CERE

# Peak load habits for sale?

## Soft load control and consumer preferences on the electricity market

Lars Persson

Centre for Environmental and Resource Economics
Umeå School of Business and Economics

”Evolving the market – matching future needs”
November 23, 2017

SLU

UMEÅ UNIVERSITET

CERE

# General observations

- Deregulation and integration of electricity markets
- Energy- and environmental policy shifts
  - CO2 taxes; Certificates; Nuclear phase out; Capacity reserves
- Production mix
  - Intermittent and stochastic generation
- Potential lack of peak capacity
  - Potentially high prices
  - Risk of supply insecurity

CERE …

- Increased interest in demand response
- Households potentially more flexible than industry
- Digitalization and ICT
- Automatic response or behavioral changes?
  - Heating system – automatic
  - Appliance level – behavioral changes

CERE

# Focus on demand management and...

- Peak load hours
- Full vs partial disruptions
- Long vs short durations
- Frequency
- Choice of appliances/flexibility
- Green framing
- VoPLL
- VoLL

CERE

# The questionnaire

- Appliance level habits during peak load hours
- Focus on high-power appliances
- Hypothetical contracts
- Compensation offers

CERE

# Peak load habits

CERE

Considering weekdays, 4.30-7.30pm, December through February.
How often does your household use the following appliances?

4-5 days/week
2-3 days/week
0-1 days/week
Never

[16 different appliances – high power]
Stove; oven; microwave; boiler; food processor; waffle iron; iron; vacuum cleaner; dishwasher; washer machine; dryer; car heater; electric hand tools; electric sauna; etc.

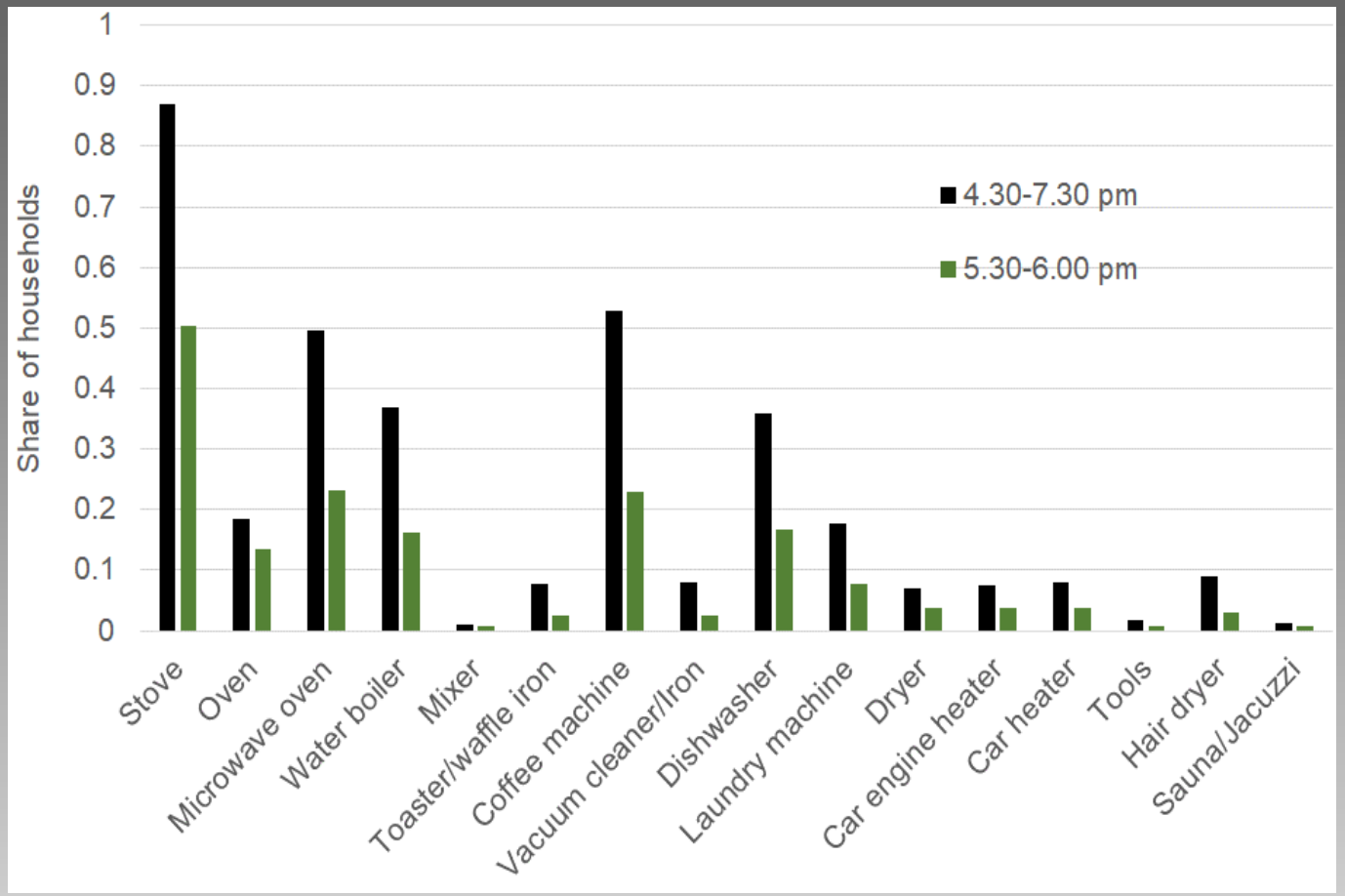
CERE

Considering weekdays, 5.30-6pm, December through February.
How often does your household use the following appliances?

4-5 days/week
2-3 days/week
0-1 days/week
Never

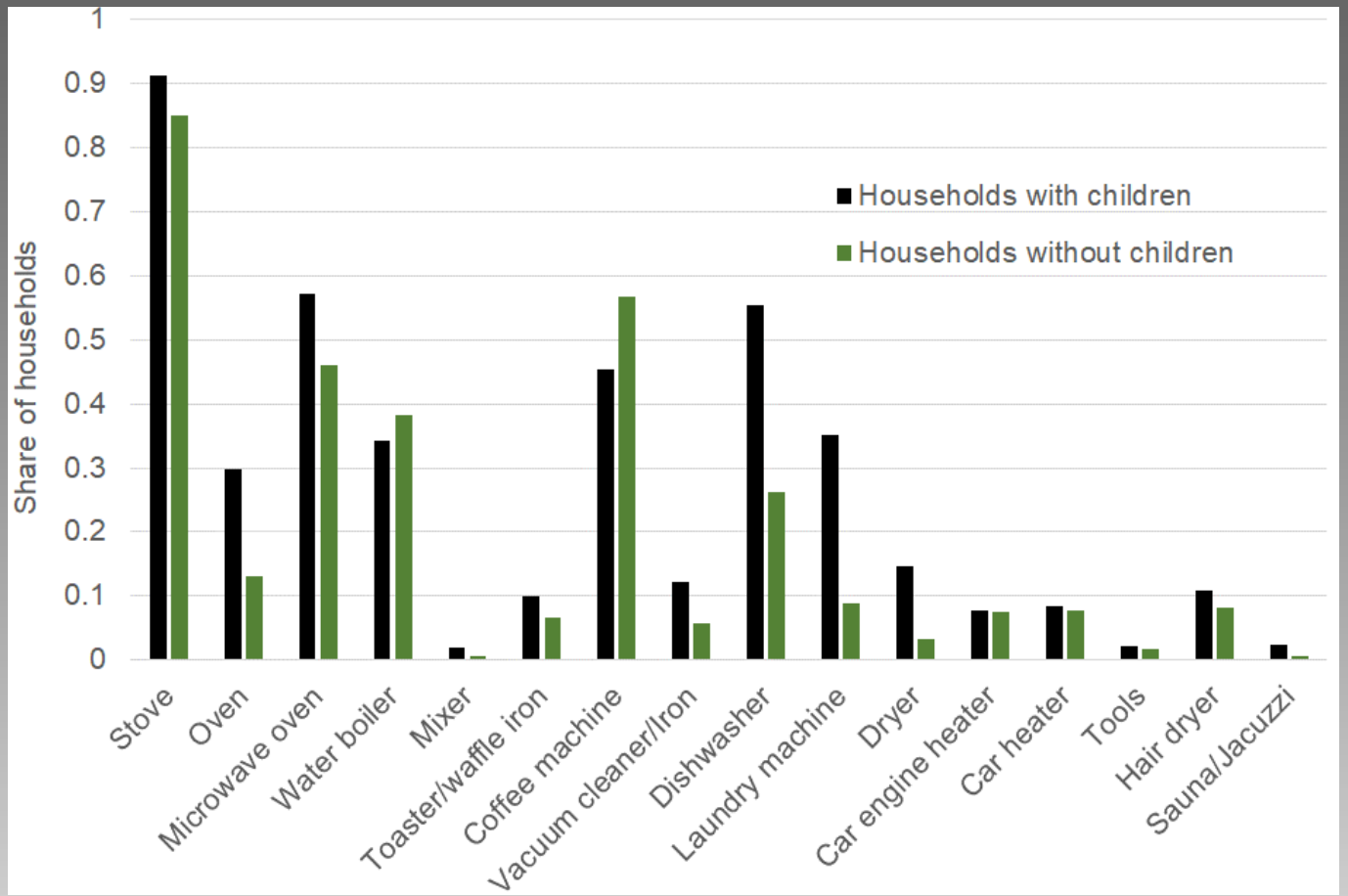
CERE

# Appliance use in winter season



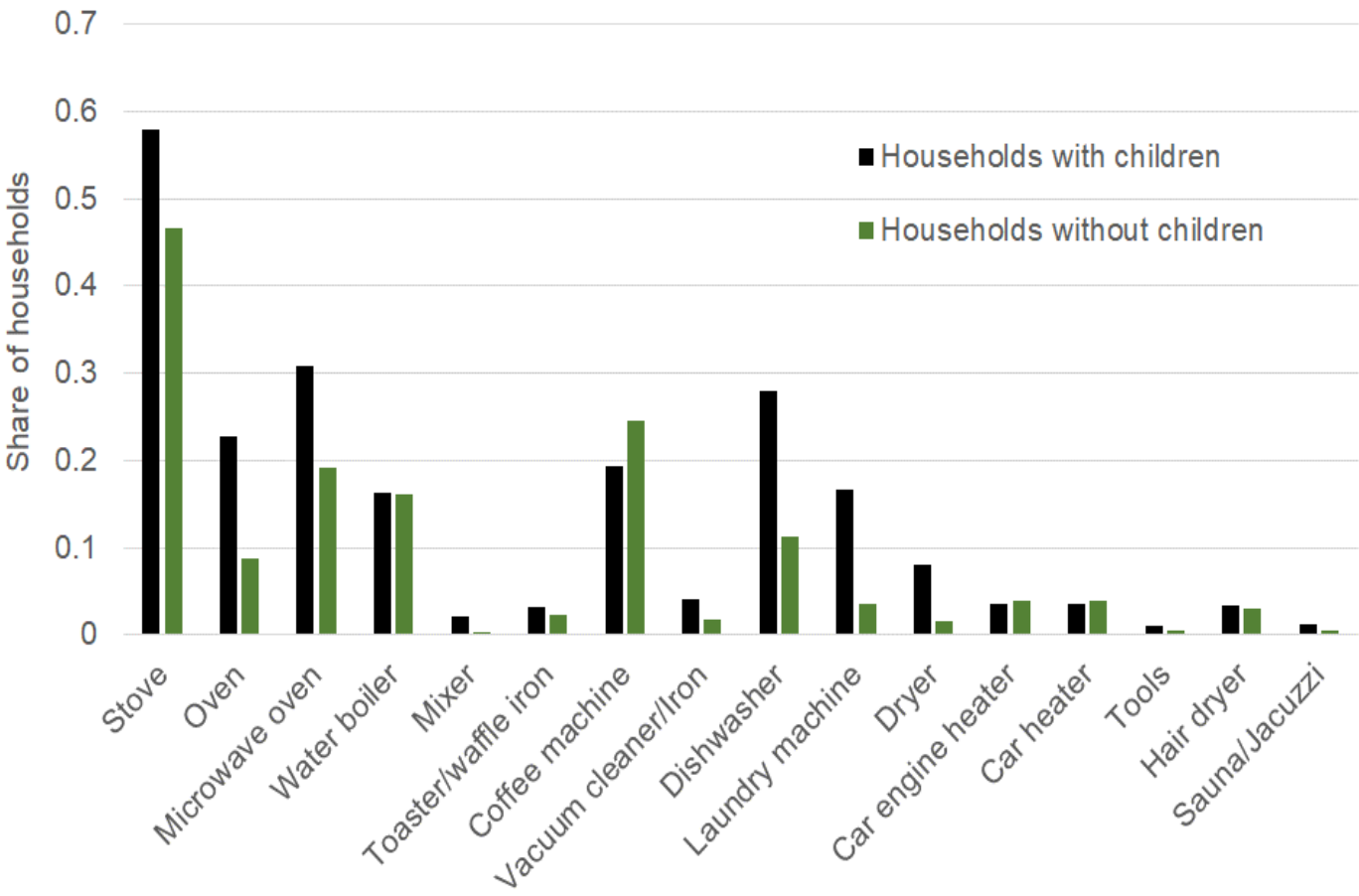
CERE

# Appliance use 4.30-7.30pm



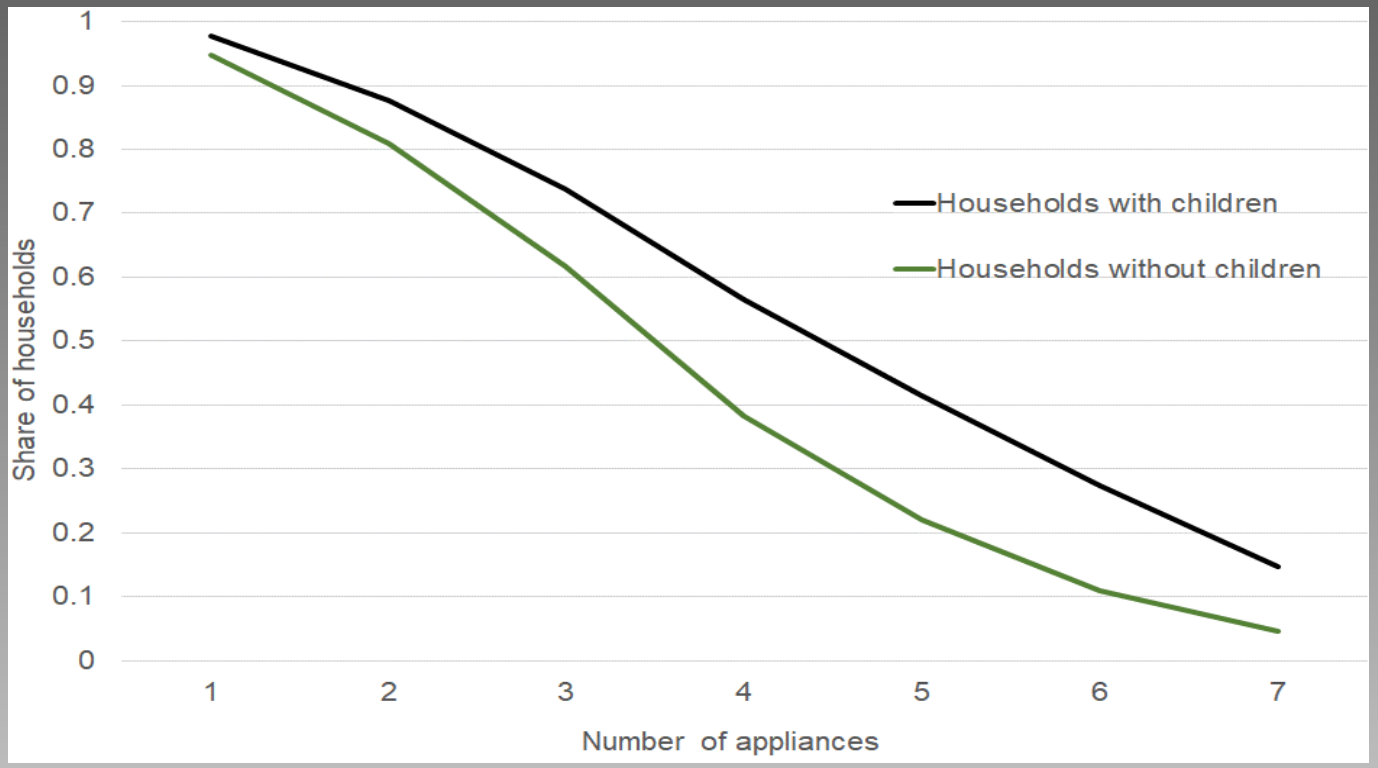
CERE

# Appliance use 5.30-6pm



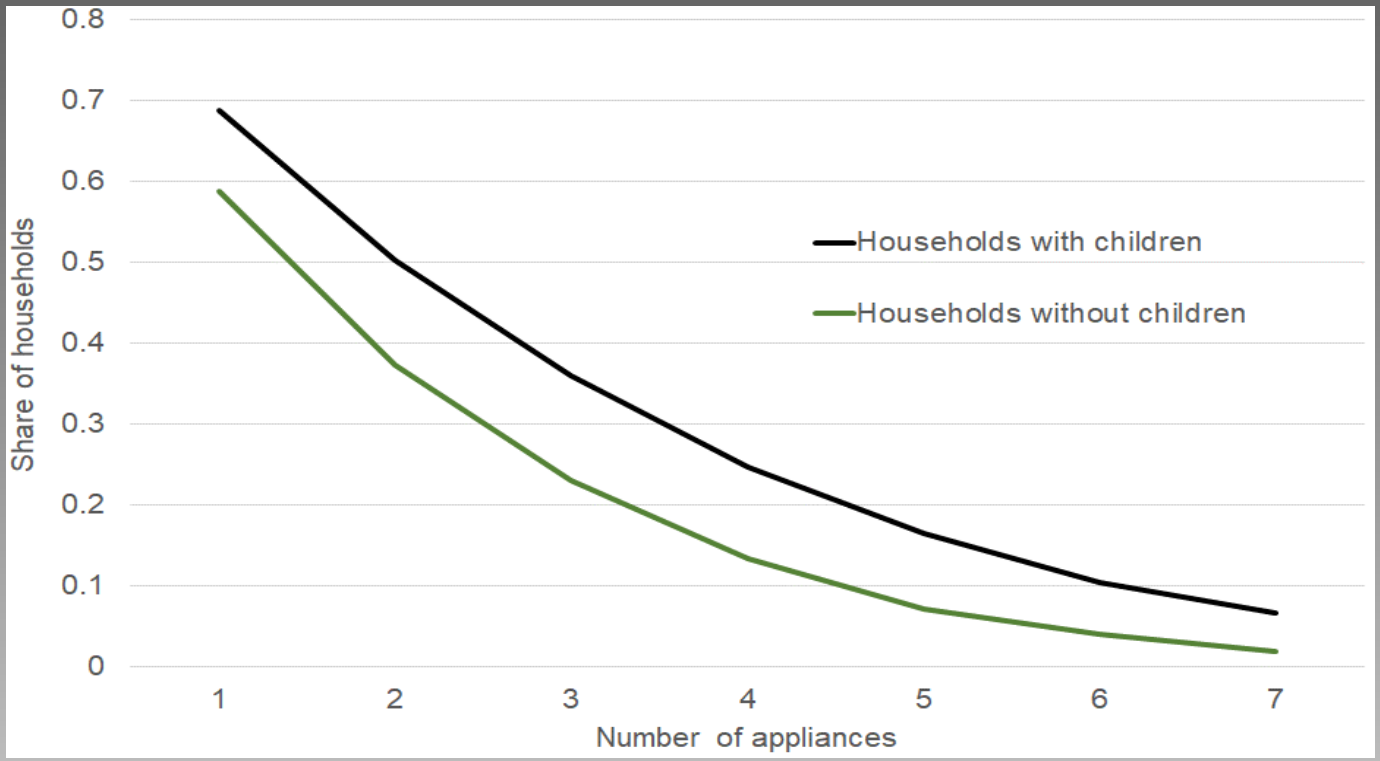
CERE

# Number of appliances 4.30-7.30pm



CERE

# Number of appliances 5.30-6pm



CERE

# The price of peak hour habits

CERE

# Ranking of appliances

Given a restriction in your potential use of electricity corresponding to a maximum load of 5000 watt, 3500 watt and 2000 watt respectively.

Mark the appliances that you would like to use 5.30-6pm on weekdays for the respective level of maximum load.

[They had to adapt to the maximum load limits]

This will be the reference use of appliances

CERE

# Cost of soft load control

- Introduce hypothetical electricity contracts
- The choice between contracts reveal preferences
- Focus on peak hours and behavioral changes
- Partial disruptions – a discrete choice experiment approach
- Green framing

CERE …

**Contract attributes:**

- Maximum load – 5000w; 3500w; 2000w
- Choice of appliances
- Duration and timing – 5.30-6pm; 5-6.30pm; 4.30-7.30pm
- Number of days during winter season – 5; 10; 20
- Monetary compensation – SEK 300; 750; 1500; 2500

[Communicated 1 day ahead]

CERE

# Example of choice card

| Which of the following A, B or C contracts would you choose if offered to you? Unless otherwise stated in the agreement, everything else works as today, for example, the electricity price you pay and how often it changes. | | | |
|---|---|---|---|
| | Contract A | Contract B | Contract C – as today |
| Load control | 5000 watt | 3500 watt | As today |
| Choice of appliances | Pre-determined given the load | Flexible given the load | As today |
| Duration | 4.30pm-7.30pm | 5pm-6.30pm | - |
| Number of days | 5 days | 20 days | - |
| Compensation | 2500 | 750 | - |
| My choice | [ ] | [ ] | [ ] |

CERE

# Green treatment

*”By reducing the use of electricity during times of high pressure on the grid, the transition to renewables such as solar and wind is facilitated. In this way, Swedish electricity production can be fully CO2 free in the future.”*

”*The new contracts facilitate the transition to renewable energy sources*.”

CERE

# Relative to the base level contract…

| | No treatment | | Green treatment | |
|---|---|---|---|---|
| | **Point estimate** | **95% conf interval** | **Point estimate** | **95% conf interval** |
| The compensation required for a… | | | | |
| 3500 watt limit is… | (61) | (-62 – 184) | 195 | 61 – 330 |
| 2000 watt limit is… | 576 | 424 – 729 | 566 | 414 – 719 |
| The compensation required for flexible choice of appliances is… | (-69) | (-179 – 41) | (88) | (-31 – 206) |
| The compensation required for a duration of… | | | | |
| 90 minutes is… | 235 | 109 – 362 | 239 | 107 – 372 |
| 180 minutes is… | 1020 | 856 – 1185 | 1174 | 993 – 1355 |
| The compensation required for… | | | | |
| 10 days is… | 454 | 351 – 558 | 339 | 225 – 453 |
| 20 days is… | 686 | 552 – 821 | 470 | 325 – 616 |
| Compared to the status quo, the compensation for… | | | | |
| contract A is… | 1293 | 1059 – 1528 | 1217 | 990 – 1444 |
| contract B is… | 1036 | 812 – 1260 | 1048 | 827 – 1269 |

CERE

# Hypothetical scenarios

| | Neutral | Green |
|---|---|---|
| Hard control | 3671 | 3456 |
| (2000w, 180min, 20days) | (3323 – 4019) | (3101 – 3810) |
| Hard but short | 2262 | 1959 |
| (2000w, 30min, 20days) | (2018 – 2506) | (1717 – 2202) |
| Hard load only | 1603 | 1543 |
| (2000w, 30min, 5days) | (1364 – 1843) | (1307 – 1778) |
| Soft but often | 2074 | 1832 |
| (5000w, 30min, 20days) | (1837 – 2311) | (1597 – 2066) |

These results can be translated such that:
The value attached to unrestricted use of high-power appliances is about SEK 20-40 per kWh.

CERE

# Cost of black-out in peak load hour

- Full power outage on weekdays at 5.30-6pm
- Five times per winter season
- Green framing

CERE

Required compensation to accept a 30 minutes power outage in the peak hour, five times during the winter period?

Separate bids ranging from SEK 100 to 4000

[Definitely yes – to definitely no]

CERE

# Results

- About 50% turned down the highest bid
- No green framing effect
- Need assumption about the right side tail of the distribution
- Lower bound and extrapolation of existing pattern
- SEK 3000 – 4600

CERE

# Concluding remarks

- VoPLL: SEK 20 – 40 per kWh
- VoLL: SEK 400 – 600 per kWh
- Demand response through behavioral changes is expensive
- Both direct value and option value
- Automatization a better way
- Value of secure access to electricity is much higher than the marginal cost of providing electricity
- Is this what it takes?