Economic Role and Effects of the Smart Grid

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Energy Demand Growth, 1949 - 2006

The chart illustrates the growth of energy demand from 1949 to 2006, categorized by sector:
- Electric Generation
- Transportation
- Industrial
- Commercial
- Residential

The y-axis represents Quadrillion Btus, while the x-axis shows the years from 1949 to 1999. The data indicates a significant increase in energy demand across all sectors, with Electric Generation leading the growth trend.
Sectoral Growth with Electricity Allocated

- Transportation
- Industrial Electric
- Industrial Direct
- Commercial Electric
- Commercial Direct
- Residential Electric
- Residential Direct

The graph shows the growth in Quadrillion Btus from 1949 to 1999 for various sectors.
Annual Percent Growth in Electricity Demand

Source: Annual Energy Outlook 2012, EIA, June 2012
Context for Transition to Smart Grid

• Electricity generation is only major growth sector for primary energy use, but load growth is flattening.

• Residential, commercial, and industrial energy use is falling except indirectly through electricity demand growth.

• Electricity generation wastes more energy than any other sector: more than one-fourth of annual national energy use is vented through utility smokestacks and cooling towers.

• Improving electricity efficiency to save one unit saves three units of input energy (and the associated GHGs).

• Societal premium on efficient electricity use.

• Most users still pay flat rate billed for historic period, cannot see or react to cost of power, cannot gain from timed efficiency, have no outage protection.

• Most utilities still incented to sell more electricity to make greater returns.
The Electric Utility Industry is Changing...

What will be different:
- The technological basis for system operation, consumption, pricing, and use.
- Utility business models, regulatory incentives and disincentives.
- Sources, sellers, volumes and end-use value of generated power.
- Utility-customer relationships, including new third-party market participants, as customers shift from passive to active, from buyers-only to some self-supply.
- Degrees of competition in electricity pricing and service options.
- Utility role in achieving social and environmental benefits – climate protection, pollution prevention, water use management, low-income support.

What is likely to remain the same:
- Utility responsibility for distribution and transmission wires investment and services.
- Utility responsibility for power reliability and quality.
- Utility responsibility as provider-of-last-resort.
- Utility ownership structures – IOU, Muni, Coop, Federal
- Matching state, local, and federal regulatory jurisdictions and regulatory responsibilities.
- Utility right to recover investment costs and fair return from ratepayers.
- Utility obligations to achieve renewable energy integration and efficiency gains.
What is the “Smart Grid?”

A “Smart Grid” will result from applying digital electronic computer processing, sensing, communications, and controls to the electric utility system and to the devices that produce and consume electric energy, in a standardized and pervasive manner.

A “Smart Grid” is necessary to enable utilities to accommodate virtually all of the coming changes.
Without Smart Grid technologies, we cannot:

- Support time-sensitive rates, letting consumers participate in electricity price-setting for the first time.
- Monitor and respond to contingencies on the grid in real time, programming greater reliability.
- Integrate thousands of variable renewable energy generators into the grid.
- Integrate distributed and retail storage technologies, including potential from electric vehicle batteries.
- Avoid substation and transformer overloads from recharging electric vehicle batteries.
- Convert radial distribution systems to more reliable network systems using smart switches.
- Support retail-level demand response and automated direct appliance load controls.
- Accommodate smart appliances and utility devices on a plug-and-play basis.
- Do all of the above while meeting ever greater needs for power reliability and power quality.
So what are the costs and benefits of Smart Grid?

- From the perspective of the utility
- From the perspective of the consumer
- From the public interest perspective
Smart Grid Business Case Summary – Utility Perspective

Annualized Savings and Costs for U.S. (150 million electric meters)

- Utility Operating Savings
- Hardware
- Installation
- Software, IT & PM
- Other Costs
- Annual O&M
- Net Annual Benefits

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Smart Grid Business Case Summary – Societal Perspective

Annualized Savings and Costs for U.S.

- Utility Operating Savings
- Grid Efficiency - Line Losses
- Grid Efficiency - CVR
- Energy Efficiency
- Peak Reduction
- Integrating EVs/Renewables
- Hardware
- Installation
- Software, IT & PM
- Other Costs
- Net Annual Benefits

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The Consumer’s Primary Economic Gain: Greater Reliability

“We find that the annual cost of power interruptions ... could be as low as $22 billion or as high as $135 billion when we consider a reasonable range in the annual duration and frequency of power interruptions...”

Kristina Hamachi LaCommare and Joseph H. Eto
Lawrence Berkeley National Laboratory
2004

Industry Average Cost of 1-Hour Interruption

<table>
<thead>
<tr>
<th>Industry</th>
<th>Average Cost</th>
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<tbody>
<tr>
<td>Cellular communications</td>
<td>$41,000</td>
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<tr>
<td>Telephone ticket sales</td>
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<td>Airline reservation system</td>
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<td>Credit card operation</td>
<td>$2,580,000</td>
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<tr>
<td>Brokerage operation</td>
<td>$6,480,000</td>
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</tbody>
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Perfect Power Institute
Challenges for the Smart Grid

• **Keeping utilities whole** – Utilities need to recover all their costs from societal benefits. How do we convert a portion of the societal benefits into collectable electric rates?

• **Interoperability** – Achieving plug and play across a variety of platforms and applications. Can the standards catch up with the devices already rolling out?

• **Cybersecurity** – The grid is already under constant cyber threat; computerizing it top-to-bottom makes cybersecurity tougher and more necessary. Can the protections get ahead of the hackers?

• **Consumer acceptance** – Most consumers are not early adapters, are scared of higher costs, and do not want to have a complex interface with their utility services and appliances. Can Smart Grid go viral?

• **Capital cost availability** – Federal stimulus bill advanced $4.5 billion in matching grants, but that’s only a down payment. Can utilities convince Wall Street to finance their conversion to smart grid?
Conclusions

• Smart Grid is inevitable:
  – Technology push, early adopters, and third-party service vendors will bring it to consumers.
  – Lack of better traditional investment options, shift to service-driven business models, and reliability gains will require utilities to embrace it.

• Utility-side savings alone are sufficient to cover the utility’s costs of implementation.

• Consumer-side savings from reliability improvement and price optimization further justify pass-through of utility investment costs.

• Within twenty years, electric system will have undergone a fundamental revolution, of which Smart Grid implementation will have been a key factor.