The Transactive Signal: Value and Benefits to the Region and Nation

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Transactive Approaches the Need for Grid Flexibility from Distributed Assets

The Problem:
• Generation is rapidly shifting from centralized to more distributed forms, and from being entirely dispatchable to significantly intermittent and stochastic.
• Operating such a grid with the reliability and affordability society demands, will require new forms and vastly increased amounts of operational flexibility.

The Opportunity:
• To provide this flexibility at reasonable cost, much of it is expected to be derived from distributed energy resources (DERs): responsive loads, electrical & thermal storage, smart inverters, electric vehicle chargers, etc.
• Transactive grid systems provide the control and coordination required to actively engage customer-owned and third-party assets to provide this flexibility through transparent, competitive means.
Fundamental Characteristics of Trans-active Control and Coordination for DERs

• Practical at scale – decentralizes optimization
• Utilize DERs regularly – not just on-peak – to manage renewables and provide ancillary services
• Level playing field for all types of DERs
• Maintain customer free will – coalition of the willing
• Minimize sensitive personal information about consumer preferences
• Feedback loop essential for “control” – reflects automated but voluntary user control
• Coordination system (not control system) – but functions with similar fidelity to achieve control objectives
NW has Led Journey on Transactive Approaches

Olympic Peninsula demo, ca. 2006-07
- Established viability of transactive, decision-making to coordinate to achieve multiple objectives
  - Peak load, distribution constraints, wholesale prices
  - Residential, commercial, & municipal water pumping loads, distributed generation

AEP gridSMART demo, ca. 2010-2014
- PUC-approved RTP tariff developed
  - Provides dynamic, real-time incentive to respond
  - Reflects real-time prices in PJM energy market
  - Manages AEP T&D constraints and peak load

Pacific NW Smart Grid demo, ca. 2010-2015
- Key advancements made by PNWSGD
  - Response to wind balancing needs
  - Developed look ahead signals
  - Formalized, scalable architecture def. transactive node, etc.
  - Showed how “old school” approaches (e.g. direct load control) can be integrated with a transactive schema
Significant New Drivers for Transactive Systems Have Emerged

- **Flexibility resources at distribution level are needed**
  - Significant value from distribution capacity
  - More importantly, to manage impacts of PV

- **Bypassing distribution, DERs straight to wholesale**
  - Misses distribution value
  - More importantly, problematic architecturally
    - no observability by distribution
    - no ability to manage conflicting objectives

- **Rise of distribution system operators (DSOs)**
  - Important new trend (6+ states lead by NY, CA, HI)
  - Broad access to distribution networks – DERs, PV, microgrids
  - Market exchange is a core concept
  - DSO as aggregator is a core concept
  - Reinforces foundational elements of transactive approach
Transactive Approaches Do Not Require Abandoning Fixed Wholesale or Retail Rates

Example: After-the-fact “true-up” adjusts hourly rate to recover fixed rate

Flat Rate Revenue Recovered: $22,000

Hourly Rate Revenue Recovered: $24,922

Adjusted Rate Factor = 0.883 Recovered: $22,000
Momentum is Building Around Transactive

U.S. DOE is increasingly engaged

- Office of Electricity
  - Supported demos, developing ancillary service algorithms for loads
  - New program to develop & test transactive designs, theory, valuation methods
- Office of Energy Efficiency & Renewables – Buildings Technology Program
  - Extending transactive beyond grid focus to include energy efficiency, building & campus controls, other consumer- & societally-motivated transactions*
  - Characterizing connected equipment & systems capable of transactions

Others around the U.S. and internationally are contributing

- TEMix design based on forward contracts for energy & transport
- University research activities: MIT, Cal Tech, Iowa State, U. Victoria, U. Michigan, Virginia Tech, many others
- Power Matcher (Netherlands), Australia
- GridWise Architecture Council convening transactive community, building consensus around foundational principles, architecture, & tech. roadmap

Path Forward: *Technology*

- Fill functional gaps, unify capabilities piloted in demos
- Extend to provision of regulation & artificial inertia
  - 5-min transactive acquisition of resource, by location
  - Autonomous response to frequency or ACE signal within 5-minute period
  - Set responsiveness by downloading trigger points/probabilities to devices
- Engage, vet, integrate emerging concepts: universities, industry
- Develop consistent means of evaluating costs & benefits, controllability, stability, equity
- Provide a theoretical foundation for “economics-based control”
- Provide resilience in event of loss of communications
- Ensure necessary interoperability protocols & standards in place
- **Ecosystem of commercially available & compliant products**
Path Forward: Outreach Needed to Gain Broad Industry Acceptance

Conduct necessary outreach to various stakeholder groups:

- **Utilities** – show them how transactive approaches support new, viable business models

- **System Operators** – show how transactive approaches are compatible with, leverage the advantages of, but do not require wholesale markets

- **Regulators** – convince them dynamic rates and transactive approaches are beneficial in keeping costs down, can be designed to be equitable and fully regulated, and simplify needs for measurement & verification of response … or re-formulate transactive approaches to use incentives instead

- **Consumers** – so they see it as a simple opportunity to do the right thing and get paid for it, rather than as a threat to their free time, free will, or privacy
Potential First Steps for the Region

• **Establish a regional exchange for demand response**
  – Attract investment by IOUs, distribution utilities, customers

• **Requires a value opportunity to be “put on the table”**

Examples:

  – Wind – develop a value signal that includes wind forecast errors
    – or flexible hydro capacity now held as balancing reserves
  – Peak loads – future need for generation capacity is a rising regional issue – could also be reflected
  – Security-constrained economic dispatch – another potential basis for value
  – Energy imbalance market – would be a natural target if established
Building on the PNWSGD: WA CEF / DOE Transactive Multi-Campus Project Regional Resource and R&D Testbed

- IBM iCS Nodes
- WA CEF Storage
- Region / BPA
- Regional peak load & wind balancing resource
- Peak/demand charge mgmt.
- Bldg. control

- VOLTTRON Nodes
- Multi-campus network operations
- Transactive campus/bldg. responsive applications
- Transactive / advanced bldg. controls testbed (SEL bldg.)

- City of Richland
- Campus Node

- Seattle City Light
- Campus Node
- Energy efficiency applications, leveraging transactive network
- Smart inverter integration w/ Seattle City Light’s distribution
- Curricula development

- Avista / Pullman
- Campus Node
- Microgrids as a resilience resource/smart city w/ Avista
- Solar PV & CEF battery in WSU microgrid ops
- Curricula development

- WSU

- PNNL
- UW

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- WA CEF Storage
- IBM iCS Nodes
Thank you … and, Questions …

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