The Economics of Transactive Energy

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Outline

• **Motivation**: what does transactive technology make possible?
  – Reduces the transaction costs that can prevent mutually-beneficial exchange
• Conceptual-theoretical **economic** framework for transactive energy networks
• Movement toward a distribution **platform**
• Modeling and simulation **methodologies**
• What **questions** should we prioritize?
New, different consumer value propositions-1

- ... because the value proposition is not only the kwh
- **Product differentiation**
  - Making more money by selling less power is possible
  - Conservation, satisfying green preferences
  - Examples
    - TOU
    - Dynamic pricing
      - Time differentiated: RTP, CPP, PTR
      - Green/grey mix
    - Service bundles – home entertainment, home security, home health care
    - Price discrimination’s mutual benefits to consumers and producers
    - Apps – innovation at the edge of the network
- **Digital transactive technology enables automation** – reduces transaction costs
New, different consumer value propositions-2

• Small-scale DER **interconnection**
  – Examples: residential solar, electric vehicles
  – **Market-connected** DER as a network of distributed storage

• **Microgrids**

• Agent **heterogeneity**: scale, location, identity
  – Agents can be **buyer or seller** depending on context, prices, opportunity costs at that time and place with that local knowledge

• **Reliability/supply security** as a **differentiated product**, not a uniform administrative definition
Conceptual-theoretical framework

• Market design for a retail market
  – **Who** can exchange – what entities can buy/sell?
  – **How** do they exchange – units, definition of the item being bought/sold
  – **Time** delimiters matter in electricity
  – Elasticity is dynamic, not static, and a function of enabling technology
Example: Olympic Peninsula retail double auction
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• Organizational economics & theory of the firm
  – What are the transactional boundaries of the distribution company?
Digital innovation at the edge of the network

SMART GRID
A vision for the future — a network of integrated microgrids that can monitor and heal itself.

- Solar panels
- Officess
- Wind farm
- Central power plant
- Industrial plant
- Generators: Energy from small generators and solar panels can reduce overall demand on the grid.
- Processors: Execute special protection schemes in microseconds.
- Storage: Energy generated at off-peak times could be stored in batteries for later use.
- Smart appliances: Can shut off in response to frequency fluctuations.
- Sensors: Detect fluctuations and disturbances, and can signal for areas to be isolated.
- Demand management: Use can be shifted to off-peak times to save money.

YOU SPEAK. YOUR HOME LISTENS.
A techno-economic electricity distribution platform

Source: EPRI (2014), p. 31
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• Regulatory economics
  – **Institutional** design for regulating a 21st century distribution company
  – Evolve from rate determination to consumer **protection** and market **monitoring**
Modeling methodologies in economics

• **Experimental** economics
  – Laboratory environment with human subjects
  – Cash payment provides salient reward
  – Can illuminate effects of individual cognitive effects such as perception and tacit knowledge
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• **Agent-based** modeling
  – Program individual computer agents
  – Focus on effects/patterns arising from interaction
  – Can improve agent programming by incorporating results of economic experiments
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- **Computer simulation**
  - Closed system (but not always), equation based
  - Often used to simulate a formal theoretical equilibrium model
  - Can use experiments and ABM to improve the model
Some questions to prioritize

• How engaged are consumers under different market designs and with transactive technologies?

• What are the implications of automation for price elasticity of demand in retail markets?

• What effect does incumbent vertical market power have in transactive retail markets?

• What are the economic implications of designing a transactive platform for the interconnection and exchange of distributed energy?