Transactive Energy in Less than a Thousand Words

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Transactive Energy is a topic that seems to crop up more and more frequently these days. It is a frequent subject of discussion at conferences and GWAC and others have focused efforts on developing the debate and understanding of this important area. GWAC organized the first International Conference on Transactive Energy in 2013 and has a second conference scheduled for December 2014. GWAC also, with support from DOE, developed and published a draft Transactive Energy Framework document in 2013.

So just what is Transactive Energy and how can it help? Transactive Energy is not a specification and it is not a standard, but rather an approach that describes economic and control tools for managing all elements of a grid including distributed energy resources such as renewables and storage. The industry is currently debating the extent of transactive energy scope but to understand more about transactive energy let's start by examining the drivers and potential benefits. The starting point for discussion is that our power system is changing and transactive energy reflects the evolving role of customers as both generators and consumers based on the value to the customer.

Historically we've operated the supply side of the power system deterministically. We estimated the load and then called on the required amount of generation to balance the load. In other words, while somewhat predictable, load was treated as a given and supply was managed to meet load. With over thirty percent of new generation expected to come from wind energy and other renewable in some regions, the supply/generation side now includes large quantities of renewable resources that are intermittent in nature. They are somewhat predictable (deterministic) – but not completely. The supply side is becoming more complex to predict and control.

The load (demand) side is changing, too, by becoming more adaptable. Lowering the costs of measuring and communicating with electrical loads makes them more capable of responding to information and adjusting consumption behavior in useful ways that benefits both the customer and the greater electrical system.

If you think of this as Economics 101, we are trying to balance a system in realtime where the supply and demand curves cross but we can't be sure where either curve will be. When it comes to keeping the lights on that's a big problem because the current system was not designed to deal with this level of uncertainty. These changes all necessitate new approaches to how electric power is managed and delivered, and in the economic and business models involved.

A further impetus for Transactive Energy is the benefit of improved efficiency that results from better coordination of generation, transmission, distribution and consumption of electric power. TE is a natural evolution of the power industry and while renewable and distributed supply e.g. (roof-top solar) and increasingly complex demand options may be instigating research into better ways to coordinate

and manage these assets, even regions without increasing renewable and distributed generation can benefit from more efficient methods that TE will ultimately define.

The challenge is simple: we need to enable interaction between large enough numbers of load and supply points in the electric system to be able to know where the supply and demand curves will be, understand what devices on both supply and demand can adjust their behavior, then create an environment where these devices can optimally adjust their performance to maintain a safe and reliable system. Thus transactive energy embraces both the benefits (often represented as economics) and engineering of the power system as a means to effectively manage and control an increasingly complex and dynamic electric power system.

There are multiple diverse stakeholders to be considered. The implications of the potential new approaches for managing and controlling electric power systems call for a broad involvement of economists, regulators, policy makers, vendors, integrators, utilities, researchers, end-consumers such as building owner-operators and other stakeholders. It is necessary for each stakeholder group to "think outside the box" to see the potential for, and drivers of, transactive energy because regulatory, policy, and business issues frame the discussion about the functional characteristics of transactive energy systems.

A further challenge to reliability comes in the form of bidirectional power flow. Introducing distributed energy resources (solar, wind, batteries etc.) at customer locations and also at intermediate points now creates the possibility of power flows in multiple directions. These changes were not anticipated in the present generation of grid controls and market systems and so introduce new challenges for distribution system operators.

Improving the management of increasing variability and complexity most efficiently, while maintaining system balance, stability, supply security, and reliability is a huge undertaking – but one with equally huge benefits. Transactive energy focuses on using decentralized control techniques that enhance grid reliability by complementing the present centralized systems. Transactive energy applies distributed control and communication techniques from other industries to increasingly complex grid operations.

In order to provide for both market agents and operational control (i.e., transactive energy capability) in an environment that supports new grid capabilities, it is clear that current grid control architecture must evolve in line with changing requirements. Such evolution leads to a more distributed kind of control especially at the distribution level. This is a paradigm change that requires much faster operation, human supervision rather than human-in-the-loop operation, and control coordination that spans multiple levels of the power grid hierarchy that can address these emerging complexities.

If a common approach can be established that allows various entities to cooperate to maintain reliability while also serving their own objectives to deliver benefits it will be a significant step that will move the nation closer to a more efficient, sustainable and resilient power system. Transactive energy is one potential answer to this challenge, but this is not just a technical challenge. This is a business challenge that requires policy discussions to facilitate change in a rapidly evolving industry at the state, regional, and federal levels.