# Where Does Transactive Energy Fit In Wholesale Energy Markets?

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Disclaimer: This paper represents the thoughts of the author and should be interpreted as a description of the final implementation plans of ISO New England Inc.

**Abstract**

Discuss transactive energy in the wholesale energy market using the New England wholesale energy market operated by ISO New England Inc. (ISO-NE) as an example and discuss one method through which transactive energy might be implemented. Aggregator of retail customers (ARC) will need to present these loads or reductions in load to the wholesale market in terms of products that the market is designed to handle. These "resources" must be providing a service that meets the needs of the market. The paper also discusses the interoperability requirements between the end-user and the ARC in order for the ARC to be able to bring these offers to the wholesale energy market.

## 1. INTRODUCTION

ISO New England Inc. (ISO-NE) is the independent system operator (ISO) and regional transmission organization (RTO) for the New England control area. ISO-NE operates the wholesale electricity markets for New England, and dispatches the generation throughout New England to meet the New England system load.

The New England wholesale electricity markets include capacity, ancillary services, and energy. To have value in the wholesale market, the resource must be able to provide a service that the ISO or RTO needs.

The capacity market is a three year forward looking market where resources receive compensation for having invested in capacity and delivery of that capacity by the appropriate capacity commitment period. In New England this forward market is FCM. FCM is a locational capacity market whereby the ISO will project the needs of the power system three years in advance and then hold an annual auction to purchase capacity resources to satisfy the region's future needs. Generation (including renewable and intermittent resources), passive demand response (energy efficiency and distributed generation), and active demand response participate in the auction as supply resources to satisfy region's capacity supply requirement.

Ancillary services are services that ensure the reliability of production and transmission of electricity. These services include operating reserve (10 minute and 30 minute operating reserve), and regulation (called automatic generation control (AGC)[1] or Automatic Voltage Regulation (AVR) for controlling system frequency. [4]

Through the energy market, ISO-NE provides a system for purchasing and selling electricity using supply and demand to set the price. Electric energy must be produced when it is needed by consumers. If there is an over production of energy, the frequency on the system will increase and if there is less energy produced than is needed by consumers, the frequency on the system will decrease. ISO-NE uses the energy offers from generators to dispatch these resources to meet the system needs including operating reserve requirements. The objective function for economic dispatch is to minimize the total cost of producing electricity over the entire day while keeping the system in balance. Economic dispatch uses the least-cost resources in a single period (hourly in the Day-Ahead Energy Market, 10-minutes in the Real-Time Energy Market) to meet the demand. ISO-NE assesses hourly resource cost and

[1] Frequency of the system will vary as load and generation change. During a severe overload caused by the unexpected lost of a generator or transmission line the power system frequency will decline, due to the imbalance of load versus generation. Loss of an interconnection, while exporting power (relative to system total generation) will cause system frequency to rise. Automatic generation control (AGC) is used to maintain scheduled frequency and interchange power flows.

establishes the wholesale cost of energy based on a uniform clearing price auction. [1, 4]

All generation with a capacity supply obligation is required to submit an offer into the day ahead and real-time energy markets.[2] Load is not required to bid into the day-ahead energy market. Load can submit price capped bids into the day-ahead market to purchase energy up to a specified price or load can submit a bid to purchase energy at any clearing price. These transactions in the day-ahead market establish financial positions which will be settled against the actual consumption that takes place in real-time.

For transactive energy transaction to participate in the wholesale energy market, these transactions must be able to provide a product or service that the wholesale market is willing to purchase.

## 2. FERC ORDER 745

On March 15, 2011, the FERC issued its final rule on demand response compensation in wholesale markets, Order 745.[3] Order 745 pertains to ISOs and RTOs that permit demand response to participate in their energy market by reducing their consumption of electric energy from their expected levels in response to price signals. Under these situations, Order 745 requires ISOs and RTOs to:

- pay demand response resources the full LMP when these resources have the capability to balance supply and demand;
- dispatch demand response when the payment is cost-effective as determined by a net benefits test accepted by the Commission; and
- allocate the costs proportionally to all entities that purchase from the relevant energy market in the area(s) where the demand response reduces the market price for energy.

A primary premise for participation is the capability to balance supply and demand. The capability to balance supply and demand makes it clear that the resource must be dispatchable by the ISO or RTO. In order to be dispatchable by the ISO or RTO, the demand response resource must submit an offer into the wholesale energy market. Transactive energy transactions are another form of demand response. It would not be cost effective for any party to have the individual assets submitting transactive energy assets for dispatch by ISO-NE.[4] Instead an ARC is going to be needed to combine all these small individual interruptions and present them to the wholesale market in some form of a portfolio of assets.

## 3. MARKET PARTICIPATION

In the Day-Ahead Energy Market there are physical transactions and virtual transactions. Physical transactions are tied to actual physical injections or withdrawals of energy in the Real-Time Energy Market. Virtual transactions are not tied to physical delivery of electricity, and allow participants (including energy traders) an opportunity to establish a position in the electricity market.

Transactive energy transactions would be physical transactions and not virtual transactions. The ARC would need to combine large numbers of individual assets to create a portfolio that can be presented to the market as a resource. [2, 3] By their very nature, transactive energy assets have limited interruption duration. The starting of the refrigeration compressor on a kitchen refrigerator can be delayed ten minutes, but not hours. The defrost cycle on a freezer can be deferred to off-peak hours, but once deferred, the postponing of the consumption cannot be credited a second time.

Transactive energy assets can be visualized as individual limited energy generators. A limited energy generator, as the name implies, has a specific amount of energy that it can provide before it must be declared unavailable, because there is no further energy that can be provided. A hydro generation facility that can hold back some water can generate energy based on the amount of water held behind the dam. Once that water is released through the dam's hydro electric generators, the unit becomes unavailable until the water behind the dam is replenished. The start of the refrigerator compressor is similar. The consumption can be postponed, but not indefinitely. When the compressor must finally run, the asset is no longer available to postpone that energy consumption.

A battery storage device is another example of a limited energy generator. It is more complicated than the case of delaying energy consumption, because there can be actual energy provided to the system. Once fully charge, the

[2] There are special submission rules for certain intermittent resources such as wind or solar that may exempt these resources from the day-ahead energy market submission requirement.

[3] FERC Order No. 745, Demand Response Compensation in Organized Wholesale Energy Markets (Issued March 15, 2011), 134 FERC ¶ 61,187. Available at URL: http://www.ferc.gov/EventCalendar/Files/20110315105757-RM10-17-000.pdf

[4] Dispatch instructions from the ISO takes place over a frame relay secure network with a remote terminal unit at the Designated Entity (DE). The DE is responsible for communicating all dispatch instructions received to the generator or demand resource. In the extreme case, each asset could be its own DE. [2, 4]

battery can provide energy to the system. However, the energy delivered is limited by the size of the battery. When all the energy in the battery has been released, the generation asset is no longer available until the battery can be recharged. However, the charging of the battery also represents a controllable load that could be participating in the energy market and possibly the reserve market.

The individual transactive energy assets would need to be presented by the ARC to the ISO as a single resource located at a single node on the network model. It may be possible to allow these assets to be aggregated over several nodes in the same dispatch zone, however. This limitation is necessary for ISO-NE to identify where the resource is affecting the system.

Presently, the real-time energy market is settled on an hourly basis. However, it is possible that in the future the real-time energy market might be settled on 15 minute or shorter intervals. These shorter settlement intervals could make the participation of transactive energy assets easier.

## 4. COMMUNICATION

The ARC would be responsible for combining the information about the available interruptions and presenting that availability as a single resource. The ARC must be able to calculate the actual interruption available or occurring in each dispatch interval. The information is necessary to accurately represent the capability of these resources and their performance to ISO-NE. The ARC also uses this information to determine that their instructions to the assets under their control are following the dispatch instructions transmitted by ISO-NE. These calculations require some information from the individual assets and some computations on the part of the ARC. Based on the present dispatch methodology, the results of the calculations must be presented to ISO-NE every five minutes for the most recently completed five minute interval.

While ISO-NE may be calculating a baseline for each asset, the ARC must determine any naturally occurring deviations from the baseline and what interruption is available for each asset. When a dispatch instruction is presented to the ARC, the ARC must determine which assets to dispatch to respond to the dispatch instruction. Under normal operating conditions, dispatch instructions for the energy market are provided typically every five minutes.

These assets are generally capable of quick response and might likely also be able to participate in the forward reserve market. Again, the ARC would need to aggregate these assets into a larger resource. In the reserve market, resources must respond in 10 or 30 minutes depending upon the product being provided. The ARC would need to be able to process information about each asset to provide a consistent reduction over the required performance period. This situation means that the ARC must calculate how long each asset can be interrupted before it must be allowed to perform the interrupted function and the change in consumption that will result since the resource's performance is measured as the sum of all the assets' performance both positive and negative.

Transactive energy resources might in the future also be able to provide AGC because these loads may be able to respond extremely fast. Presently these resources can participate in the Alternative Technology Regulation (ATR) Pilot Program.[5] AGC is the most data intensive service and dispatch instructions are presented to the resource every four seconds, and data on all the assets comprised in that resource must be provided in the next four second increment back to ISO-NE.

## 5. FORECASTING REQUIREMENTS

The proposed model, using ARCs to present end-user generation and reductions in consumption to the wholesale markets requires additional efforts by the ARCs when compared to the efforts presently required for demand response participation. The ARC must now develop load profiles for each customer or customer group. The ARC must also understand how the customer is actually capable of responding, what factors influence the level of responsiveness, and any delay between the request to perform a specific action and the actual implementation of that action. Utilities and energy providers presently perform these types of forecasts every day to determine their hourly bids into the wholesale energy market. However the typical ARC has not been required to undertake these same forecasting activities.

Several utilities use control of residential central A/C as part of their operating reserve (especially 10 minute operating reserve). These utilities have developed algorithms based on overnight temperatures and humidity, as well as the forecast or real-time temperatures to determine the amount of reserve that can realistically be derived from these

[5] In response to FERC Order 890 regarding the provision of Regulation and Frequency services by non-generating resources, ISO-New England implemented an Alternative Technology Regulation (ATR) Pilot Program. The goal of the ATR Pilot Program is to allow ISO-NE to identify the impact on the New England system of alternative technologies with new and unique performance characteristics that might previously have been unable to participate in the Regulation market and to allow the owners of the ATR resources to evaluate the technical and economic suitability of their technologies as market sources of Regulation service. For more information on ATR see: http://www.iso-ne.com/support/faq/atr/index.html#faq1

resources. If these resources are participating in the wholesale market, then the utilities have a commitment to provide a specific amount of reserve capacity over each on-peak hour of the day. If the utility determines that it will not be able to provide that level, then the utility must contract with another supplier to provide the shortfall. These transactions must be submitted before the operating day, and therefore the utility's forecasted availability of these resources can significantly affect the revenue received from these markets.

Further, the responsiveness of a customer is directly related to the present load of that customer. The typical end-user's energy consumption varies over each hour of the day and the level of responsiveness may changes as well. The end-user's responsiveness generally is not the same fixed level (same kW in each hour) nor is it the same percentage of the end-user's total load in each hour.

For the most part, ARCs have been restricted to participating in demand response. Generally, demand response is not bidding into the wholesale markets, but rather is instructed only when they are to interrupt their load. As a result, ARCs have not performed such analyses on a daily basis, but will need to adapt to these additional requirements of real-time wholesale market participation.

## 6. CONCLUSIONS

Transactive energy assets may be able to participate in the wholesale markets provided they can provide a service that the market requires. As a result of FERC order 745, the most logical method for participation in the markets may be as a demand resource. The ARC will need to aggregate large numbers of end-users in a zone (dispatch or capacity zone) to be present a single resource which ISO-NE can dispatch. The ARC will need to communicate with the transactive energy assets, obtain load information, calculate the available interruption, and present that information to ISO-NE in real-time.

The ATR may present the ARC with a method to test out their systems and information collection methodologies before implementing larger scale projects. Clearly, if transactive energy assets can perform in the ATR, then they should be able to perform in other energy markets.

### Reference List or References

[1] ISO New England Operating Procedure No. 1: Central Dispatch Operating Responsibility and Authority of ISO New England, the Local Control Centers and Market Participants
[2] ISO New England Operating Procedure No. 14: Technical Requirements for Generators, Demand Resources and Asset Related Demands
[3] ISO New England Operating Procedure No. 18: Metering and Telemetering Criteria
[4] Overview of New England Wholesale Electricity Market

### Biography

Mr. Burke is a Principal Analyst in Market Development with ISO New England (the RTO for the New England control area). He has over thirty-five years of experience in the energy industry. Since joining ISO-NE, he has held various positions and been involved with the development and subsequent on-going improvement of the wholesale energy markets. Mr. Burke has been involved in the development and implementation of the ISO's system for real-time demand response activation and providing near real-time data on demand response assets, the Internet Based Communication System Open Solution, and its successor system.

Mr. Burke has been a member of the GridWise Architecture Council (GWAC) since 2009, and he is also a member of IEEE. Mr. Burke has a B.E. in heat and power from Stevens Institute of Technology, MBA and MS in Computer Science, both from Rensselaer Polytechnic Institute, and has completed all examination requirements in Connecticut for a CPA.