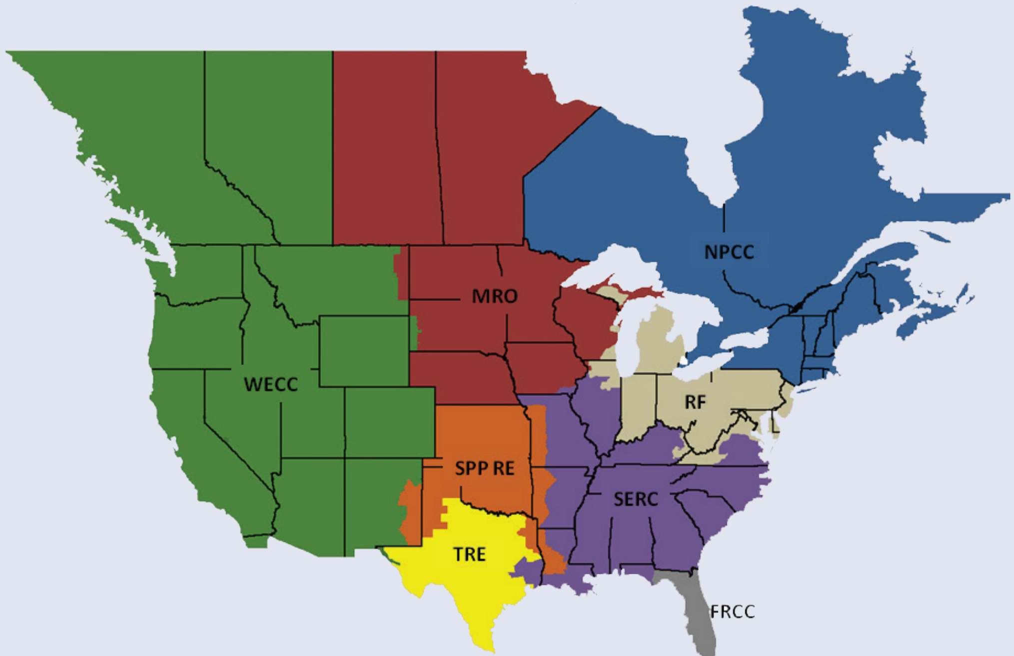
An emerging issue is whether the basic definition of the capacity product should account for specific operational

15 Some observers of wholesale markets have suggested that the inclusion of energy efficiency and DR in capacity markets could also discourage the construction of new, lower-emitting EGUs. This may be possible, but there are several factors working in opposition to the proposition. To begin with, energy efficiency and DR resources only clear in the capacity market if they are less expensive than other options. If energy efficiency and DR are removed from the capacity market, the gap will almost certainly be filled by a combination of existing and new EGUs, all of which can provide capacity but at a higher cost. The clearing price may rise significantly. (An example of this dynamic is detailed later in this chapter.) So not only will *more EGUs* be able to earn capacity payments, but they will also receive *larger* payments. Some of those larger payments will go to older, higher-emitting EGUs that would receive a *smaller* capacity payment (or none at all) if energy efficiency and DR were allowed to compete. And then there are the energy market impacts, which mirror those in the capacity market. If energy efficiency and DR cannot receive capacity payments, they will be less cost-effective and less of each resource will be deployed. This means that EGUs will collectively have to generate more electricity to meet demand, and energy market clearing prices will also rise. Some of that extra generation may come from new EGUs, but the output (and revenues) of existing, inefficient, higher-emitting EGUs might also increase. The combined impact of higher capacity prices and higher energy prices might be enough to keep older, inefficient resources in business even as new, cleaner EGUs are built.

16 "Dispatchable" refers to the ability to increase or decrease electricity output on command (i.e., the resource is controllable). "Firm" refers to the volume of MWs that the system operator can rely on being available to provide energy to the system at any moment in time, including generation or reduction of demand for energy (through demand-side resources like energy efficiency and DR).

***Figure 19-2***

**Regional Entities With Delegated Responsibility for Reliability**[21]




**FRCC** – Florida Reliability Coordinating Council
**MRO** – Midwest Reliability Organization
**NPCC** – Northeast Power Coordinating Council
**RF** – ReliabilityFirst
**SERC** – SERC Reliability Corporation
**SPP** – Southwest Power Pool, RE
**TRE** – Texas Reliability Entity
**WECC** – Western Electricity Coordinating Council

attributes needed to address system quality. For example, as noted previously, changes in the electric industry have created additional operational and system requirements, including an increased need for more responsive and flexible resources, for example, quick start and fast ramp capability, responsiveness in providing regulation or load following, and so on. In particular, the rapid growth in VERs creates a greater need for flexible resources to balance load instantaneously and to smooth fluctuations in output during the operating day. To address these emerging needs and challenges, new product definitions could be developed that specify offer parameters such as startup time, minimum run time, minimum down time, or other operational parameters that would address specific system needs such as quick-start and fast-ramping capability, or load-following ability.[17] Another approach is to apportion the capacity mechanism into tranches based on the target mix of resource capabilities derived from the net demand forecast. All firm resources, including qualifying DR and energy efficiency resources, would bid into the highest-value tranche for which they could qualify. The most flexible tranche of firm resources would be cleared first, followed by the next most flexible, and so on.[18]

## 2. Regulatory Backdrop

The North American Electric Reliability Corporation (NERC) has chief responsibility for establishing reliability standards for the bulk (wholesale) power system that must be met throughout the continental United States and Canada, in regions with and without ISOs. NERC delegates its responsibility for monitoring and enforcing reliability standards to eight regional entities, depicted in Figure 19-2.[19] In the United States, the Federal Energy Regulatory Commission (FERC) has regulatory authority to oversee the decisions of NERC and the regional entities. A detailed discussion of the roles and responsibilities of FERC, NERC, and the regional entities is beyond the scope of this chapter, but can be obtained by visiting the NERC website.[20]

NERC's reliability standards are imposed on a wide variety of entities. Depending on the standard in question,

17 Supra footnote 5.

18 For more information on this option, see Hogan, M., & Gottstein, M. (2012, August). *What Lies "Beyond Capacity Markets?" Delivering Least-Cost Reliability Under the New Resource Paradigm. A "straw man" proposal for discussion.* Montpelier, VT: The Regulatory Assistance Project. Available at: http://www.raponline.org/document/download/id/6041

19 As Figures 19-1 and 19-2 indicate, the NERC regions do not align in all cases with the regions served by ISOs. Some regional entities (e.g., NPCC) have responsibilities that span more than one ISO, and some ISOs (e.g., MISO) are overseen by more than one regional entity.

20 See: http://www.nerc.com/pa/Stand/Pages/default.aspx

21 NERC. Available at: http://www.nerc.com/AboutNERC/keyplayers/Documents/NERC_Regions_Color.jpg

responsibility may fall on EGU operators, transmission operators, distribution utilities, ISOs, or others. Capacity markets were created as a mechanism for ensuring that regions where competitive wholesale markets have been established through ISOs will have enough available generating capacity to comply with NERC's reliability standards (i.e., "resource adequacy").

Competitive wholesale electricity markets grew out of FERC Order No. 888, issued in April 1996, which required utilities to offer open access to their transmission lines to all generators.[22] Order 888 did not explicitly require the formation of ISOs, or require the formation of competitive wholesale markets. Rather, utilities in some parts of the country elected to form ISOs and create competitive wholesale markets as a means of complying with Order 888 and subsequent FERC orders. As discussed earlier, there are currently seven ISOs operating in the United States, as well as several regions that have not formed ISOs.

ISOs, on behalf of their members, develop tariffs and wholesale market rules, in addition to operating the bulk power system. Capacity markets are one of the options available to ISOs for ensuring resource adequacy within their systems. In the United States, market rules and tariffs associated with transmission and competitive wholesale markets, including capacity markets, mostly fall within FERC's regulatory jurisdiction. FERC can approve or reject transmission tariffs and wholesale market rules proposed by ISOs (or by utilities operating outside ISO regions). Exceptions to FERC's authority exist in states that are islands (Hawaii) or that are electrically separate from the remainder of the continental 48 states (Alaska and parts of Texas), because electricity in those jurisdictions is not traded in interstate commerce. In those exceptional areas, the state Public Utility Commission has regulatory authority similar to FERC's over most aspects of transmission tariffs and competitive wholesale markets.

## 3. State and Local Implementation Experiences

Capacity markets, to date, have not been implemented at the state or local level, but rather at the ISO level. There are four capacity markets in operation in the United States currently, in the regions operated by ISO-NE, MISO, PJM, and NYISO. CAISO has a bilateral capacity mechanism to ensure resource adequacy, but it is not considered a full capacity market. CAISO worked with the California Public Utilities Commission and other stakeholders from 2007 to 2010 to explore development of a long-term resource adequacy framework. The discussion included consideration of multiyear forward procurement of resource adequacy capacity and potentially a capacity market. But on June 3, 2010, the California Public Utilities Commission issued a decision in the long-term resource adequacy proceeding that leaves the current resource adequacy program essentially unchanged.[23] Capacity mechanisms are also present in a handful of European countries and in Brazil. Table 19-1 provides an overview and comparison of the key features of current US capacity markets.

In addition to the details presented in Table 19-1, these existing capacity markets differ in some ways that may have specific (albeit indirect) impacts on GHG emissions. Some of the key differences are noted below.

22 FERC. (1996). *Order No. 888 - Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Services by Public Utilities; Recovery of Stranded Costs by Public Utilities and Transmitting Utilities.* Available at: http://www.ferc.gov/legal/maj-ord-reg/land-docs/order888.asp

23 For more information, see: California ISO. (2014). *Capacity Markets.* Available at: http://www.caiso.com/informed/Pages/StakeholderProcesses/CompletedStakeholderProcesses/CapacityMarkets.aspx

*Table 19-1*

| Overview of US Capacity Markets | | | | |
|---|---|---|---|---|
| | **PJM** | **ISO-NE** | **NYISO** | **MISO** |
| **Overview** | The Reliability Pricing Model (RPM) comprises a series of forward-looking auctions, including one Base Residual Auction (BRA) three years in advance and at least three Incremental Auctions (IAs) per Delivery Year (DY). In addition, there is a Bilateral Market that provides resource providers an avenue to cover shortages or monetize surpluses. It also allows LSEs to hedge against Locational Reliability Charges (LRCs) that could be levied against them via the RPM auctions. | The ISO-NE capacity market is called a Forward Capacity Market (FCM). It functions with an annual Forward Capacity Auction held in February three years in advance of a Capacity Commitment Period. The FCM also includes reconfiguration auctions and bilateral exchanges to facilitate trading of capacity supply obligations. | The NYISO installed capacity market provides a backstop to fulfill an LSE's capacity obligations that aren't satisfied through self-supply or bilateral contracts. The installed capacity market consists of three auctions: The Capability Period Auction (6-month term), the Monthly Auction, and the Spot Auction (2–4 days prior to start of month). | The MISO resource adequacy requirement construct allows LSEs to meet their capacity obligations as defined by the sum of LSEs load projections and a reserve margin calculated by MISO or a state. LSEs are able to meet these obligations by:<br>1. Acquiring capacity from annual Planning Resource Auctions;<br>2. Self-scheduling capacity resources; or<br>3. Submitting Fixed Resource Adequacy Plans. |
| **Market Composition** | The RPM market is broadly composed of generation, DR, and energy efficiency resources. Although generation resources represent the overwhelming majority of capacity that cleared the 17/18 BRA (93%), DR also played a meaningful role (6%). | Existing generation and demand resources accounted for 95% of total capacity that cleared in the 17/18 forward capacity auction. Of the new resources that cleared, imports represented 75%. New and existing DR represented 9.1%. | Also allows DR to participate.[25] | Generating resources represented the vast majority of what cleared in the 13/14 Planning Resource Auctions. DR represented 4%. |
| **Locational Constraints** | All costs associated with the resources procured in RPM auctions are allocated proportionally among LSEs who serve load in PJM through the LRC. This charge is billed weekly during the DY and is calculated for each LSE daily. Since Final Zonal Capacity Prices are determined as a blend of zonal resource clearing prices across auctions, LSEs don't know exactly what their LRC costs will be until the completion of a DY's final IA. | Locational information is provided for specific capacity zones (i.e., geographic subregions of the New England Balancing Authority Area that may represent load zones that are export constrained, import constrained, or contiguous—neither export nor import constrained.)[26] | Addressing the fact that certain areas within the New York Control Area have acute transmission constraints, NYISO establishes locational requirements that dictate specific percentages of an LSE's minimum unforced capacity requirements that must be procured from resources located within such constrained areas. | |

24 Unless otherwise noted, information in this chart is from: Karbone Research and Advisory. (2014). *Capacity Market Primer: PJM, MISO, NYISO & ISO-NE.* Available at: http://www.karbone.com/wp-content/uploads/2014/12/Capacity-Primer-Research-Report-7.10.14.pdf

25 NYISO. (2014). *About the NYISO.* Capacity Market webpage. Available at: http://www.nyiso.com/public/about_nyiso/understanding_the_markets/capacity_market/index.jsp.

26 ISO-NE. (2012). *Overview of New England's Wholesale Electricity Markets and Market Oversight.* Available at: http://www.iso-ne.com/static-assets/documents/pubs/spcl_rpts/2013/markets_overview_051513_final.pdf

## Eligible Resources

Demand response resources are now eligible to participate in all four capacity markets, but the markets differ in the eligibility requirements and performance expectations they impose on DR resources. Those differences can influence the amount of DR procured through the capacity market. DR has been most successful in the PJM market, where 10,975 MW of DR cleared in the 2014 capacity auction for DY 2017/2018. This represented more than six percent of all capacity procured through the auction. In contrast, in the 2014 ISO-NE auction for DY 2017/2018, 810 MW of DR cleared. This represented a little more than two percent of total acquired capacity. However, a May 2014 decision by the US Court of Appeals for the District of Columbia Circuit vacated the FERC order governing energy market compensation for DR resources.[27] The Court issued a temporary stay of this decision in October 2014 pending a possible FERC appeal to the US Supreme Court, but if the decision is upheld many observers believe the logic of the ruling will eventually extend to capacity market compensation as well. This calls into question whether DR (and perhaps all demand-side resources) can continue to participate in FERC-regulated capacity markets.

ISO-NE and PJM also allow energy efficiency providers to participate in forward capacity auctions. The other ISOs do not. Under PJM's rules, energy efficiency resources may participate in Base Residual Auctions (BRAs) only up to four years. This means that energy efficiency measures are limited to receiving compensation for their capacity contribution for just four years of their measure life, rather than their full measure life. In contrast, energy efficiency providers in ISO-NE are eligible to bid capacity for their full measure life, an approach that recognizes the full contribution of these resources to regional resource adequacy requirements and that encourages investment in long-lived energy efficiency assets.[28] Figure 19-3 summarizes the amount of energy efficiency that has cleared the ISO-NE and PJM capacity markets in the last six auctions. Energy efficiency resources have provided a greater share of acquired capacity than DR resources in the last four ISO-NE auctions, but have always provided a much smaller share of capacity in PJM. Market rules may explain some of the difference.

*Figure 19-3*

**Energy Efficiency Procured in Forward Capacity Markets (in MW)**[29]

| | Market | 2012-2013 | 2013-2014 | 2014-2015 | 2015-2016 | 2016-2017 | 2017-2018 |
|---|---|---|---|---|---|---|---|
| **Total Capacity** | ISO-NE | 36,996 | 37,501 | 36,918 | 36,309 | 36,220 | 33,702 |
| | PJM | 139,487 | 156,493 | 153,683 | 168,631 | 173,313 | 171,129 |
| **EE Capacity** | ISO-NE | 1,062 | 1,295 | 1,486 | 1,770 | 1,752 | 2,059 |
| | PJM | 569 | 679 | 822 | 923 | 1,117 | 1,340 |
| **EE Capacity as a % of overall obligation** | ISO-NE | 2.9% | 3.5% | 4.0% | 4.9% | 4.8% | 6.1% |
| | PJM | 0.4% | 0.4% | 0.5% | 0.5% | 0.6% | 0.8% |

27 *Elec. Power Supply Ass'n v. Fed. Energy Regulatory Comm'n,* No. 11-1486 (D.C. Cir. May 23, 2014).

28 For more information on energy efficiency in FCMs, and FCMs in general, see: Supra footnote 8. Also see: Neme, C., & Cowart, R. (2014). *Energy Efficiency Participation in Electricity Capacity Markets – The US Experience.* Montpelier, VT: The Regulatory Assistance Project. Available at: http://www.raponline.org/document/download/id/7303

29 Knight, P., Hurley, D., & Fields, S. (2014, May). *Energy Efficiency in US Capacity Markets.* Synapse Energy Economics. Available at: http://www.synapse-energy.com/sites/default/files/SynapseReport.2014-05.0.EE-in-Capacity-Markets.14-035.pdf

### Time Scale

NYISO's installed capacity market is short-term in nature, with the longest forward period being at least 30 days prior to its Capability Period Auction, sometimes called the six-month strip auction. PJM and ISO-NE use a three-year forward period. A longer forward period (such as the three years currently utilized in PJM and ISO-NE) provides more lead time to allow new resources that can be constructed or activated within that period to compete with existing capacity resources, thus increasing competition among different capacity supply options. If the forward period is not sufficiently long to develop capacity resources that need relatively longer lead times, then market participants may have to commit to developing these resources and incur significant costs prior to participating in the auction and without the benefit of auction results. For example, the three-year forward period adopted by PJM and ISO-NE is based on the average lead-time for a new gas-fired combustion turbine or a gas-fired combined-cycle generator, and is viewed as providing sufficient time for those resources to arrange for financing and to complete construction. Similarly, a longer forward period provides more time for an existing resource considering whether to exit a market to make decisions to either retrofit or retire if it does not clear in the auction. However, a longer forward period can result in increased risk for customers when compared to a shorter forward period. Forecasts of planning reserve margins are generally more accurate closer to the period in which capacity resources are needed, when market conditions are better known. More accurate forecasts lead to more accurate procurements of capacity, helping to mitigate economic and resource adequacy risk for customers. PJM and ISO-NE's use of realignment auctions closer to the commitment period is intended, in part, to address this concern.[30]

### Capacity Credit for Variable Energy Resources

A capacity factor is a measure of how often an electric generator runs for a specific period of time. It indicates how much electricity a generator actually produces relative to the maximum it could produce at continuous full power operation during the same period.[31] Capacity markets assign a capacity credit to various types of generation that may be based on the capacity factor. The assigned value can have a huge implication for the price a generation source commands and how frequently it is deployed. Capacity markets have recognized some capacity value for VERs, either through a deemed on-peak capacity factor or a demonstration of claimed capacity for specified on-peak periods. Policymakers need to pay attention to how these values are established so they can be confident the committed capacity will be available when called on, while at the same time encouraging the participation of all low-carbon resources in the market.[32] The capacity credit assigned can discount the capacity value of VERs like wind and solar in favorable or unfavorable ways. For example, MISO assigns a system-wide capacity credit for wind generators that is equal to 14.1 percent of rated capacity. In ISO-NE, all VERs are assigned unique capacity credit values based on their most recent five years of site-specific generation data during winter and summer peaks.[33] So a VER generator can get more or less capacity credit (and thus more or less market revenue) depending on the ISO region it serves.

## 4. GHG Emissions Reductions

Quantitative data showing the impact of capacity market rules on GHG emissions do not exist. This is not surprising, because capacity markets have been created as a mechanism for ensuring resource adequacy and electric system reliability. They have not been created specifically as

30 FERC Commission Staff Report. (2013). *Centralized Capacity Market Design Elements. Report AD13-7-000.* Available at: http://www.ferc.gov/CalendarFiles/20130826142258-Staff%20Paper.pdf

31 US Energy Information Administration. (2014). *Frequently Asked Questions.* Available at: http://www.eia.gov/tools/faqs/faq.cfm?id=187&t=3

32 Supra footnote 8.

33 The Electric Reliability Council of Texas, which does not operate a capacity market but is still responsible for ensuring resource adequacy, assigns a capacity value of 14.2 percent of rated capacity to non-coastal wind generators, 32.9 percent of rated capacity to coastal wind generators, and 100 percent of rated capacity to solar generators up to 200 MW in size.

a means to reduce GHG emissions, and the mere creation of a capacity market is unlikely to have a direct or predictable impact on emissions. Nevertheless, the market design and rules of a capacity market will, inevitably, have a material impact on the carbon emissions profile of a given state or region. The size and character of that impact is difficult to characterize in a general way, as much of the impact will depend on the details of the market mechanism and the resources that are close to participating or withdrawing from participation in the market. In a capacity market like those operated by ISO-NE and PJM, the market provides an additional source of revenue for all firm capacity used to meet loads during system peaks. The additional source of revenue applies equally to all generation sources that can contribute to meeting loads at peak, whether the capacity is zero-emitting or a source of high GHG emissions. In such a framework, the capacity market may actually perpetuate the existence of aging fossil fuel generation by providing a lifeline of revenue for a facility that is otherwise on the road to retirement. Of course the same may be true for an aging zero-emissions generator like an aging nuclear facility. Regardless of whether the facility is a high or low emitter, the additional source of revenues can have a substantial impact on the bottom line and longevity of generation.[34]

If energy efficiency programs are allowed to participate in capacity markets, as is the case in ISO-NE and PJM, investment in energy efficiency is likely to increase and the GHG emissions reduction benefits can be material. If the introduction of energy efficiency creates competition that removes the lifeline for aging, inefficient fossil generation, the GHG emissions benefits are even greater as a zero-carbon resource replaces a high-emitting one. The links between energy efficiency and GHG emissions are described in detail in Chapters 11 to 15.

The inclusion of DR in capacity markets can also have GHG emissions impacts. Chapter 23 explains the complicated links between DR and GHG emissions in detail, but a brief summary can be repeated here. DR programs may reduce energy consumption, but they are more likely to shift the timing of energy consumption from peak demand periods to off-peak periods. The emissions impact of such a shift will depend on the relative emissions rates of EGUs that operate on-peak versus off-peak, and could be positive or negative. On the clearly positive side of the ledger, DR programs can help the ISO integrate higher penetrations of VERs, which tend to reduce system-wide emissions. And on the negative side of the ledger, DR programs may encourage some customers to replace on-peak energy purchases from the grid with generation from high-emitting backup generators. (Air pollution regulations and wholesale electricity market rules can mitigate this last possibility, as noted in the text box.)[35,36] Designing rules that favor inclusion of low-emitting DR and are detrimental to high-emitting customer generation can together lead to

### ISO-NE Rules for Emergency Generators Advance Environmental Goals

Emergency ("backup") generators typically are diesel-fired, and states in New England and elsewhere in the US have restricted the number of hours and days they may be operated through the state permitting process. At the time the first regional DR tariffs were being designed in New England, a collaborative of energy regulators, environmental regulators, the ISO, utilities, and other stakeholders realized that active DR programs could lead to substantial incentives for diesel-fired backup generators to operate more often, when air quality was at its worst. Regulators and the ISO proposed a rule limiting those generators to run for reliability purposes during system emergencies.

34 For example, in 2013, capacity market revenues comprised 12 to 13 percent of the total revenues in both the ISO-NE and PJM wholesale electricity markets. An EGU that has a higher-than-average capacity factor will earn relatively more of its total revenues from the energy markets and less from the capacity market than this system-wide average would suggest, whereas a generator that has a lower-than-average capacity factor will earn relatively less from energy markets and more from the capacity market. An EGU with a very low capacity factor could potentially earn more revenues from the capacity market than from actually selling energy. This dynamic is especially important for large, aging, inefficient fossil plants that no longer operate as baseload generators.

35 Cowart, R., & Raab, J. (2003, July 23). *Dimensions of Demand Response: Capturing Customer-Based Resources in New England's Power Systems and Markets - Report and Recommendations of the New England Demand Response Initiative.* The Regulatory Assistance Project and Raab Associates, Ltd. Available at: http://www.raponline.org/docs/RAP_Cowart_DemandResponseAndNEDRI_2003_07_23.pdf

36 See: The Regulatory Assistance Project. (2002, October). *Model Regulations for the Output of Specified Air Emissions From Smaller Scale Electric Generation Resources.* Available at: http://www.raponline.org/document/download/id/421

lower GHG emissions than would be expected absent these rule changes.

Perhaps the most material contribution to GHG emissions reductions that can be realized through a capacity market is in addressing the needs of a system with higher levels of zero-emissions VERs, like wind and solar generators. The GHG emissions benefits of those resources are detailed in Chapters 6, 16, and 17. Allowing DR resources and electricity storage systems to compete in capacity markets is helpful but is only a partial solution to this challenge. As noted previously, the characteristics that are likely to be needed most in such a system focus on the residual flexibility of the system (stop/start capabilities, ramping capabilities up and down, and load shifting). The next big challenge in resource adequacy is to understand and address how the growing share of variable renewable production will require us to rethink our capacity market rules and, indeed, all of the mechanisms used throughout the US to ensure resource adequacy and system quality.[37]

37 Interested readers can learn more about this at: Supra footnote 18.

## 5. Co-Benefits

The co-benefits that can be realized by increasing renewable generation and energy efficiency are identified and explained in detail in Chapter 6 and in Chapters 11 to 17. Those benefits include potentially significant reductions

*Table 19-2*

**Types of Co-Benefits Potentially Associated With Capacity Market Practices and Policies**

| Type of Co-Benefit | Provided by This Policy or Technology? |
|---|---|
| **Benefits to Society** | |
| Non-GHG Air Quality Impacts | Maybe – market rules can encourage or discourage energy efficiency and low-emissions generators |
| Nitrogen Oxides | Maybe – market rules can encourage or discourage energy efficiency and low-emissions generators |
| Sulfur Dioxide | Maybe – market rules can encourage or discourage energy efficiency and low-emissions generators |
| Particulate Matter | Maybe – market rules can encourage or discourage energy efficiency and low-emissions generators |
| Mercury | Maybe – market rules can encourage or discourage energy efficiency and low-emissions generators |
| Other | Maybe – market rules can encourage or discourage energy efficiency and low-emissions generators |
| Water Quantity and Quality Impacts | Maybe – market rules can encourage or discourage energy efficiency and low-water-use generators |
| Coal Ash Ponds and Coal Combustion Residuals | Maybe – if energy efficiency can participate or if market rules extend the life of coal EGUs |
| Employment Impacts | Maybe |
| Economic Development | Maybe |
| Other Economic Considerations | Maybe |
| Societal Risk and Energy Security | Yes |
| Reduction of Effects of Termination of Service | No |
| Avoidance of Uncollectible Bills for Utilities | No |
| **Benefits to the Utility System** | |
| Avoided Production Capacity Costs | Yes |
| Avoided Production Energy Costs | Maybe – if energy efficiency can participate |
| Avoided Costs of Existing Environmental Regulations | Maybe – if energy efficiency can participate |
| Avoided Costs of Future Environmental Regulations | Maybe – if energy efficiency can participate |
| Avoided Transmission Capacity Costs | Maybe – if energy efficiency or DR can participate |
| Avoided Distribution Capacity Costs | Maybe – if energy efficiency or DR can participate |
| Avoided Line Losses | Maybe – if energy efficiency or DR can participate |
| Avoided Reserves | Maybe – if energy efficiency or DR can participate |
| Avoided Risk | Yes |
| Increased Reliability | Yes |
| Displacement of Renewable Resource Obligation | Maybe – if energy efficiency can participate |
| Reduced Credit and Collection Costs | No |
| Demand Response-Induced Price Effect | Maybe – if energy efficiency or DR can participate |
| Other | |

in criteria and hazardous air pollutant emissions. Capacity market policies that enable and facilitate increased renewable generation and energy efficiency enable and facilitate a greater level of those same co-benefits.

Including DR resources in a capacity market can facilitate greater levels of renewable resource deployment, as explained in Chapter 23, but if DR program participants use backup diesel generators instead of temporarily reducing load, it can result in increased emissions of criteria and hazardous air pollutants. This is especially worrying because most DR events happen during hot weather peaks when ozone concentrations may already be at unhealthy levels. Diesel generators also tend to have short stacks, which leads to more concentrated emissions plumes. Capacity market rules that encourage or reward the use of diesel generators can thus be counterproductive in terms of environmental impacts, even though those resources can contribute to increased reliability, energy security, and some other economic co-benefits.

Table 19-2 summarizes the most likely co-benefits associated with capacity markets. Obviously, most of these benefits do not derive from the capacity market itself, but rather from the fact that it can encourage and enable increased deployment of renewable generation and energy efficiency. Some of the benefits relating to electric reliability can be expected regardless of whether the market rules allow for the participation of energy efficiency or DR resources.

## 6. Costs and Cost-Effectiveness

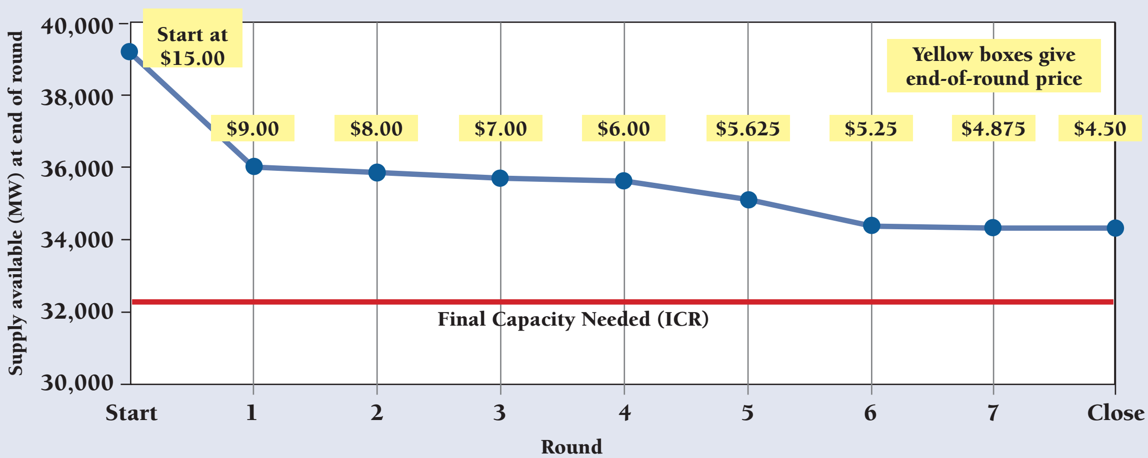
The costs and cost-effectiveness of capacity markets can be considered from several different perspectives, beginning with the perspective that motivated their creation. Capacity markets are intended to meet the resource adequacy requirements of LSEs at a lower cost than the traditional method whereby each LSE acquired all of its capacity through self-supply or bilateral contracts. Capacity markets are designed to reduce resource adequacy costs through economies of scale (addressing capacity needs across the footprint of an ISO serving many LSEs) and by fostering competition. So long as LSEs retain the right to meet some or all of their requirements through self-supply and bilateral contracts, the existence of a capacity market should only add to their options and reduce costs.

Another perspective that can be assessed based on actual market data is the impact on capacity market costs of rules *that include or exclude certain types of resources.* As noted previously, the inclusion of demand-side resources (DR and energy efficiency) in the market has the potential to decrease costs for consumers. For example, in the ISO-NE capacity market, demand-side resources made up 2279 MW of cleared capacity in Forward Capacity Auction 1. The clearing price in this auction was $4.50/kilowatt (kW)-month. Without the participation of demand-side resources, the system would have been more than 500 MW short at the prescribed floor price of $4.50/kW-month.[38]

***Figure 19-4***

**Final Results of ISO-NE Forward Capacity Auction 1**[39]

*(Prices in Dollars/kW-Month)*




38 Jenkins, C., Neme, C., & Enterline, S. *Energy Efficiency as a Resource in the ISO New England Forward Capacity Market.* Proceedings of the ECEEE 2009 Summer Study, pp. 175–183. Available at: http://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2009/Panel_1/1.313/paper

39 Neme & Cowart, at supra footnote 28.

As a result, the price would have had to rise to somewhere between $5.25 and $5.625/kW-month, as illustrated in Figure 19-4. The participation of DR and energy efficiency in the auction thus translates to between $290 million and $435 million in savings to consumers in just that year.[40]

Similar results have been observed in the PJM capacity market, which also allows demand-side resources to participate. The independent market monitor reported after the most recent forward capacity auction that consumer costs would have been more than $9.3 billion higher if capacity offers from DR and energy efficiency resources had not been accepted, as indicated in Table 19-3. (The savings in PJM are considerably bigger than those in ISO-NE in part because it is a much larger electricity market.)

The final perspective we consider is the cost-effectiveness of achieving GHG emissions reductions. Here again we repeat the fact that the creation of a capacity market is not likely to materially affect GHG emissions, but the rules governing a capacity market (where one exists) can significantly influence emissions. If a state is developing a GHG reduction plan and the state is served by an ISO that has a capacity market, regulators should understand that the cost-effectiveness of supply-side and demand-side resources (energy efficiency, renewable generation, nuclear power, coal with carbon capture, and so on) will be partially dependent on capacity market rules, because those rules determine some of the revenues that will be earned by each resource. Any change to capacity market rules could thus result in more clean energy deployment, and thus indirectly result in GHG emissions reductions. (Or the opposite could occur, depending on the rule changes.) However, predicting in a quantitative way how existing market actors and potential new market actors will respond to a change in market rules may prove to be impossible. Regulators may need to focus instead on changes that nudge the market toward more clean energy resources without knowing how significant the impact will be.

## 7. Other Considerations

Although the majority of the loads in the United States exist in regions that are currently served by competitive wholesale markets, the remainder do not. A resource adequacy framework that enables and encourages the addition of cost-effective technologies to support the introduction of high levels of VERs will be needed in non-ISO markets as well.

One idea that may be worthy of further exploration and consideration would be to develop capacity market rules that in some way explicitly favor zero- and low-emitting resources, in the same way that "environmental dispatch" rules for energy markets (discussed in Chapter 21) might. This has not been done or even proposed in any market to date, so it remains to be seen what such rules might look like. Proponents of wholesale electricity markets would likely resist such an idea as a manipulation of the market, unless it were shown to be an efficient way of using the markets to achieve a regulatory requirement.

***Table 19-3***

**Sensitivity Results for PJM's 2017/2018 Base Residual Auction**[41]

| Scenario Description | RPM Revenue ($ per Delivery Year | Difference from Actual Results: RPM Revenue ($ per Delivery Year | Difference from Actual Results: Percentage |
|---|---|---|---|
| **Actual Results** | $7,512,229,630 | NA | NA |
| **Annual Resources Only** | $9,738,222,922 | $2,225,993,292 | 29.6% |
| **No Offers for DR or EE** (Generation Resources Only) | $16,859,658,203 | $9,347,428,573 | 124.4% |

40 Neme & Cowart, at supra footnote 28.

41 Monitoring Analytics. (2014, July). *The 2017/2018 RPM Base Residual Auction: Sensitivity Analyses.* The Independent Market Monitor for PJM. Available at: http://www.monitoringanalytics.com/reports/Reports/2014/IMM_20172018_RPM_BRA_Sensitivity_Analyses_20140710.pdf

## 8. For More Information


- Cowart, R., & Raab, J. (2003, July 23). *Dimensions of Demand Response: Capturing Customer-Based Resources in New England's Power Systems and Markets — Report and Recommendations of the New England Demand Response Initiative.* The Regulatory Assistance Project and Raab Associates, Ltd. Available at: http://www.raponline.org/docs/RAP_Cowart_DemandResponseAndNEDRI_2003_07_23.pdf
- Baker, P., & Gottstein, M. (2013, March). *Capacity Markets and European Markets Coupling — Can they Coexist?* Montpelier, VT: The Regulatory Assistance Project. Available at: http://www.raponline.org/document/download/id/6386
- Gottstein, M., & Schwartz, L. (2010, May). *The Role of Forward Capacity Markets in Increasing Demand-Side and Other Low-Carbon Resources: Experience and Prospects.* Montpelier, VT: The Regulatory Assistance Project. Available at http://www.raponline.org/docs/RAP_Gottstein_Schwartz_RoleofFCM_ExperienceandProspects2_2010_05_04.pdf.
- Hogan, M., & Gottstein, M. (2012, August 14). *What Lies "Beyond Capacity Markets"? Delivering Least-Cost Reliability Under the New Resource Paradigm: A "Straw Man" Proposal for Discussion.* Montpelier, VT: The Regulatory Assistance Project. Available at: http://www.raponline.org/document/download/id/6041
- Keay-Bright, S. (2013, October). *Capacity Mechanisms for Power System Reliability.* Montpelier, VT: The Regulatory Assistance Project. Available at: http://www.raponline.org/document/download/id/6805


## 9. Summary

Industrialized societies place a high value on system reliability. Resource adequacy, meaning the availability of sufficient resources to meet peak loads, is a necessary precondition of reliability. Capacity markets have been created in some regions as a mechanism to unleash competitive forces to reduce the costs of ensuring resource adequacy. The existence or absence of such markets does not directly impact GHG emissions, but the rules that govern the markets (where they exist) can favor or disfavor certain types of resources in ways that can facilitate or hinder GHG emissions reductions.

Capacity markets focus on procuring adequate capacity, but have not to date considered the varying capabilities of different types of capacity resources. As the share of VERs in the US generation portfolio increases, we may need to retool electricity markets to cost-effectively spur the introduction of a resource mix with the capabilities necessary to assure an efficient and reliable system. Capacity markets may need to be reformulated or abandoned in favor of more robust markets capable of supporting higher levels of VERs. Demand-side resources such as energy efficiency and DR are likely key to any market formulation that attempts to cost-effectively deliver the level of system flexibility needed to support clean energy resources. Policies that ease the integration of VERs, such as those discussed in Chapter 20, will likely be integral to this effort as well.