



Appendix D: Capacity and Ancillary Service Markets: How CHP can Participate

D.1 Overview

Regional Transmissions Organizations/Independent System Operators (RTO/ISOs) administer and manage capacity and ancillary services markets. Demand reduction which includes CHP can participate in these markets depending on size (varies by RTO/ISO but can be as low as 1 MW for CHP in ISO-NE), metering, performance and registration requirements. State utility regulators have the ability to influence market rules, particularly when multiple states petition for a market rule change together. There are several opportunities for this influence on rules that impact CHP, including metering (requirements and meter cost) and planning (ensuring the balancing authority knows about CHP and includes it in their planning). In addition, there are opportunities advance the dialogue of the potential role that distributed generation can play in capacity and ancillary services markets, as well as any challenges it poses. This can be done through discussions with stakeholders inside the state or to the balancing authority. This section is focused on this opportunity.

D.2 What Additional Markets can CHP Participate In?

In areas of the United States with organized wholesale markets,²²⁶ a CHP facility can sell energy, capacity and ancillary services, depending on the facility's operational characteristics and the requirements of the particular market²²⁷ (see Figure D.1 for a map of organized markets). For example, some markets require participants to determine how much energy or capacity will be available to the market at each hour. Other markets require participants to accept dispatch instructions with short notice and for specific amounts of energy over time (i.e., adjust their electricity output up or down by specified amounts within specific timeframes). Each of these markets provides CHP facilities with an opportunity to generate an additional revenue stream that improves project economics, but may require changes in the design or in the operation of the CHP asset.


The power grid is a dynamic system that requires constant balancing or regulation of generator power flows and customer loads that constantly fluctuate. Grid operators use regulation response services also known as automatic generator control, by transmitting real-time control signals to generators to adjust their output in relation to demand. Operators automatically adjust generator output from a central location to balance momentary fluctuations in generation and load; maintain synchronized reserves which is unloaded generation that is synchronized with the grid and ready to serve additional demand (or customer load that can quickly be removed from the system); and voltage support, reactive power and frequency regulation, which are needed to keep the system within electrical and safety tolerances. These services are traditionally provided by load serving entities connected at the transmission level with resources that are dispatchable by the RTO/ISO or purchased from third parties.

Such services are also purchased by the ISO/RTOs from third parties. Specific services markets include the following:

- *Capacity or Forward Capacity Markets* are markets whereby new and existing resources bid into grid operator auctions that acquire capacity sufficient for reliable system operation for future years at competitive prices.
- *Ancillary Services* markets include the following:
 - *Operating & Spinning Reserves* supply electricity if the grid has an unexpected need for more power on short notice. Operating reserves are operating generating units that can be increased quickly to supply the needed energy to balance supply and demand; spinning reserves are

²²⁶ Organized wholesale electric markets (the markets operated by ISO New England, NYISO, PJM, Midwest ISO, CAISO, and SPP) are regulated by FERC under the authority of the Federal Power Act. These markets are engaged in interstate electricity transmission and wholesale electricity sales (sale for resale between load serving entities and not retail sales). www.ferc.gov/about/ferc-does/ferc101.pdf.

²²⁷ CHP facilities operating as demand response resources or interruptible load are not addressed here.



unloaded synchronized units that are ready to serve additional demand; demand resources also can bid to supply synchronized reserve by reducing their energy use on short notice.

- *Regulation and Frequency Response* service corrects for short-term changes in electricity use that might affect the stability of the power system. This service helps match generation and load and adjusts generation output to maintain the desired frequency.
- *Reactive Power and Voltage Control* service corrects for reactive power and voltage fluctuations caused by customer operations. This service helps maintain voltage within limits set by the National Electric Reliability Council for the reliable operation of the system.

As more distributed generation resources are being added as electric supply resources, ISO/RTOs are allowing or evaluating participation by these resources in capacity and ancillary services markets. CHP systems with appropriate metering can provide these services at the transmission or distribution level and companies are currently providing these resources on behalf of CHP customers in the PJM market.²²⁸ Single prime mover, or modular prime mover applications, such as multiple engine or turbine CHP systems may have capacity available to provide operating and spinning reserves and other ancillary services. Microgrids that incorporate distributed generation are also technically capable of providing ancillary services.²²⁹

Ancillary services are essential to keep the system balanced and prevent it from cascading into a blackout. And it turns out that demand response, local storage, and DG are among the best "dance partners" to ensure we can reliably integrate renewable energy resources into the grid. Indeed, it has been demonstrated that these distributed resources are more efficient than central station fast response natural gas fired generators at matching load variations and providing ancillary services needed to ensure reliability. They are even faster, generally cheaper, and have a lower carbon footprint than the traditional power plant provided ancillary service.

-Remarks of FERC Chairman Jon Wellinghoff , CAISO Stakeholder Symposium, October 7, 2009

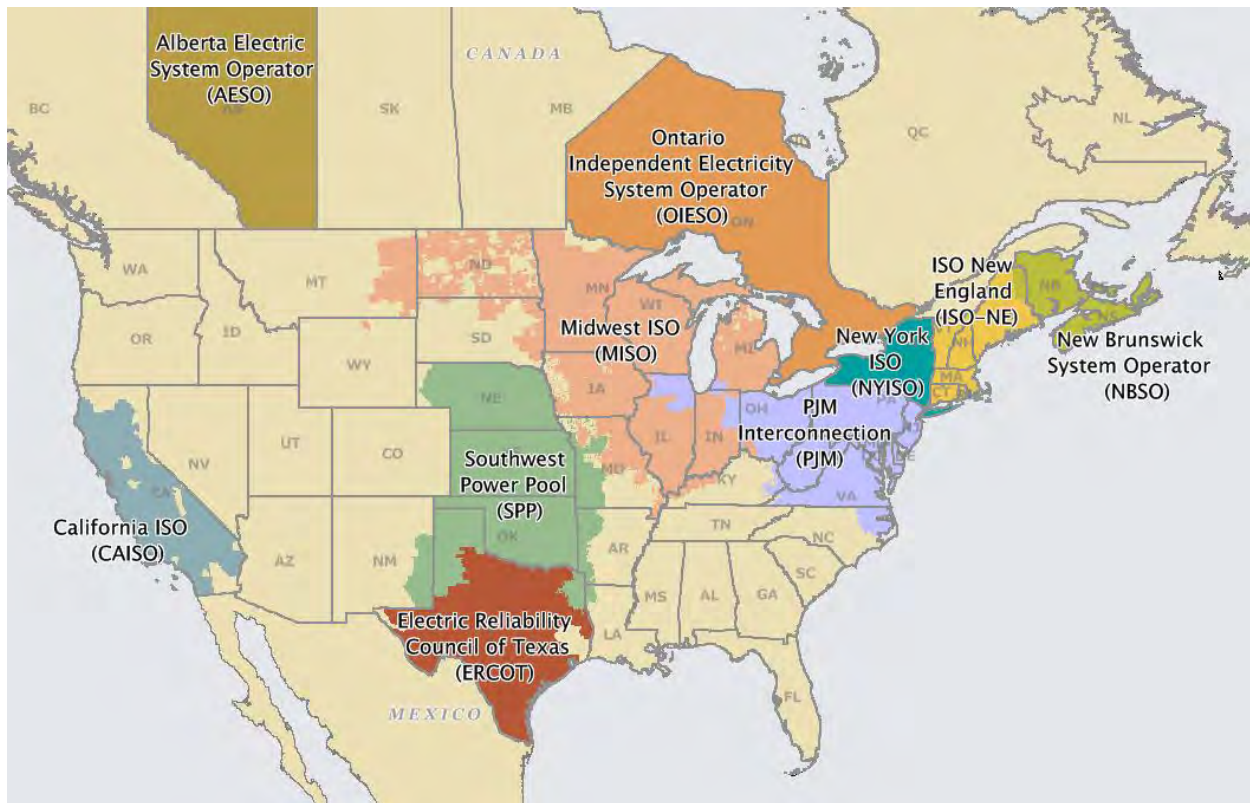
Capacity and ancillary services are unique commodities. Capacity markets support future market needs. Ancillary services support daily operation of the grid to maintain system reliability.²³⁰ Provision of these services is tied to the design of the energy market and the location of the resources relative to the locational need on the grid. Procurement of these services can be through regulated systems or market-based. Rules for procurement and financial settlement are fairly complex. Service providers are paid by the ISO a regulated fixed cost price or, in restructured markets, a market based price. While this section focuses on market designs in the United States, these markets have been developed in many regions in the world.²³¹

²²⁸ The argument that CHP is firm capacity and contributes to resource adequacy has been raised by the CHP industry. The theory is that such resources should qualify for a capacity payment as CHP capacity is a new utility power plant that would otherwise be built. The California PUC is currently addressing the role of distributed generation resources in meeting local reliability requirements and resources needed for the next 20 year planning period—Long Term Procurement Proceeding, R1203014.

²²⁹ Appen, Marnay, Stadler, et al. "Assessment of the Economic Potential of Microgrids for Reactive Power Supply." Presented at the ICPE2011-ECCE Asia 8th International Conference on Power Electronics—ECCE Asia, Shilla Hotel, Jeju, Korea, 30 May—3 June 2011. <http://der.lbl.gov/publications/assessment-economic-potential-microgrids-reactive-power-supply>.

²³⁰ If properly located and reliably operated, offer an alternative generation resource that relieves the strain on utility infrastructure, helping to keep rates low for other utility customers. See <http://www.fortnightly.com/fortnightly/2012/08/capturing-distributed-benefits?authkey=ed2f91bfeb755dc6c222d2a76b32f98d675ae9db26fee62ecd0f798b0e67528b>.

²³¹ Ela, Kirby, Navid and Smith. "Effective Ancillary Services Market Designs on High Wind Power Penetration Systems." Conference Paper, NREL/CP-5500-53514. December 2011.



Source: Federal Energy Regulatory Commission. www.ferc.gov/industries/electric/indus-act/rto/elec-ovr-rto-map.pdf#xml=http://search.atomz.com/search/pdfhelper.tk?sp_o=1,100000,0

Note: ERCOT and the system operators of Alberta and Ontario are not under the jurisdiction of FERC.


Figure D.1. Regional transmission organizations and independent system operators

Current CHP participation in capacity, reserves and ancillary services markets is very low across the United States.²³² One reason for the low participation is that each of the markets for these services is highly specialized with detailed rules to ensure that the electric system remains safe and reliable. In capacity markets also known as Forward Capacity Markets, compensation is established through a competitive auction and paid to resources that commit several years forward to being available to meet peak demand.²³³ Failure to meet the contractual obligation invokes a penalty. The ancillary services market is also governed by detailed rules and system aggregators or the load serving entity arrange participation on behalf of the CHP owner. Participation requirements include metering that allows for financial settlement, active market engagement, and periodic ISO training courses to maintain certification.

Another reason for low participation is that CHP operating characteristics may not align with participation requirements. CHP systems are usually sized to meet site thermal loads and are normally operated in a baseload manner or follow the operating schedule of the facility to maximize savings. Electricity produced is typically less than customer demand and no excess is generated. If there is no export capability, participation in capacity markets is precluded. CHP could participate in ancillary services markets if operational flexibility is designed into the system (e.g., the CHP system is sized with single or multiple prime movers that provide excess capacity when needed or the system can operate during times when the thermal load is predictably lower affording excess

²³² Personal communication between ICF and PJM and ISO-NE staff and their perspectives of CHP market participation in their own and neighboring ISO/RTOs. However, there are companies actively working with CHP systems to provide this service in PJM.

²³³ Regulatory Assistance Project. "The Role of Forward Capacity Markets in Increasing Demand-Side and Other Low-Carbon Resources: Experience and Prospects." Prepared by Meg Gottstein. Brussels. June 2010. http://raponline.org/search/document-library/page/3?keyword=Gottstein&submit=Submit&publish_date_preset=&publish_date_start=&publish_date_end=&document_type_id=&sort=publish_date&order=desc.



electrical generation to be available). Again thermal matching considerations will affect the ability of CHP to successfully compete in this market. Finally, CHP systems with a synchronous generator or a generator with a power electronic interface have the advantage that they can be controlled to provide or absorb reactive power.²³⁴ However, thermal load that do not match well may lead to system inefficiencies and perhaps greenhouse gas emissions increases.

FERC is encouraging third party participation in the ancillary services market, particularly distributed generation with synchronous generators or with a power electronic interface.²³⁵

D.3 Successful Implementation Approaches

Participation in capacity and ancillary services markets requires dedicated time by the end-user to understand the rules of participation. The technical and procedural requirements may be complicated but the ISO/RTOs have training and certification courses available and aggregators and load serving entities are also be able to help end-users participate.

How the Criteria Are Addressed

Policy Intent. CHP participation in these markets enables grid operators to correct system imbalances close to load, increasing the efficiency of the system in a potentially more cost-effective manner. Markets are designed to serve customers with reliable electric service at the lowest cost.²³⁶ The markets do not provide a preference for a particular type of technology; rather, the most efficient technologies, with the most competitive bids, will tend to prevail. To the extent that CHP facilities compete well against other technologies, they will succeed in these markets. Such programs achieve the policy intent of obtaining power when and where required on the system. Inclusion of CHP in capacity, reserves and ancillary markets can be viewed as a key measure by state regulators to achieve resource adequacy, energy efficiency, and GHG reduction goals.

Market Signals. As stated earlier, participation in these markets is challenging and requires dedication and commitment. However, prices paid for market services versus the costs of participation will usually be a net benefit. ISOs/RTOs active in these markets conduct annual market outreach, on-line market tools and workshops to educate and acquire participation from private businesses. These market signals are vital to participation. For example, in PJM, CHP facilities can see these market signals using several on-line tools, including day-ahead and real-time market statistics and an annual state of the market report produced by an independent Market Monitor.²³⁷

Ratepayer Impact. The regulatory framework for the markets described is to ensure a reliable and secure supply of electricity at an affordable cost to consumers while promoting and engaging private businesses to participate. Generally, grid operators use these services when the existing or future resources are not available or in sufficient quantities. The costs of the services are what would otherwise have been built, or purchased from another generator. In what are termed scarcity conditions—when inadequate supplies to meet demand are not available—the price paid for capacity and ancillary services bid through auction or related programs do not exceed market clearing prices and sometimes may be less than the cost of new generation that would otherwise have been built. The utility is therefore held neutral. The ratepayer base is also neutral to the costs or held “indifferent” as CHP imposes no more costs on the market than any other type of resource and may indeed benefit from a cost savings from the avoidance of having to build new resources.

²³⁴ Ferry August Viawan. “Voltage Control and Voltage Stability of Power Distribution Systems in the Presence of Distributed Generation.” PhD Thesis. Chalmers University of Technology. Göteborg, Sweden. 2008.

²³⁵ NOPR, Docket Nos. RM11-24-000 and AD10-13-000. June 22, 2012.

²³⁶ “A Review of Generation Compensation and Cost Elements in the PJM Markets.” PJM. 2009. <http://pjm.com>.

²³⁷ See www.pjm.com/home.aspx.



D.4 Conclusions

CHP participation in these markets is at an evolutionary point. Despite the benefits described above, current CHP participation in these markets is very limited due in part to complexity of the rules and requirements. Growth potential for CHP participation is generally perceived to be significant. As an example, ISO-NE provides financial incentives to aggregators who in turn reach out to the commercial and industrial sectors for demand resource measures that include CHP.²³⁸ State utility regulators can express the importance of this outreach and in including CHP in these markets. Inclusion of CHP in capacity and ancillary markets can be viewed as a key measure by state regulators to achieve resource adequacy, energy efficiency and greenhouse gas reduction goals. The market for third party grid balancing services and local voltage support is growing.²³⁹ Integration of distributed generation and storage technologies continues to be a focus of FERC as it seeks to promote robust competitive markets for the provision of ancillary services from a variety of sources.²⁴⁰ As the rules evolve and the opportunity for an additional revenue stream begins to outweigh the cost of participation, greater CHP participation in these markets seems likely.

²³⁸ Personal communications between ICF and Henry Yoshimura and Laura Corcoran, Demand Resource Strategy Analyst, ISO-NE, May 15 and July 5, 2012. Email from Laura Corcoran, Oct. 17, 2012.

²³⁹ Tighe, Mary Beth. "Electricity Market Opportunities: Revenues Improve Paybacks." FERC, Heat is Power Annual Meeting. Aug. 15, 2012.

²⁴⁰ FERC NOPR, Docket Nos. RM11-24-000 and AD10-13-000. June 22, 2012.