Smart Policies for a SmartGrid (or, the other way around)

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A SmartGrid

E = MC²
Buy low/sell high
Fire broker
MC = $ = MC

Nudge
Expensive Wines
Joy of Cooking
Go Big Red
A SmartGrid would use resources more efficiently

<table>
<thead>
<tr>
<th>Generation</th>
<th>Transmission &amp; Distribution</th>
<th>End Use Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ 65% loss</td>
<td>~ 7% loss</td>
<td>~ 88% loss (incandescent light example)</td>
</tr>
<tr>
<td>coal 100</td>
<td>electricity 35</td>
<td>electricity 32</td>
</tr>
<tr>
<td>~6%</td>
<td>~3%</td>
<td>~5%</td>
</tr>
</tbody>
</table>

SmartGrid as an End-to-End Energy Efficiency Initiative
A SmartGrid accommodates economies for the grid investment—distributed generation

Bulk Generation

Central Plant

Step-Up Transformer

Transmission

Subtransmission

Distributed Generation

Distribution Substation

Gas Turbine

Receiving Station

Distribution Substation

Commercial

Recip Engine

Industrial

Flywheel

Residential

Micro-turbine

Photo voltaics

Batteries

Fuel Cells

PHEV

Transmission Bulk Generation

Distributed Generation

Receiving Station

Distribution Substation

Commercial

Recip Engine

Industrial

Flywheel

Residential

Micro-turbine

Photo voltaics

Batteries

Fuel Cells

PHEV
New technology opportunities abound

Set it, and forget it homes

Hyper-Efficient Technologies

- Residential
  - Heat Pumps
  - Ductless Cooling
  - Appliances
  - VFC Cooling
  - VFC Cooling
  - Data Centers
Where’s the beef?

• The SmartGrid infrastructure will be expensive – maybe $100 billion, maybe a lot more

• There will be additional transition or enabling costs to induce behaviors that generate benefits

• A truly interoperable grid will break down traditional market drawbridges that protect local interests – can state-level policy survive?
Operational benefits (utility cost savings)

### AMI Operating Benefits

#### Quantifiable Benefits

- **New Revenue**
  - Reduced Read-to-Pay Time
  - PBR Incentive Harvesting
  - Reduced Outage Minutes
  - Fewer Estimated Bills
- **Customer Service**
  - Bill Inquiries Reduced
  - Faster Inquiry Resolution
  - Customer Site Visits
- **Billing**
  - Reduced Manual Processing
  - Fewer Estimated Bills
  - Fewer Pre-bill Audits
- **Metering & Reading**
  - On-Cycle Reads
  - Off-Cycle Reads
  - Meter Reader Safety, Liability
  - Meter Reader Training
  - Reduced Meter Testing
  - Direct Access Settlement
  - Load Research Metering
- **Distribution Operations**
  - Capacitor Control
  - Outage Restoration
  - Transformer Failure
- **One Time & Short Term Benefits**
  - Meter Accuracy Improved
  - Sale of used meters
  - Meter Changeout Ends
  - Tamper Detection & Correction
- **Capital Reductions**
  - Load Research Equip.
  - Meter Reader Vehicles
  - Optimal Transformer Sizing
  - Meter Inventory
- **Avoided Losses**
  - Reduced Non-Billable Consumption
  - Tamper Deferred
  - Unoccupied Premises
  - Electric System Optimization
  - End of Line Voltage
  - Feeder Load Balancing
  - Power Factor Losses

#### Intangible Benefits

- **Customer Service Benefits**
  - Overtake Customer Services
  - New Rates Possible
  - Increased Responsiveness to Customer
  - Less intrusive to Customer
  - Power Quality Monitoring

- **Strategic Benefits**
  - Distribution Automation
  - Monitor/Manage Distributed Generation
  - Greater Approved Return
  - Improved Costs & Pricing Basis
  - Improved Load Forecasting & System Planning
  - Improved System Reliability
  - Market Segmentation & Targeting
  - Improved Public/Regulatory Relations
  - Improved Customer Satisfaction
Sources of operating benefits

Large Electric Investor Owned Utility

Annual AMI Benefits ($ per meter)

- $7.97
- $2.92
- $2.77
- $2.46
- $0.99
- $0.99
- $0.43
- $0.28
- $0.16
- $0.17

- Total Annual Benefit = $21.58

Rexus Research, An R. W. Beck Company
Relative Benefits Attributed to Smart Metering
(Revised July 21)

On Average, 34% of Attributed Benefits are Societal

Who pays for the missing 1/3 of the investment cost?
### Source and Measurement of Societal Benefits

#### Quantifying the Societal Benefits Attributable to Smart Metering

<table>
<thead>
<tr>
<th>Influence</th>
<th>Benefit Source</th>
<th>Manifestation</th>
<th>Value Transformation</th>
<th>Who Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outages</td>
<td>Service Quality Enhancement</td>
<td>Fewer and Shorter Outages</td>
<td>Value of Lost Load</td>
<td>All Electricity Consumers</td>
</tr>
<tr>
<td>Consumer Usage Visualization</td>
<td>Feedback</td>
<td>Reduced kW, kWh</td>
<td>Market/Utility Price and Investment Impacts Model</td>
<td>DR Participants, Event Respondents, All Elect. Consumers</td>
</tr>
<tr>
<td>Measure and Communicate</td>
<td>Demand Response Programs</td>
<td>Modify kW, kWh Pattern</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Products, Services</td>
<td>Externalities</td>
<td>Lower Emissions, imports</td>
<td>Emission Cost</td>
<td>All Consumers</td>
</tr>
<tr>
<td></td>
<td>Macro</td>
<td>Increased Employment, Wages</td>
<td>Economic Impact Model</td>
<td>Regional Consumers</td>
</tr>
</tbody>
</table>

**Who Benefits**
- All Electricity Consumers
- DR Participants
- Event Respondents
- All Elect. Consumers
- All Consumers
- Regional Consumers

**Total Economic Impact Model**

$\text{TOTAL} \quad 1$
Comparison of DR Plan Event Impacts

Source: Faruqui, April 2008

- Differences among pricing structures are largely due to event price differences, not elasticity differences
- Technology effect has not been demonstrated to be sustainable except perhaps for AC and water heating control
Synopsis of Price Elasticity Estimates

Electricity Price Elasticity Estimates - Range and Mass Central Points (Absolute Values) for 15 Studies

Points are mass center, lines the values range (where appropriate)

<table>
<thead>
<tr>
<th>Study Number (Table 4)</th>
<th>Estimated Elasticity - Absolute Value</th>
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<tbody>
<tr>
<td></td>
<td>Household</td>
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</table>

Own-price elasticity (all others substitution)
Policy issues

• How do we justify filling the gap?
• How do we socialize or otherwise recover the gap?
• What obligations do utilities have to close the gap through performance clauses?
• Do consumers know what a SmartGrid is, and what it will cost?
• How long can economists milk this issue?
Questions?