

Is our everyday comfort for sale?

Household preferences for demand
management on the Swedish electricity
market

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and Swedish university of agricultural science



- Environmental and energy economics
- More than 30 researchers
- More than 10 nationalities



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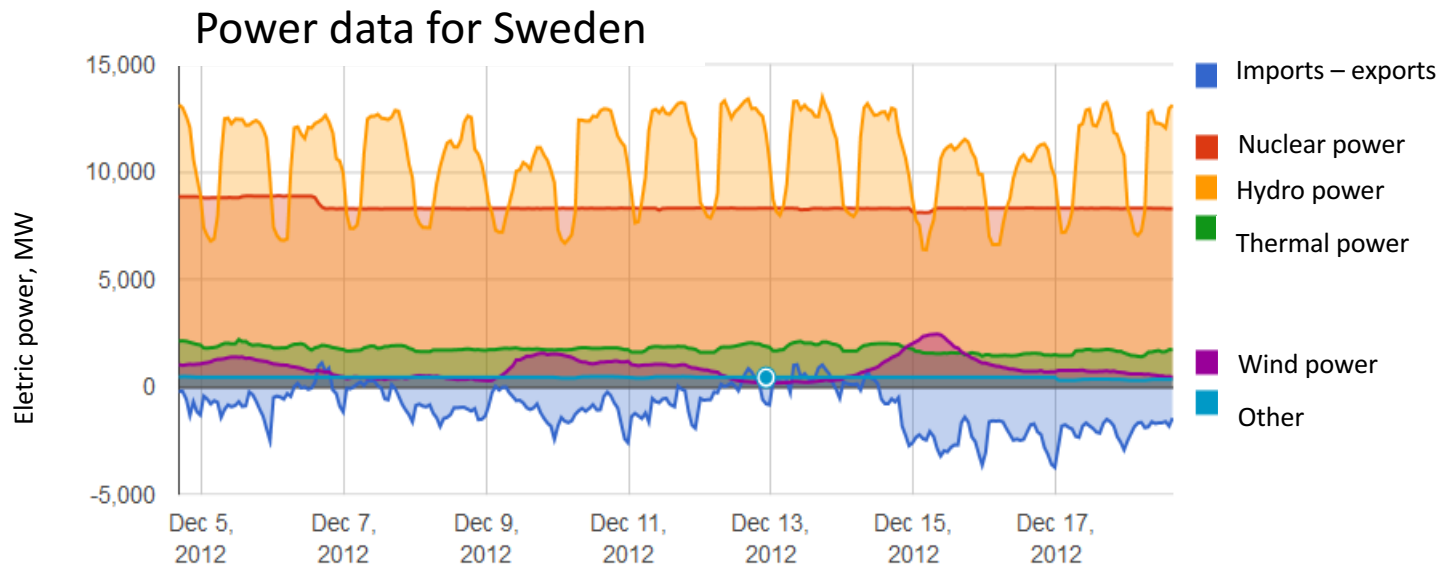
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The challenge for the power systems

- Instant balance in production and consumption is necessary
- The market has been transforming
 - Deregulation
 - Market integration, Swedish → Nordic → European
 - Technical progress (production, distribution, consumption)
 - 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

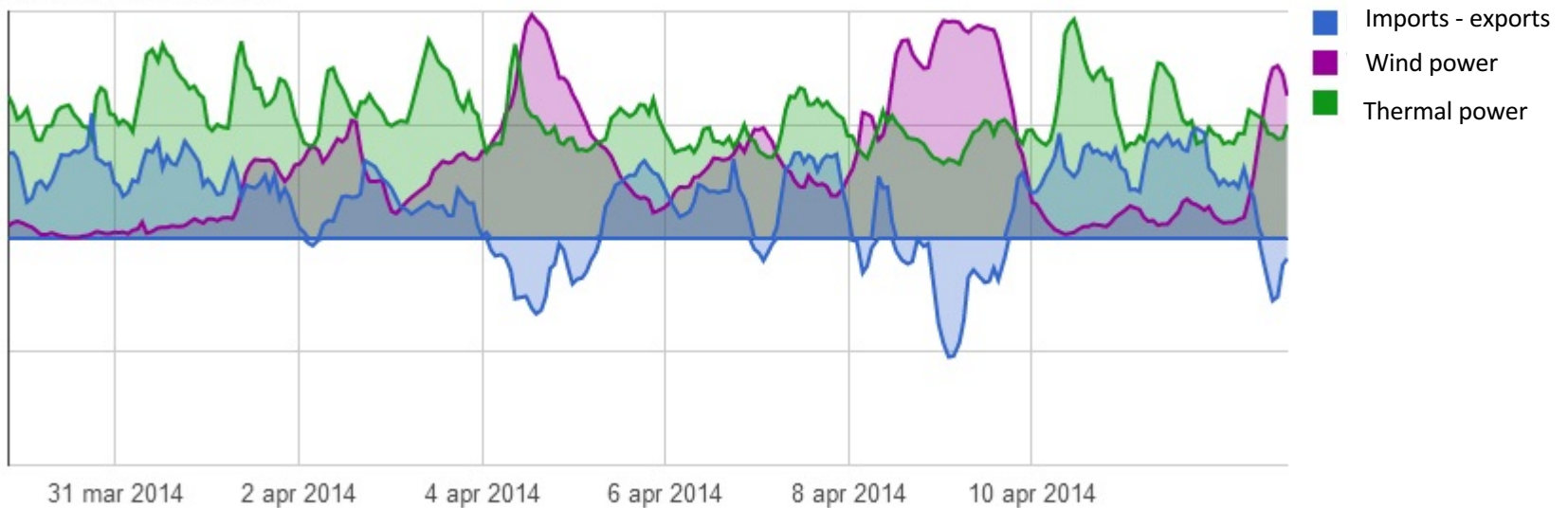
- Hydro power regulates variations in wind power
- Cold days net import is positive



Source: www.elstatistik.se

Denmark has a lot of wind power which is regulated by thermal power and hydro power from Sweden and Norway

Power data for Denmark



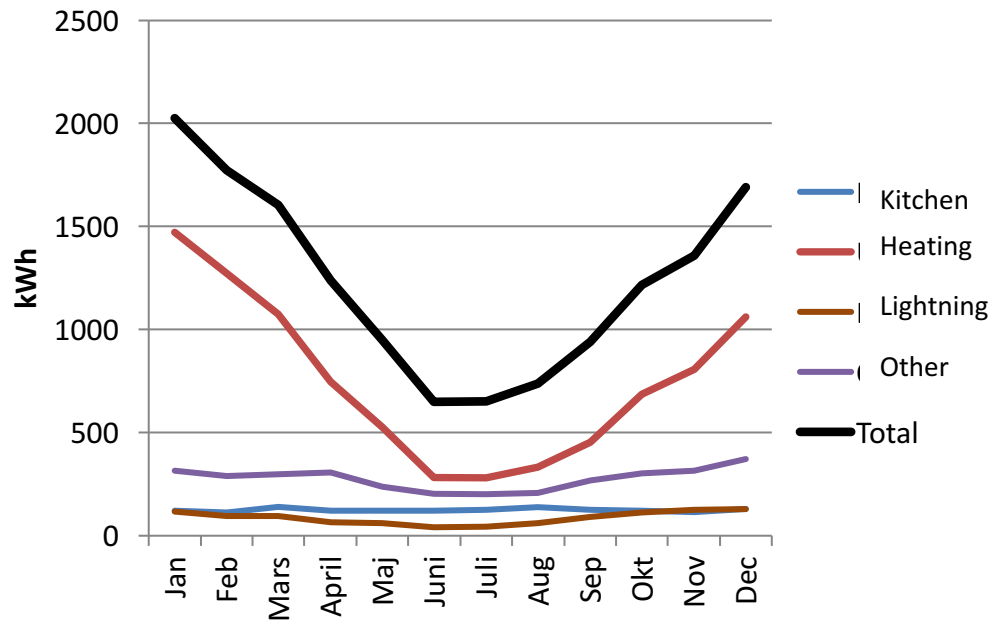
Source: www.elstatistik.se

Load shifting at the household level

Household electricity use - where and when?

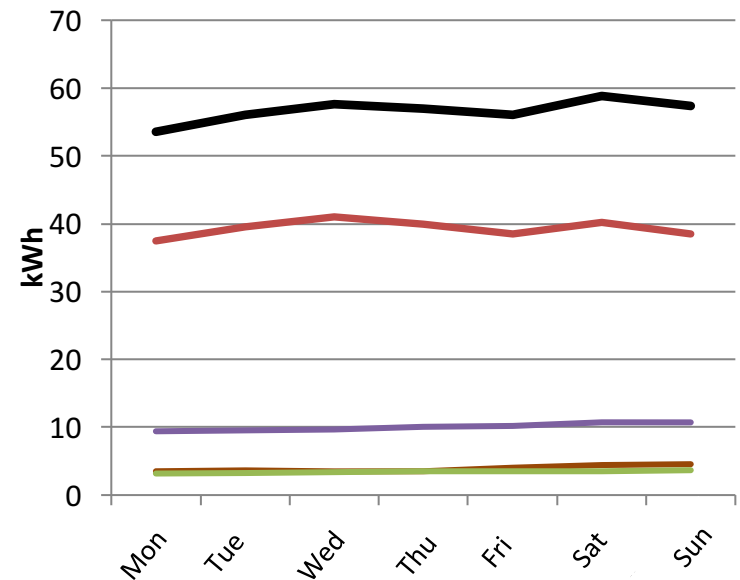
Median Swedish detached house

Electricity use per month



- High use in winter, low use in summer
- Heating dominant

Electricity use per day

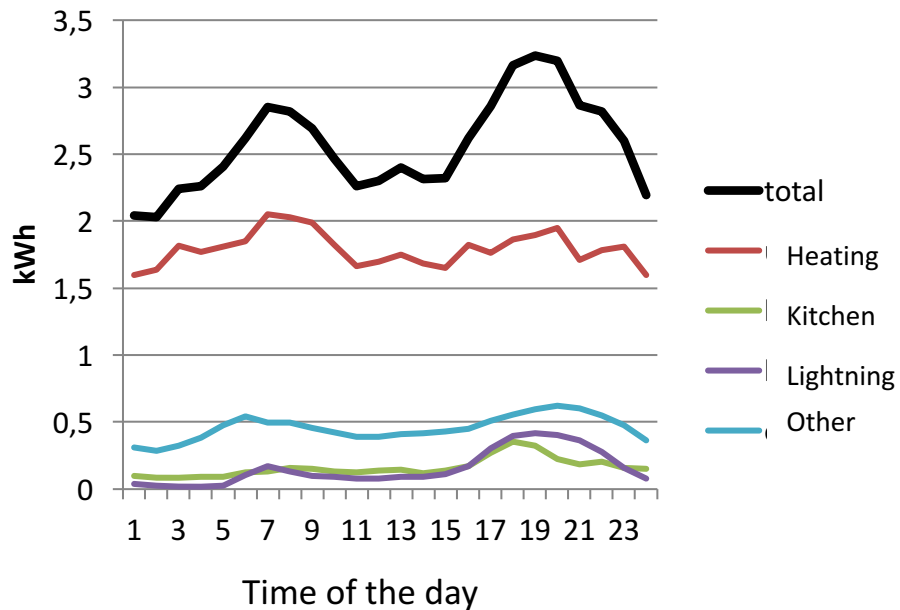


- Almost constant
- More use in weekends

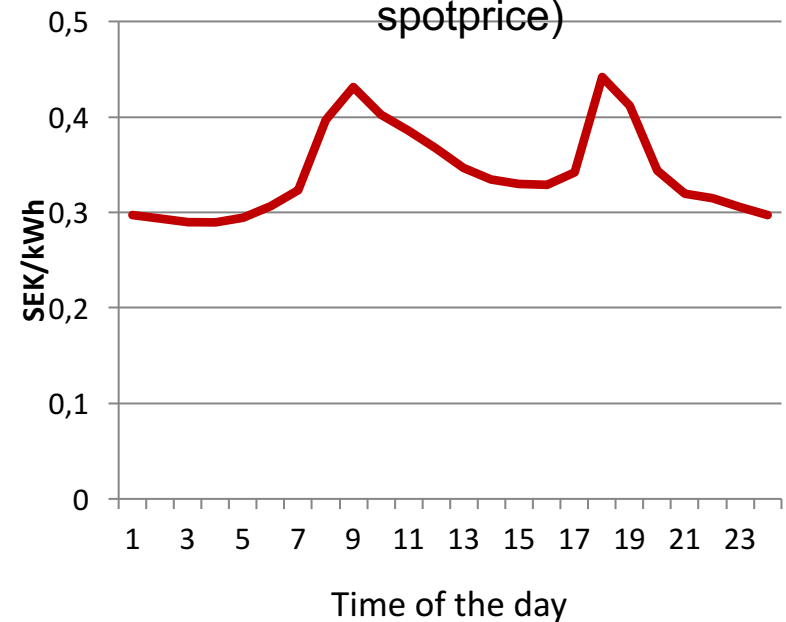
Household electricity use - where and when?

Median Swedish detached house during a weekday in February

Hourly electricity use



Hourly prices (Nordpool spotprice)



- Morning peak – evening peak

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

Incentives and context

- Real time pricing (demand response)
 - High expectations, but how flexible are consumers?
 - Very few with fully flexible contracts – many on fixed contracts
 - Swedes don't behave as “expected”
 - 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
 - Aggregators link consumers to grid operators

What's the household scenario?

Perhaps 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...

A choice experiment approach

“Demand management in real”

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

ATTRIBUTE	Levels
EXTERNAL CONTROL OF HEATING, MONDAY-FRIDAY	<p>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</p> <ul style="list-style-type: none"> • 7am to 10am • 5pm to 8pm • Never (as today)
EXTERNAL CONTROL OF DOMESTIC ELECTRICITY, MONDAY-FRIDAY	<p>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</p> <ul style="list-style-type: none"> • 7am to 10am • 5pm to 8pm • Never (as today)
EXTERNAL CONTROL IN EXTREME CASES	<p>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.</p> <ul style="list-style-type: none"> • 3 days per year • 7 days per year • 10 days per year • Never (as today)
DISTRIBUTION OF INFORMATION	<p>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.</p> <ul style="list-style-type: none"> • 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	<p>A new contract is related to an annual monetary compensation.</p> <ul style="list-style-type: none"> • 300 SEK (€33) • 750 SEK (€83) • 1500 SEK (€167) • 2500 SEK (€278)

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.

	Contract A	Contract B	Contract C – as today
External control of heating, mon - fri	5pm – 8pm	7am – 10am	No
External control of electricity use, mon - fri	7am – 10am	No	No
External control of use in extreme situations	No	Max 10 days	No
Dissemination of information	Yes	No	No
Compensation (SEK per year)	1500	750	0
MY CHOICE	[]	[]	[]

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

Variable	Sample mean	Swedish population
Proportion male	0.54	0.50
Average age	54	41
Do you know about real time (every hour) contracts?	316 (34%)	
Households w real time contract	13 (1.4%)	
Don't want real time pricing	345 (37.6%)	
"Neighbors using anonymous information about you? Yes	496 (54%)	
Type of contract:		
Variable price contract	284 (31%)	
Fixed price contract	419 (46%)	
The "no-contract"	32 (3.5%)	
Reason for fixed price?		
"Nice price"	200 (48%)	
Risk averse (volatility)	182 (43%)	

- Strong preferences for status quo (the “as today” contract)
 - 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

	Annual compensation
<ul style="list-style-type: none"> External control of heating 7-10 am External control of heating 5-8 pm 	Not sign. €71
<ul style="list-style-type: none"> External control of household electricity 7-10 am External control of household electricity 5-8 pm 	€93 €156
<ul style="list-style-type: none"> External control in extreme cases, 0, 3, 7 or 10 days of preparedness 	€5 / day
<ul style="list-style-type: none"> Distribution of information (for peer comparisons) 	€27
Just to consider <i>any</i> restriction in energy use <ul style="list-style-type: none"> People require 	€310

- 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 €233 - €543 per year
- €0.6 - €1.5 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 €93 – €403 per year

→ €0.25 - €1.1 per day

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

Heat, 7-10am*Adults	(-)	Dom. el., 5-8pm*Age	-
Heat, 7-10am*Children	(-)	Dom. el., 5-8pm*Apartment	(+)
Heat, 5-8pm*Household income	+	Ext. occ.*Household income	+
Heat, 5-8pm*Adults	-	Ext. occ. *Apartment	(+)
Heat, 5-8pm*Electric heating	(+)	Information*Age	+
Heat, 5-8pm*High indoor temp	+	Information*Adults	+
Dom. el., 7-10am*Age	-	Information*Apartment	+
Dom. el., 7-10am*Male	-	Information*Electric heating	(+)
Dom. el., 7-10am*Home, 7-10am	+		

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

Conclusions

- A large compensation is needed, (compared 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

Discussion...

- Variations in climate over the year, and the way we live, impose very strong restrictions concerning our electricity use pattern
- The cost for electricity is a small share of total expenditures (income)
- Very strong incentives are needed to change behavior

The next step...

- Partial restrictions in electricity use
- Household appliances during dinner time and in the early evening (recall load curves)
- Shorter (variable) time of restrictions (micro-restrictions)
- Environmental framing

- Given
 - Weekdays
 - December – February
 - Restrictions centered around the evening peak (6.15pm)
 - Short to semi-short durations
 - Household appliances

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

	Contract A	Contract B	Contract C – as today
Max load	3500 Watt	2000 Watt	As today
Choice of appl.	Flexible	Predetermined	As today
Time	5.45pm-6.15pm	5pm-7pm	-
Number of days December - Mars	30 days	10 days	-
Compensation (SEK per year)	1 200	300	-
My choice	[]	[]	[]

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Thanks!

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