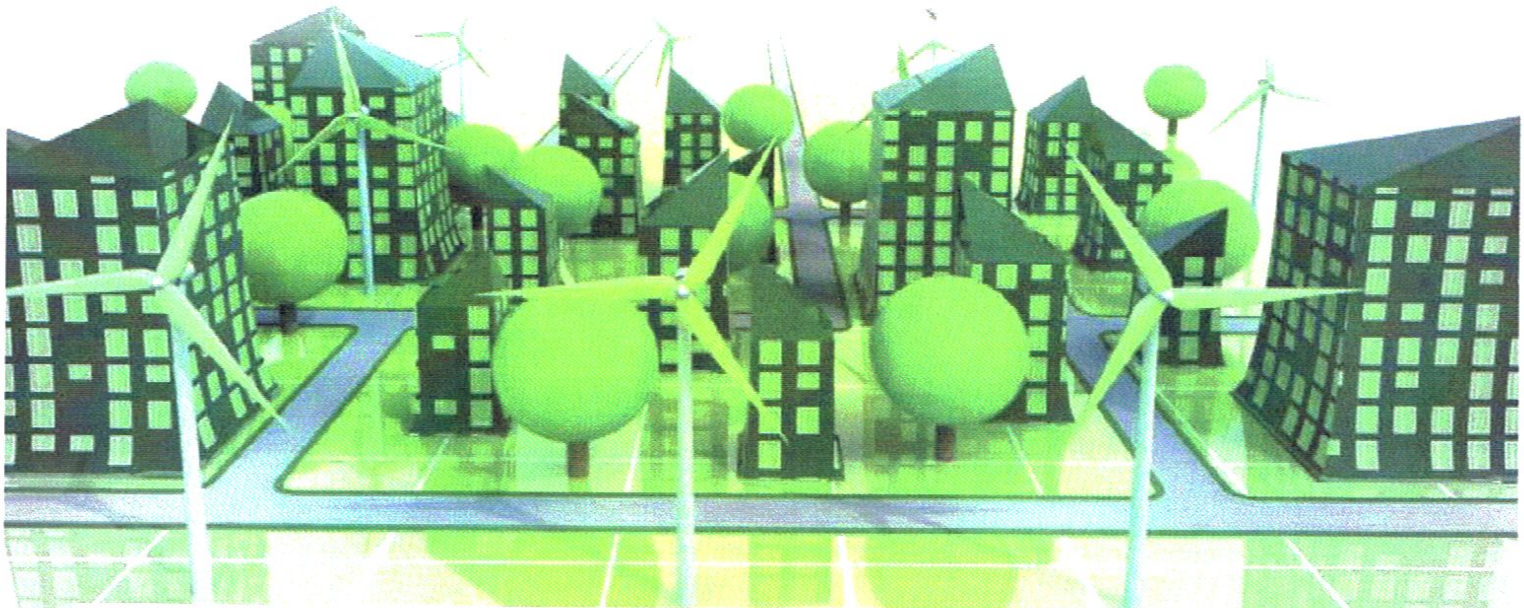
THE FUTURE OF TRANSACTIVE ENERGY



Advancing operation efficiency and cost-effectiveness

BY DAVID KATZ, Sustainable Resources Management, WITH EDWARD CAZALET, TeMix Inc. and Transactive Energy Association

"Transactive energy", according to the Transactive Energy Association (TEA) engages customers and suppliers in decentralized markets for energy transactions that strive towards the three goals of economic efficiency, reliability and environmental enhancement. Simply, think of "transactive" as "interactive" meaning that utilities, generators and customers all interact to achieve the same goals.

STATE OF INDUSTRY

At the moment, organizations and working groups are hard at work trying to solve key challenges facing the power grid by identifying and framing solutions to enable a future power system that realizes the benefits of information interconnection and taking advantage of new information-enabled sensors, devices and technology.

For the past two years, the GridWise Architecture Council (GWAC), formed by the U.S. Department of Energy (DOE), has been facilitating discussion in efforts to integrate the economic and engineering approaches to managing and optimizing the electric power system including how to address critical requirements such as reliability. While that scope sounds grid-centric, in fact the intent is to include those systems connected to the grid—in other words, buildings, facilities, vehicles and customer-owned generation and storage (including electric vehicles).

The changing nature of North America's power grid—ever-increasing variable generation resources at large scale on the bulk power side, the introduction of new, intelligent devices and technology in the control elements of the grid, and the increasing use of intelligent devices and technologies in energy devices on the consumption side—require end-to-end consideration of all active or potentially active elements of the electric power energy system.

DID YOU KNOW

Smart Grid activities in North America now include efforts to:

- Develop a roadmap for transactive energy architecture
- Improve cost-effectiveness through coordinated economic and reliability constraints
- Assess how transactive energy can improve the integration of intermittent, distributed renewables.

WHY TRANSACTIVE ENERGY

As consumers become *prosumers* in the energy market, developing the architecture for transactive energy is becoming increasingly imperative. As the Smart Grid needs to optimize on all sides of the energy service interface, the development and clear understanding of transactive energy will be needed. While utilities have had a variety of different electricity rates that provided customers with some options to lower their costs and help overcome emergency situations, the traditional monopoly service was assumed to always be available and utility rates were highly regulated.

The electrical industry now has demand response and other options such as renewable energy and feed-in-tariffs that change the power grid into a two-way system with the customer having more choices and also supplying power to the grid. The next step in Smart Grid development is to increase the transactions possible that reflect the different costs and benefits for both the utility and each individual customer.

VALUE

Inside the facility, the goal is to minimize cost and maximize value to the facility by balancing electric, gas, or other energy and non-energy costs in the context of requirements to carry out the facility's mission. Making the appropriate decisions and performing the appropriate operations will enable an adequate amount of grid reliability support. Also, addressing value in comparison to cost will provide other benefits to facility owners.

Furthermore, each service in the building or home or industrial site has some value (dollars per hour) such as hot water for showering versus hot water for industrial processes. Each service also has a real cost to provision of which energy is one part (also maintenance, equipment cost, and labor). The value of each service dynamically and costs can be reduced. At this point, utilities can ask the following questions: What information is needed by a facility? What is the complexity and diversity of the customer base? Is there potential for buildings, homes and industrial sites to manage their energy usage to better follow variable wind and solar generation and reduce peak generation needs?

Transactive energy engages facilities in energy transactions that provide value to the facilities. Since most of the electricity generated by the power grid goes to buildings and industrial loads, and since Smart Grid depends, in part, on engaging facility loads and distributed energy resources (DER) to improve grid reliability, facility responsiveness is important. How much—and variety of response—that a grid service provider gets from a facility depends on how it interacts with facility loads, and DER. The best way to interact with facilities depends on level of automation, types of loads/DER, market environment, and other important factors.

Various research and application efforts from industry groups such as the Smart Grid Interoperability Panel's (SGIP's) Building-to-Grid domain expert working group (B2G DEWG) have provided valuable information on what is needed for facility-to-grid communications.

transactions

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LOAD PROBLEMS

There are potentially many different kinds of loads and DER with varying system complexity in the facility (customer) domain. Demand response using traditional direct load control approaches is an effective utility tool to access simple sheddable loads to shave demand peaks. However, direct load control is only suitable for relatively simple loads in customer facilities with simple systems and very little automation (that is, residential and small commercial). The problem is that direct load control cannot make use of the potential demand response of more complex systems. System complexity and inter-dependencies are opaque to the utility. The only solution is to incentivize the customer to better manage the customer loads—and generation and storage—for the benefit of the grid. The problem is that a typical demand response program payment or a "critical peak price" tariff are poor incentive signals. Typically, these options only provide enough incentive for a customer to perform some load shedding which has minimal impact on the business.

On the other hand, if the customer was exposed to the true value of electricity on a real-time basis, there would be more motivation to shift energy. However, one very important variable is still missing. In order to manage load shifting, which means managing storage resources, the customer must have more than the real-time price. The customer must know what the price will be over the next 24 hours or beyond. The customer also needs some guarantee on that price. What mechanism can guarantee the price 24 hours or one week from now such that the customer may realize the value of investment in storage? One mechanism is that already used in the wholesale energy markets, namely, purchasing the electricity in a forward market.

What the facility needs for effective response is transactive energy. Forward transactions secure the value that will incentivize customers to invest in storage resources and automation capabilities that will in turn work together with utility resources to meet the goals of a reliable grid. In essence, the consumer becomes a "prosumer", providing generation and other grid services alongside the larger generators run by independent power producers and utilities. And the distribution utility becomes the "wires service" and "grid voltage and power quality manager" service provider.

Looking at the choices in a different way (back of the envelope), the cost for purchasing one kilowatt-hour of battery storage is approximately 10 times the cost of configuring a facility for one kilowatt-hour of demand response. Thermal storage is cheaper than battery storage, but there is generally no market incentive for the facility owner to invest in any kind of storage.

Demand response was a first step, but generally limited to a few events per year. Transactive energy is a stronger option, but the key objectives of this technology must be considered before moving forward. Also, utilities must work with state or provincial governments on possible policy changes to allow investments that can help provide optimal value while protecting the public interest. The best way to achieve this goal is to properly price energy and let the facilities to utilize their full array of loads and distributed energy resources to profit from better use of energy.

DEFINING TRANSACTIVE ENERGY

Techniques of transactive energy are proven in wholesale forward markets; now with more efficient and cheaper metering, communications, and automated facility/device controls, those same techniques can be applied to the same techniques to retail markets.

The concept of transactive energy is not about real-time pricing; it is about forward and real-time transactions. Customers can be forward buyers and sellers as well as spot or real-time buyers and sellers. Prices are determined by the interactions of willing buyers and sellers.

Some concerns exist when it comes to implementing a transactive energy plan. Utilities must consider whether or not public utilities commissions (PUCs) will approve of their transactive energy plan and how single-line transmission and distribution costs will be factored into this type of pricing. Lastly, utilities must determine if customers will embrace the concept.

While these are valid concerns, utilities, PUCs, legislators and customers don't have many other options to address the problems of solar and other distributed generation (DG) placing more stress on the electrical infrastructure. Flat rates, increased fixed charges, limits on solar and DG, complex tariffs, demand response programs, demand charges, and subsidies make these problems worse and drive even more customers from the grid while impeding the development of sustainable and resilient decentralized energy. So, as a solution, many utilities are stepping forward with new sustainable business models and proposals to promote regulatory change.

TRANSACTIVE ENERGY IN T&D SYSTEMS

For the most part, the transmission and distribution (T&D) infrastructure will largely remain a fixed cost-based service. Today, T&D is typically sold on a flat per-kilowatt-hour basis with annoying and ineffective demand charges for larger customers. With transactive energy, T&D can be bought and sold by customers with forward subscription transactions that provide revenue stability to utilities and cost stability to customers. These forward subscriptions allow or obligate a customer to buy a shared ownership of the T&D structure. What T&D isn't used can be sold to other customers in forward or spot transactions that are acceptable to both the buyer and seller (market based). The transactive prices of the transactions in this secondary T&D market will improve T&D utilization and reduce congestion and the need for new T&D investment.

Certainly, there will be customers and self-appointed customer advocates who will oppose any changes while advocating for special treatment by PUCs and legislatures. However, if the problems facing utilities in high renewables and distributed generation states such as California and in some European countries aren't fixed, then there will be overbuilding of backup fossil generation and T&D systems that will greatly increase costs to customers. This will inevitably result in a death spiral of higher costs, departing customers and increased costs to remaining customers.

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TRANSACTIVE ENERGY IN CANADA

In Canada, the recent Canadian Smart Grid Standards Roadmap, completed by the Standards Council of Canada (SCC), has been released and an advisory committee is being formed. SCC is collaborating with Natural Resources Canada (NRCan) and the Canadian Electricity Association (CEA) to establish the Smart Grid Standards Advisory Committee (SGSAC).

As per the SGSAC Terms of Reference that have been established by the aforementioned three parties, the focus of the committee will be on addressing the policy-related implications of the recommendations identified within the Roadmap. Hopefully, this committee will address the evolving transactive energy opportunities within the Canadian regulatory and public power perspective.

In Ontario, the Smart Grid Forum and its Corporate Partners Committee are actively working on issues such as energy storage and intelligent load management. Transactive energy potential will be studied in their smart meter interoperability test bed project. More information on transactive energy will be reported in future issues. ET

POWER POINT

When North American electric utilities use transactive energy, electricity can be bought and sold by customers with forward subscription transactions that provide revenue stability to utilities and cost stability to customers.

David Katz is president of Sustainable Resources Management and is responsible for its consulting on Smart Grid issues including demand response and intelligent building system integration. Edward Cazalet is the chief executive officer of TeMix Inc. a transactive energy service provider and is executive director of the Transactive Energy Association, a transactive energy trade association.