Smart metering: Costs, benefits and international experience

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Metering

• **Purpose**
  – Information
  – Interaction

• “Traditional” electromechanical metering (domestic and SME)
  – Cumulative measurement
  – Ex-post estimated billing
  – One-way interaction
Smart Metering

- Automated meter reading (AMR): 1-way
- Automated meter management (AMM): 2-way
Smart metering Functions (2-way)

- Improved Information
  - Record consumption at intervals
  - Multiple tariff registers
  - Import/export capability
  - Detect and record supply losses
- Improved Interaction
  - Remote reading
  - Interface with load control technology
  - Remote changes in tariffs
  - Notification of supply losses
  - Switch b/w credit and prepayment
  - Remote connection/disconnection

- Instantaneous consumption displayed

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[ESRC]  
Economic & Social Research Council
# Smart metering costs

<table>
<thead>
<tr>
<th></th>
<th>% of total cost (approx.)*</th>
<th>Sensitive to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meters</td>
<td>36-59%</td>
<td>Functionality; scale; roll-out</td>
</tr>
<tr>
<td>Meter Installation</td>
<td>1-19%</td>
<td>Roll-out schedule; gas/electricity</td>
</tr>
<tr>
<td>Communications System (Infrastructure &amp; management)</td>
<td>18-33%</td>
<td>Type; scale; roll-out; gas/electricity</td>
</tr>
</tbody>
</table>

*Based on following CBAs: PG&E California 2006; Frontier 2007 GB study; Ofgem 2006; Victoria Australia CRA 2005*
Smart metering benefits

Metering service efficiency
- Lower reading/connection costs
- Accurate billing; fraud detection

Quality of Service
- Better outage detection
- Reduced customer service costs

Demand Response
- Peak shifts
- Average consumption reduction
*Pricing
*Pricing/information
Distribution of costs and benefits

- International differences in market structure
- Implications
  - Variations in how incentives are split
Case study 1:
Distribution of costs and benefits

- Netherlands: Decision to change market structure
  - Electricity and gas; 6.7 million households

## Case study 2: Demand response

**California Pricing Pilot 2003/4**

(Interval electricity meter; daily collection; 3 utilities; 2500 customers)

<table>
<thead>
<tr>
<th>Customer (residential)</th>
<th>Critical peak pricing shift</th>
<th>Conservation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>13%</td>
<td>No change in total energy use observed</td>
</tr>
<tr>
<td>Central A/C</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>No Central A/C</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>Annual Income $100,000</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>Annual Income $40,000</td>
<td>11%</td>
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</table>

**Ontario Pricing Pilot 2006/7**

(Interval electricity meter; 2-way; 1 DNO; 373 customers)

<table>
<thead>
<tr>
<th></th>
<th>Summer shifts in consumption (entire peak)*</th>
<th>Conservation effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical peak pricing (CPP)</td>
<td>12%</td>
<td>5% (n/s)</td>
</tr>
<tr>
<td>Critical peak rebate</td>
<td>9%</td>
<td>7%</td>
</tr>
<tr>
<td>Time of use pricing</td>
<td>2% (n/s)</td>
<td>6%</td>
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</table>

*None of the winter shifts were statistically significant*
Lessons

- Information and interaction
- Role of market structure
- Demand response
  - Context and drivers
Evaluating Government’s Policies on Promoting Smart Metering in Retail Electricity Markets via Agent Based Simulation

Tao Zhang, Bill Nuttall
Electricity Policy Research Group
Judge Business School, University of Cambridge

EPRG Spring Research Seminar
Cambridge, 16th May 2008
Agenda

• The Retail Electricity Metering Market in Britain
• BERR’s 2008-2010 Policies on Promoting Smart Metering
• Model Description
• Simulation Scenarios
• Simulation Results
• Conclusions
The Retail Electricity Metering Market

- Market Size: 22.5 million domestic electricity meters in E&W
- DNOs are traditional dominate meter operators (license obligation)
- Metering competition introduced in 2001, and entered into force in 2003, in order to lower service prices, improve quality of services and encourage innovate (Ofgem)
- Under the current regulatory framework, meter ownership is diversified/ambiguous
BERR’s 2008-10 Policies on Promoting Smart Metering

• “Within the next 10 years, all domestic energy customers will have smart meters with visual displays of real-time information that allow communication between the meter, the energy supplier and the customer” (EWP 2007)

• From 2008-10, real-time visual displays will be available free of charge to any household that requests one

• “Standalone real-time display devices were seen as both an interim measure and as an integral function of a smart meter” (BERR)
Model Description

- Behaviour of RC agents

RC agent $i$’s interactions
Model Description

- Environment design

A square lattice of 62,500 cells (250*250) with periodic boundary conditions
Model Description

• Social network design

An RC agent’s regular (blue) and random interactions (red) with other RC agents
Simulation Scenarios

<table>
<thead>
<tr>
<th>Group</th>
<th>Dec-02</th>
<th>Jun-03</th>
<th>Dec-03</th>
<th>Jun-04</th>
<th>Dec-04</th>
<th>Jun-05</th>
<th>Mar-06</th>
<th>Mar-07</th>
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<tbody>
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<td>BGT</td>
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<td>23%</td>
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<td>Powergen</td>
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<td>22%</td>
<td>21%</td>
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<td>21%</td>
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<tr>
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<td>15%</td>
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<tr>
<td>ScottishPowe</td>
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<td>10%</td>
<td>11%</td>
<td>12%</td>
<td>13%</td>
<td>13%</td>
<td>13%</td>
<td>12%</td>
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<tr>
<td>Others</td>
<td>0%</td>
<td>1%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
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National market share in electricity (Source: Domestic Retail Market Report, Ofgem, June 2007)

ES agents in the model of market game
Simulation Scenarios

Free Real-time Display Policy Between 2008-2010

Who pays?

The Government  Electricity Suppliers  DNOs

How to roll out?

Competition  Monopoly  Competition  Monopoly

Scenario 1  Scenario 2  Scenario 3  Scenario 4

Scenarios of strategies in the simulation
Simulation Results

The Trends of Real-time Visual Display Diffusion

Scenario 1
Scenario 2
Scenario 3
Scenario 4
Conclusions

- Policy Implications
  - Mandated free real-time visual display policy will be very effective
  - Under the mandated free real-time visual display policy, government subsidizes the promotion of smart metering and meanwhile imposing an obligation on electricity suppliers so as to force them roll out real-time visual display through competition

- Methodological Contribution
  - Agent-based simulation as a new approach for policy assessment
Thank You For Your Attention