Smart Loads and Smart Grids
Creating the Smart Grid Business Case

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Agenda

- Business practices and engagement
- Balancing smart loads
- Managed Energy
- Collaborative Energy
- Service-Oriented Energy and Buildings
- Load Shaping
- Collaborative Energy Enablers
- Business Case for Smart Loads
- Actions
- More Information

Business Practices and Participation

- Traditional business practices discourage participation
  - Utilities provide price and risk arbitrage to the end nodes
  - Limited value to end nodes
  - Reduced interest in working with the grid
- Difficult and intrusive practices
  - Complex—rely on direct management
  - Difficult—diverse purposes and many technologies
  - Intrusive—un-invited remote control affects use
  - Ineffective—manage efforts not results
- Limited response and minimal benefits

The Problem is Engagement

"If a grid is not transactive, it's not a smart grid"

– Lynne Kiesling

- Must balance energy supply and demand
  – Quality must be maintained
- Engage the end nodes for best results

We Want to Avoid Risk

- Consumer avoidance of risk
  - Traditional markets manage risk for the consumer
  - Reliability managed by oversupply
- Arbitrage of risk significant component of traditional utility business model
  - Whether explicit or not

Approaching Breakdown

- Limits being reached
  - Public policy and transmission
  - Public policy and generation
  - Public policy favors intermittent sources
- Volatile supply is harder to balance
- Balancing supply and demand

Diverse Interactions

- The Grid no longer the source of all energy
- End node—anything attached to the grid that is neither the grid nor a bulk generator
- End nodes include
  - Residential, Commercial, Industrial facilities
- And more including
  - Microgrids
  - Plug in vehicles
  - Distributed Energy Resources (DER)
- Need at least some local intelligence and control

Three Paths to Balancing Energy

- Dynamic balancing of energy supply
  - Tune generation and distribution to react to demand
- Managed Energy
  - Directly manage energy use in the end nodes
- Collaborative Energy
  - Autonomous end nodes manage their own alignment with supply

- Next slides examine these in more detail

Dynamic Balancing of Energy Supply

- Supply side adapts
  - Anticipation of needs of the end node
- Rapid dispatch of generation to support load
  - Few bulk generators can respond quickly and cheaply
- Today's systems too expensive in money and fuel
  - Fast start gas turbines very expensive for balancing
  - Need fast response to fill in for volatile renewables
    - Non-hydro
- More renewables, greater cost
- Not sustainable

Managed Energy

- Direct load control and related approaches
  - ZigBee Smart Energy Profile
  - OpenHAN (Home Area Network)
- Intrusive
- Exerts control beyond the demarcation boundary
- For effective control and greater response need to understand the end node
  - Complexities
  - Goals and requirements
  - Controllable characteristics
- Consumers have little affection for managed energy, hence try to limit its application even if mandated

Collaborative Energy

- End node intelligence required
  - Embedded in systems that understand the specifics better than a central controller can
  - Understand the business processes and aspirations of the occupants better than the grid can
- More variable than managed energy
- Service performance rather than process performance
  - Reduces complexity of control and understanding
  - Generation? Demand Response? Storage draw down?
  - Who can better manage?

Collaborative Energy in Buildings

- Commercial Buildings are good candidates for collaborative energy
  - Same characteristics that make them poor candidates for managed energy
- Growth of collaborative energy restricted by lack of live usage and price information
  - Limits ability to understand energy use
  - Limits engagement and ability to commit to changing us

Collaborative Energy In Industry

- Participation can involve
  - Scheduling long-running processes in advance
  - Manage shape of load by balancing internal processes
  - Often supported by combined heat and power plants
    - Assets to a stressed grid
- Many devices
  - Time and control load profiles and shapes
- Take advantage of dynamic prices
- Take advantage of forward markets
  - Aggregators may not be needed

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Service-Oriented Energy and Buildings

- Focus on desired results *not* on specific processes
- Complements loose integration
- Works well across ownership and control boundaries
- Connect end nodes to markets
- Internal economic choices
  - Microgrids as a different ecosystem with similar needs
- Services to support grid operations at first

Transactional Energy

- Services exchange information
- Common abstraction for supply, demand, scarcity, and value—money
  - Signals must be primarily economic
  - Economic signals light and loose
  - Economic signals may exchange minimal information
- Services are paid for results, not for efforts
- Transaction energy is service oriented

Load Shaping and Future Readiness

- Large end nodes face problems similar to the grid
  - Hard to partially upgrade or tailor to occupant needs
- Service orientation and decoupling inside the facility
  - Exposed services can support parts of a building
  - More understandable than the composed total energy usage
  - Express usage and demand in comparable ways
- Autonomous load shaping in buildings
  - Subsystems respond by monitoring own usage and tasks, report load profile and projected use to its peers.
  - Assemble profiles and coordination patterns to smooth loads
- A well-behaved & more predictable load is more valuable

Collaborative Energy Enablers

- Transparent accounting
- Actionable information
- Limited interoperation points
- Common price, usage, interaction patterns
- Avoid complexity
  - In accounting, in risk mitigation, in markets
  - Shift risk/reward tradeoffs
- Service orientation
- Allow for evolution

Business Case for Smart Loads

- Smart loads are important to the smart grid
- Price and risk arbitrage are barriers to engagement
- Smart loads require simple clean communications
  - Results, not process-oriented
  - Communications primarily economic
  - Communications not control-oriented
- Simple interactions offer the simplest approach to engaged end nodes
- Light, loose coupling and service orientation support innovation in processes and technologies
- Autonomous load shaping valuable to smart grids and microgrids

Actions

- Common price and product communication
- Simple service-oriented interactions
- Common usage information
- Common schedule information
- Supported by NIST Priority Action Plans
  - Common Price and Product Definition
  - Common Scheduling
  - Standard DR and DER Signals
    - Plus OASIS Energy Interoperation Protocol
  - Standard Energy Usage Information

More Information

- Toby Considine's blog The New Daedelus
- William Cox's web site collects papers and presentations on energy and Collaborative Energy
- NIST Smart Grid Collaborative site
  - Domain Expert Working Groups are open to all
  - These and related issues are frequently discussed in
    - Building to Grid (B2G)
    - Industry to Grid (I2G)
- The NIST DEWG will transition to the Smart Grid Interoperability Panel in late 2009