Is our everyday comfort for sale?

Preferences for demand management on the Swedish electricity market

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How much do you need to be freezing in dirty clothes, looking at mountains of dishes and dirty clothes, while your kids are in a bad mood waiting for the cold dinner to be served?

Why ask?
Perhaps this it what it takes!
Household electricity use - Where and when?

Median Swedish detached house during a weekday in February

- Morning peak – evening peak

- Demand peaks coincide with price peaks
- Price variation is demand driven
Introduction

• The market has been transforming
  – Deregulation
  – Market integration, Swedish → Nordic → European
  – Technical progress (production, distribution, consumption)
  – Renewables
  – Intermittent production (production mix)

• Hydropower is/has been fundamental for flexibility on the Swedish market, but…
  – Net exports and phase-out of backup load
  – Increased pressure on balancing power
  – Consumer flexibility will help/be necessary
Introduction

• Need incentives and a framework where consumers can/must be flexible

• Real time pricing (demand response)
  – High expectations, but how flexible are consumers?
  – “Open” the market and wait for the effect?
  – Well, so far Swedes don’t seem to behave accordingly
  – If no (too little) flexibility
    → Very expensive reforms (smart meters etc.) and only small effects on the market

• Contracts (demand side management)
  – Compensate consumers to reduce load in a predictable way
  – “External” control – incentive based load management
Demand management in real

A choice experiment approach
The choice experiment

• Hypothetical contracts
  – Asked to choose the preferred contract
  – Contracts are defined by relevant attributes (including a compensation) with varying levels
  – Implicitly make trade-offs between attributes in the contracts → reveal preferences (→ discrete choice methods)

– What to manage?
  • Morning – Evening
  • Heating system – Household appliances
  • In addition, information sharing and monetary compensation are considered
<table>
<thead>
<tr>
<th>ATTRIBUTE</th>
<th>Levels</th>
</tr>
</thead>
</table>
| **EXTERNAL CONTROL OF HEATING, MONDAY-FRIDAY** | A firm, e.g. a utility company, controls your heating system every day, Monday to Friday during certain hours. The heating will be turned off but the temperature never decreases more than two degrees (Celsius) and never below 18 degrees (64 F). The control will take place  
  • 7am to 10am  
  • 5pm to 8pm  
  • Never (as today) |
| **EXTERNAL CONTROL OF DOMESTIC ELECTRICITY, MONDAY-FRIDAY** | A firm, e.g. a utility company, controls your domestic electricity use every day, Monday to Friday during certain hours. During these hours it is not possible to use the dishwasher, the laundry machine and dryer. In addition, the electricity for towel warmers and comfort floor heating will be cut off. The control will take place  
  • 7am to 10am  
  • 5pm to 8pm  
  • Never (as today) |
| **EXTERNAL CONTROL IN EXTREME CASES** | During certain days there are extreme situations on the energy market due to e.g. extreme cold or low production. You will be notified one day ahead that the heating system and domestic electricity will be turned off the coming day between 7am and 8pm (including weekends). The control implies the same restrictions as in the attributes above. Extreme situations are more or less unexpected and will, to each household, be limited to a maximum number of days per year.  
  • 3 days per year  
  • 7 days per year  
  • 10 days per year  
  • Never (as today) |
| **DISTRIBUTION OF INFORMATION** | Information from your electricity meter and similar can be communicated to companies and compared to neighboring and similar households. Each household is kept anonymous in the comparisons.  
  • Yes – It is okay to spread information about my household consumption and use it in anonymous comparisons across e.g. the neighborhood.  
  • No – It is not okay to spread information about my household consumption and use it in anonymous comparisons across e.g. the neighborhood. |
| **COMPENSATION** | A new contract is related to an annual monetary compensation.  
  • 300 SEK ($38)  
  • 750 SEK ($94)  
  • 1500 SEK ($188)  
  • 2500 SEK ($313) |
An example

Which contract, A, B or C, would be your choice? Things not given by the suggested contract is to be considered as today.

<table>
<thead>
<tr>
<th></th>
<th>Contract A</th>
<th>Contract B</th>
<th>Contract C – as today</th>
</tr>
</thead>
<tbody>
<tr>
<td>External control of heating, mon - fri</td>
<td>5pm – 8pm</td>
<td>7am – 10am</td>
<td>No</td>
</tr>
<tr>
<td>External control of electricity use, mon - fri</td>
<td>7am – 10am</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>External control of use in extreme situations</td>
<td>No</td>
<td>Max 10 days</td>
<td>No</td>
</tr>
<tr>
<td>Dissemination of information</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Compensation (SEK per year)</td>
<td>1500 ($188)</td>
<td>750 ($94)</td>
<td>0</td>
</tr>
<tr>
<td>MY CHOICE</td>
<td>[  ]</td>
<td>[  ]</td>
<td>[  ]</td>
</tr>
</tbody>
</table>
The survey

- Focus groups
- Pilot study, 100 respondents
  - Test attributes etc.
  - Priors for an efficient design
- Representative sample, Sweden
  - 918 respondents
  - Age, gender, place of residence
  - Not just those with certain contracts
<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample mean</th>
<th>Swedish population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion male</td>
<td>0.54</td>
<td>0.50</td>
</tr>
<tr>
<td>Average age</td>
<td>54</td>
<td>41</td>
</tr>
<tr>
<td>Do you know about real time (every hour) contracts?</td>
<td>316 (34%)</td>
<td></td>
</tr>
<tr>
<td>Households w real time contract</td>
<td>13 (1.4%)</td>
<td></td>
</tr>
<tr>
<td>Don’t want real time pricing</td>
<td>345 (37.6%)</td>
<td></td>
</tr>
<tr>
<td>“Neighbors using anonymous information about you? Yes&quot;</td>
<td>496 (54%)</td>
<td></td>
</tr>
<tr>
<td>Type of contract:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable price contract</td>
<td>284 (31%)</td>
<td></td>
</tr>
<tr>
<td>Fixed price contract</td>
<td>419 (46%)</td>
<td></td>
</tr>
<tr>
<td>The “no-contract”</td>
<td>32 (3.5%)</td>
<td></td>
</tr>
<tr>
<td>Reason for fixed price?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Nice price”</td>
<td>200 (48%)</td>
<td></td>
</tr>
<tr>
<td>Risk averse (volatility)</td>
<td>182 (43%)</td>
<td></td>
</tr>
</tbody>
</table>
Results

• Strong preferences for status quo (the “as today” alternative)
  – On each choice question there are 43-68% “status quo” choices
  – 39% chooses ”status quo” on all choice questions

• Households don’t like changes
  – Expected?
Let’s have a look at preferences for the attributes in the contracts!
## Valuation of attributes

<table>
<thead>
<tr>
<th></th>
<th>Annual compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>● External control of heating 7-10 am</td>
<td>Not sign.</td>
</tr>
<tr>
<td>● External control of heating 5-8 pm</td>
<td>$80</td>
</tr>
<tr>
<td>● External control of household electricity 7-10 am</td>
<td>$104</td>
</tr>
<tr>
<td>● External control of household electricity 5-8 pm</td>
<td>$176</td>
</tr>
<tr>
<td>● External control in extreme cases, 0, 3, 7 or 10 days of preparedness</td>
<td>$5.5 / day</td>
</tr>
<tr>
<td>● Distribution of information (for peer comparisons)</td>
<td>$30</td>
</tr>
<tr>
<td>Just to consider <em>any</em> restriction in energy use</td>
<td></td>
</tr>
<tr>
<td>● People require</td>
<td>$349</td>
</tr>
</tbody>
</table>
How much do we have to pay households to:

- make them look at mountains of unwashed plates and cloths in the evening.
- worrying about 10 potential days with restrictions on their energy use.
- knowing that their neighbors probably see how much electricity they consume?

→ On average $261 -- $610 per year
→ $0.7 -- $1.67 per day
How much do we have to pay households to make them:

- not wash or do their dishes in the morning.
- not worry about days with restricted energy use.
- keeping their secrets (no info. sharing)

→ On average $104 – $453 per year
→ $0.28 - $1.24
Results

- The compensations are really high, especially relative to current incentives to be flexible.
- The common belief about the ability and will to be flexible is perhaps too optimistic.
- However, it can’t be ruled out that the respondent exaggerate the effects of restrictions.
Preference heterogeneity

Who is the flexible consumer?
• The preference for status quo
  – Age, Income, Apartment
    → More likely to choose status quo
  – Education, Green preferences, Politically active
    → Less likely to choose status quo
The attributes and socioeconomics
<table>
<thead>
<tr>
<th>Heat, 7-10am*Adults</th>
<th>(-)</th>
<th>Dom. el., 5-8pm*Age</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat, 7-10am*Children</td>
<td>(-)</td>
<td>Dom. el., 5-8pm*Apartment</td>
<td>(+)</td>
</tr>
<tr>
<td>Heat, 5-8pm*Household income</td>
<td>+</td>
<td>Ext. occ.*Household income</td>
<td>+</td>
</tr>
<tr>
<td>Heat, 5-8pm*Adults</td>
<td>-</td>
<td>Ext. occ. *Apartment</td>
<td>(+)</td>
</tr>
<tr>
<td>Heat, 5-8pm*Electric heating</td>
<td>(+)</td>
<td>Information*Age</td>
<td>+</td>
</tr>
<tr>
<td>Heat, 5-8pm*High indoor temp</td>
<td>+</td>
<td>Information*Adults</td>
<td>+</td>
</tr>
<tr>
<td>Dom. el., 7-10am*Age</td>
<td>-</td>
<td>Information*Apartment</td>
<td>+</td>
</tr>
<tr>
<td>Dom. el., 7-10am*Male</td>
<td>-</td>
<td>Information*Electric heating</td>
<td>(+)</td>
</tr>
<tr>
<td>Dom. el., 7-10am*Home, 7-10am</td>
<td>+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note that a + means more disutility (discomfort) and that signs within brackets are not statistically significant.
Conclusions

• A large compensation is needed, (especially related to the current benefits from extreme load shifting)
• We look at certain restrictions in energy use – not a perfect measure of “real” flexibility
• You get what you pay for…
  – Low compensation → small effect on power demand
• No general patterns for heterogeneity
  – Perhaps are preferences most related to individual life-style, habits, time constraints and ideology
Thanks!

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