

Results from Demand Response demonstration project in households

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DEMONSTRATION PROJECT

Participants

- Supported with research funds from Danish TSO: Energinet.dk
- Participating companies:
 - Danish Energy Industries Federation
 - Part of the Confederation of Danish Industries
 - Siemens
 - Danfoss
 - SydEnergi (utility: 300,000 customers)
 - SEAS/NVE (utility: 380,000 customers)
 - Ea Energy Analysis
- Single family houses with electric heating
 - 593 houses in six groups
 - Average consumption: 18,400 kWh/year

Data

- Groups
 - Automatic control (2 groups)
 - With automatic price control: 13-31
 - With automatic price control disconnected: 17-35
 - E-mail, SMS (2 groups): 171
 - Special display (Electronic Housekeeper): 20
 - Control group: 354
- Standard spot price in active groups
 - Standard, fixed price to control group
- Hourly data per house
 - From 1. May 2007
 - Here: From 1. October 2007 (1,7 million observations)

PRICING

Pricing

Standard: Yearly meter reading and profiling

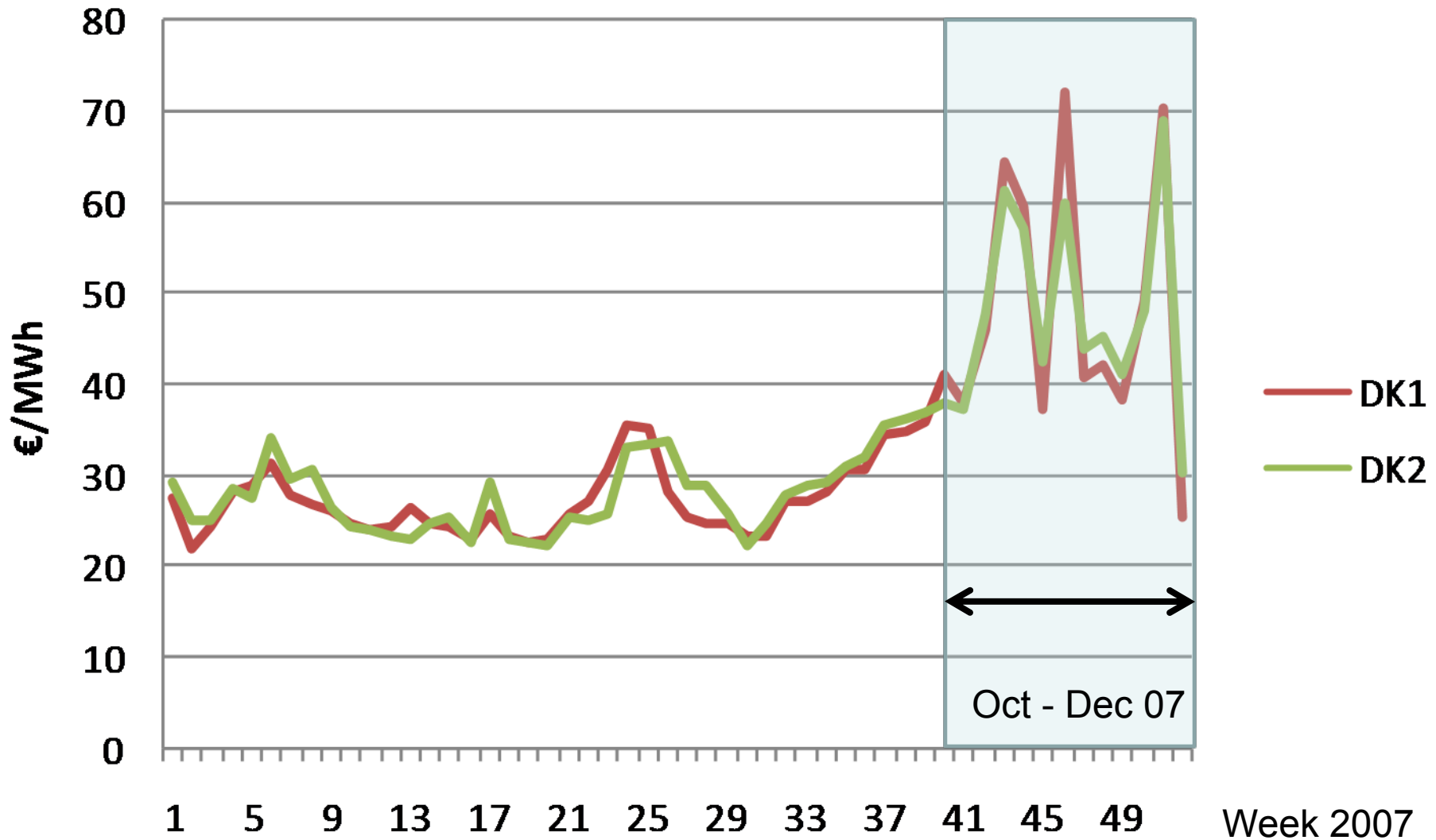
- Financial contract entered each quarter
- Profiling
 - Average of all customers without interval meter

The tested alternative: Interval meter and spot price

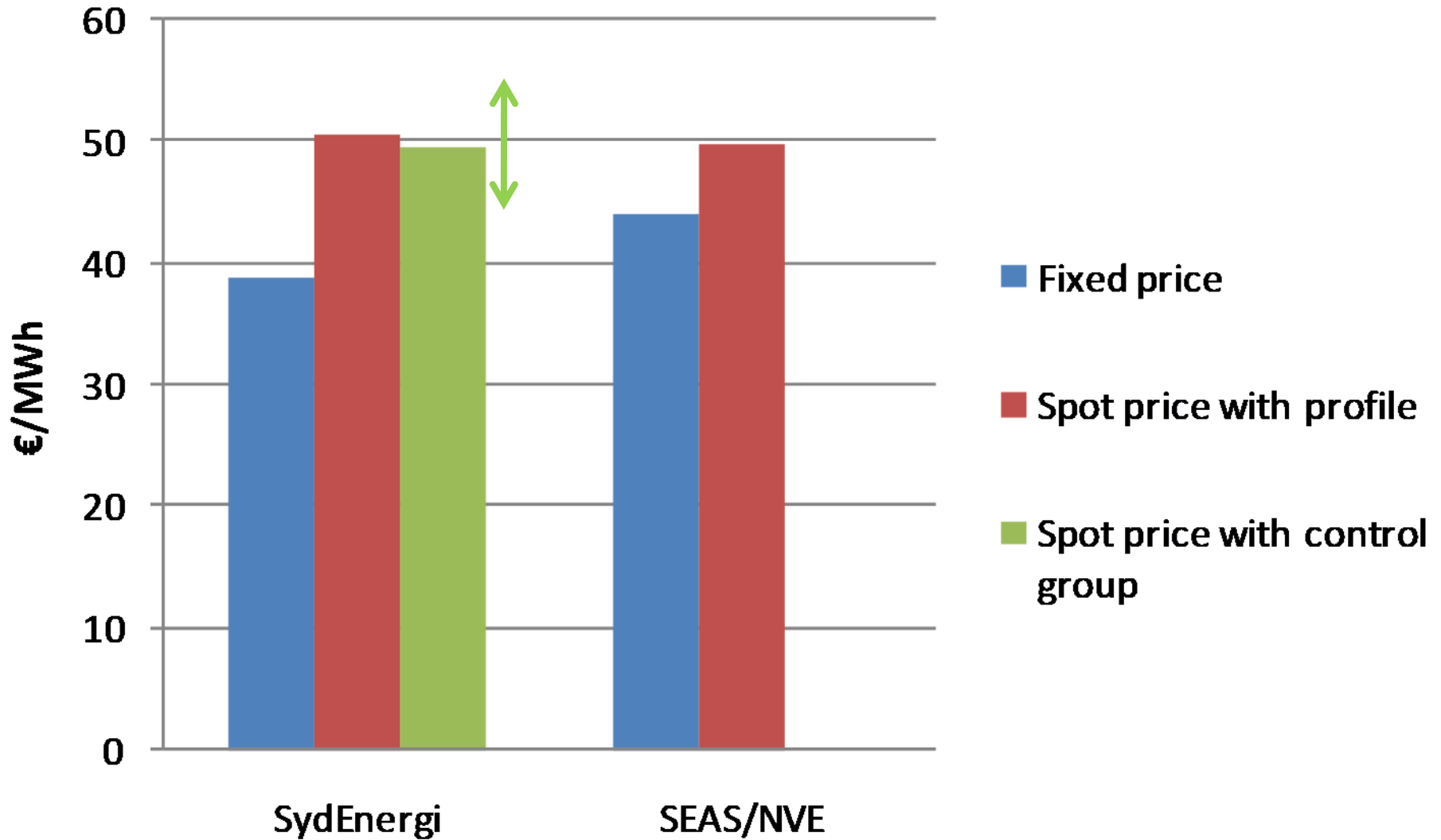
- No financial contract +/-
- Metered values +/-
- Demand response +

Spot price: 0-1.35 €/kWh (average 0.05 €/kWh)
Tariffs and taxes as usual ~ 0.15 €/kWh
Total: 0.15-1.5 €/kWh (average 0.20 €/kWh)

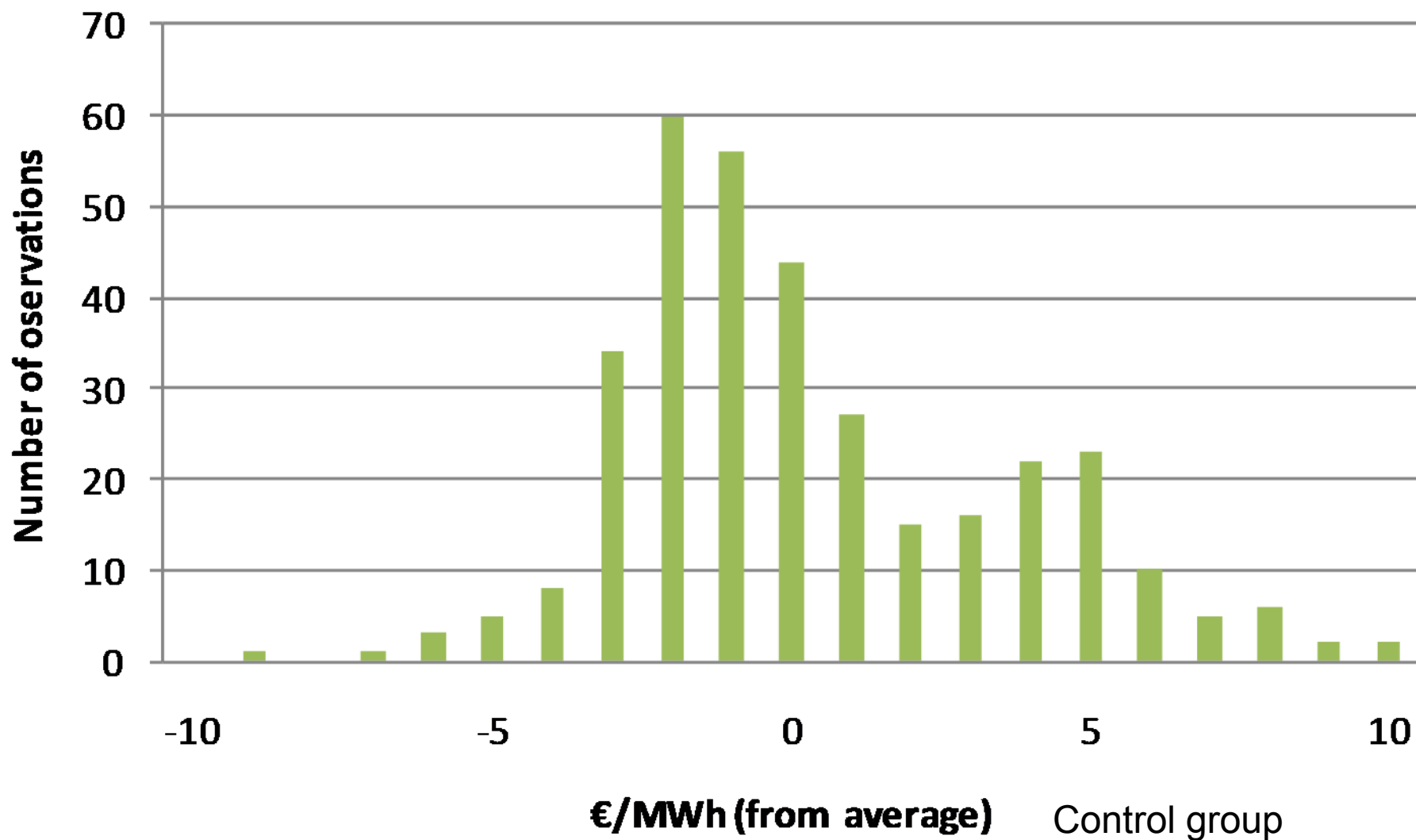
Spot price development



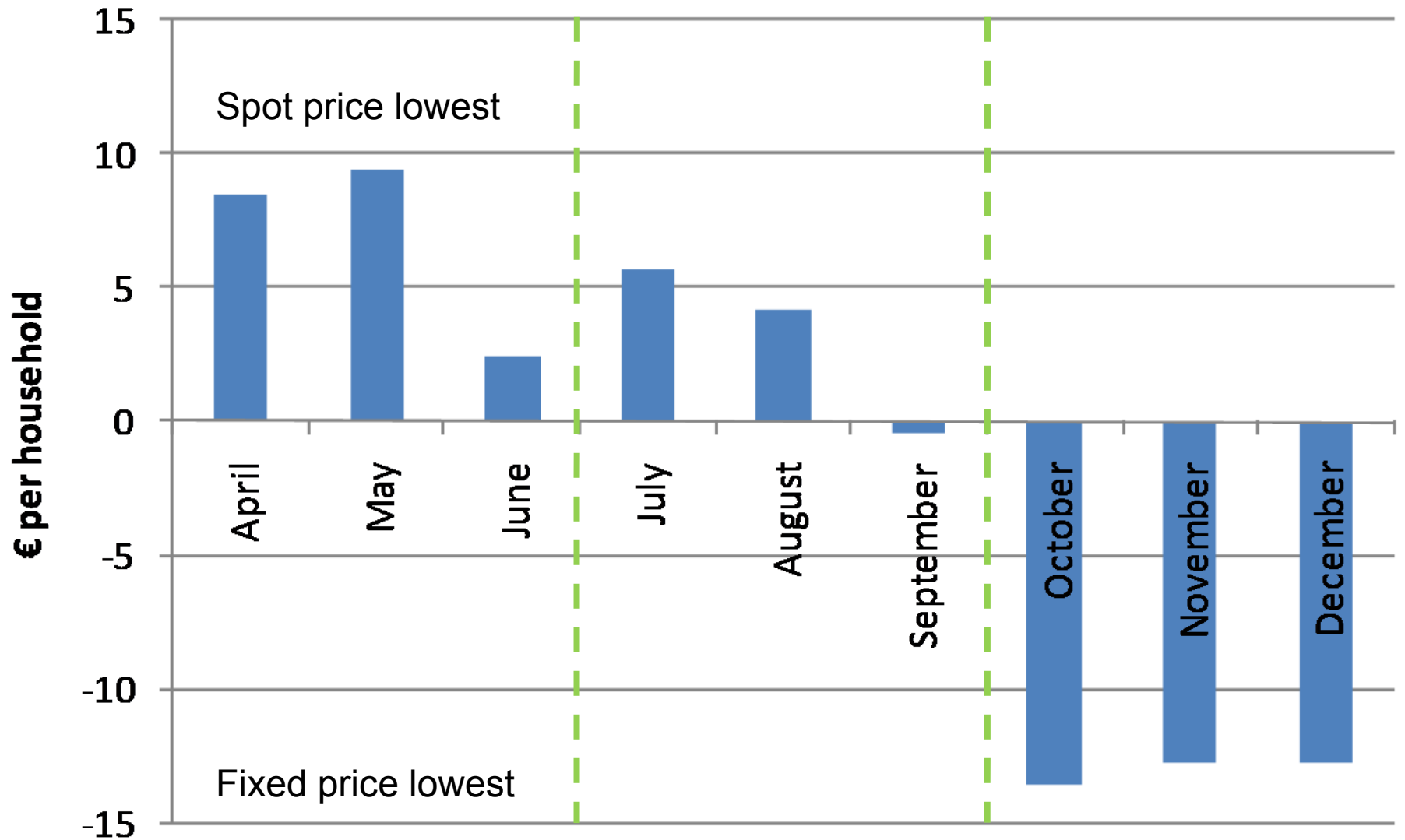
Prices



Variation in average price due to load profile

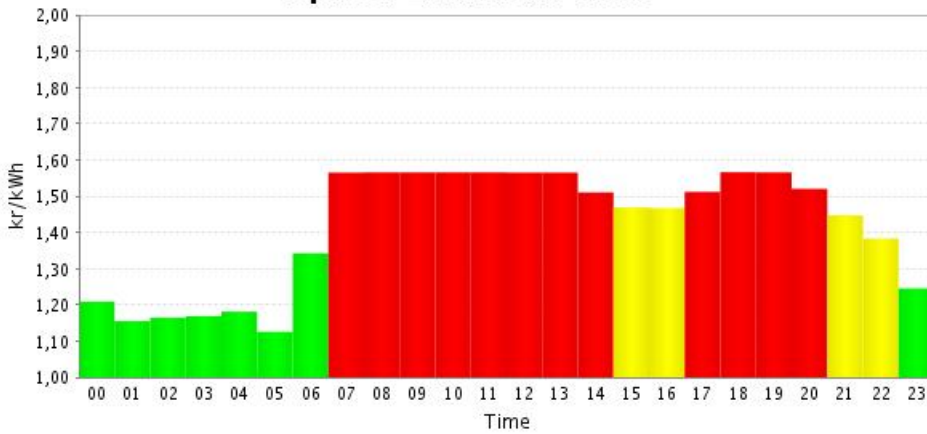


Spot price vs. Fixed price

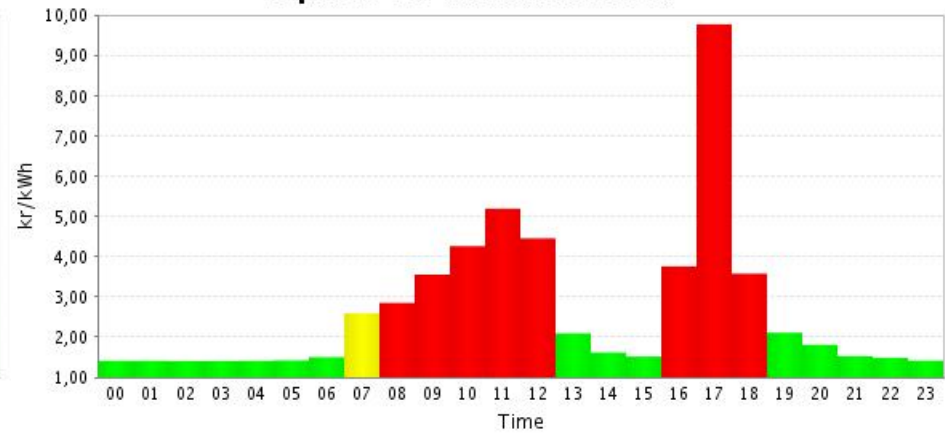


The colour of a spot price...

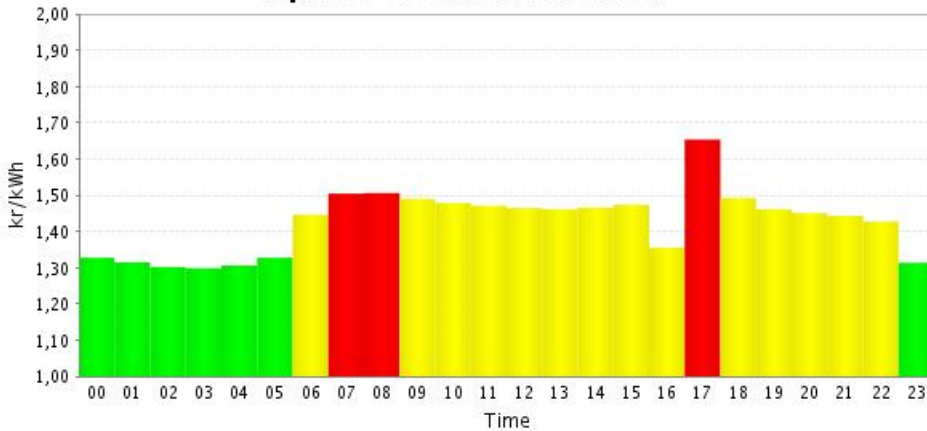
Elpriser 25 februar 2008



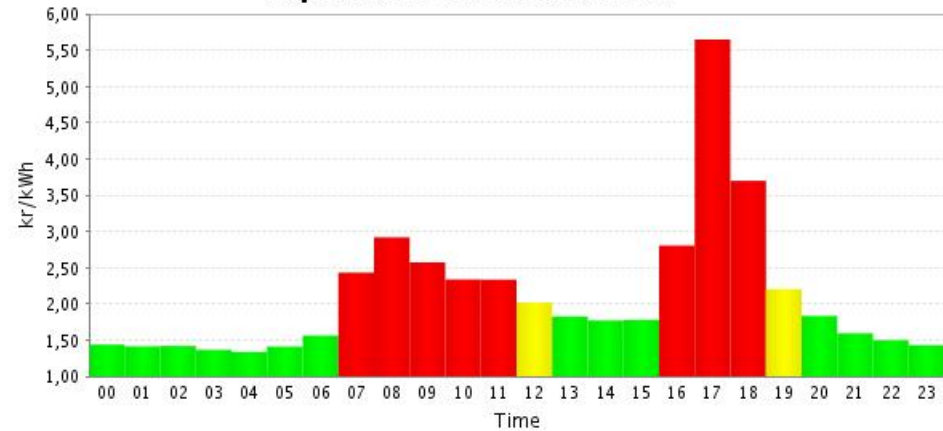
Elpriser 15 november 2007



Elpriser 28 november 2007



Elpriser 20 december 2007



Three colours

- A spot price can be difficult to communicate
 - Any value is possible
- In this project we have tested a simplified way:
 - Green = Less than 5% below daily average
 - Yellow
 - Red = More than 5% above daily average

Automatic price control

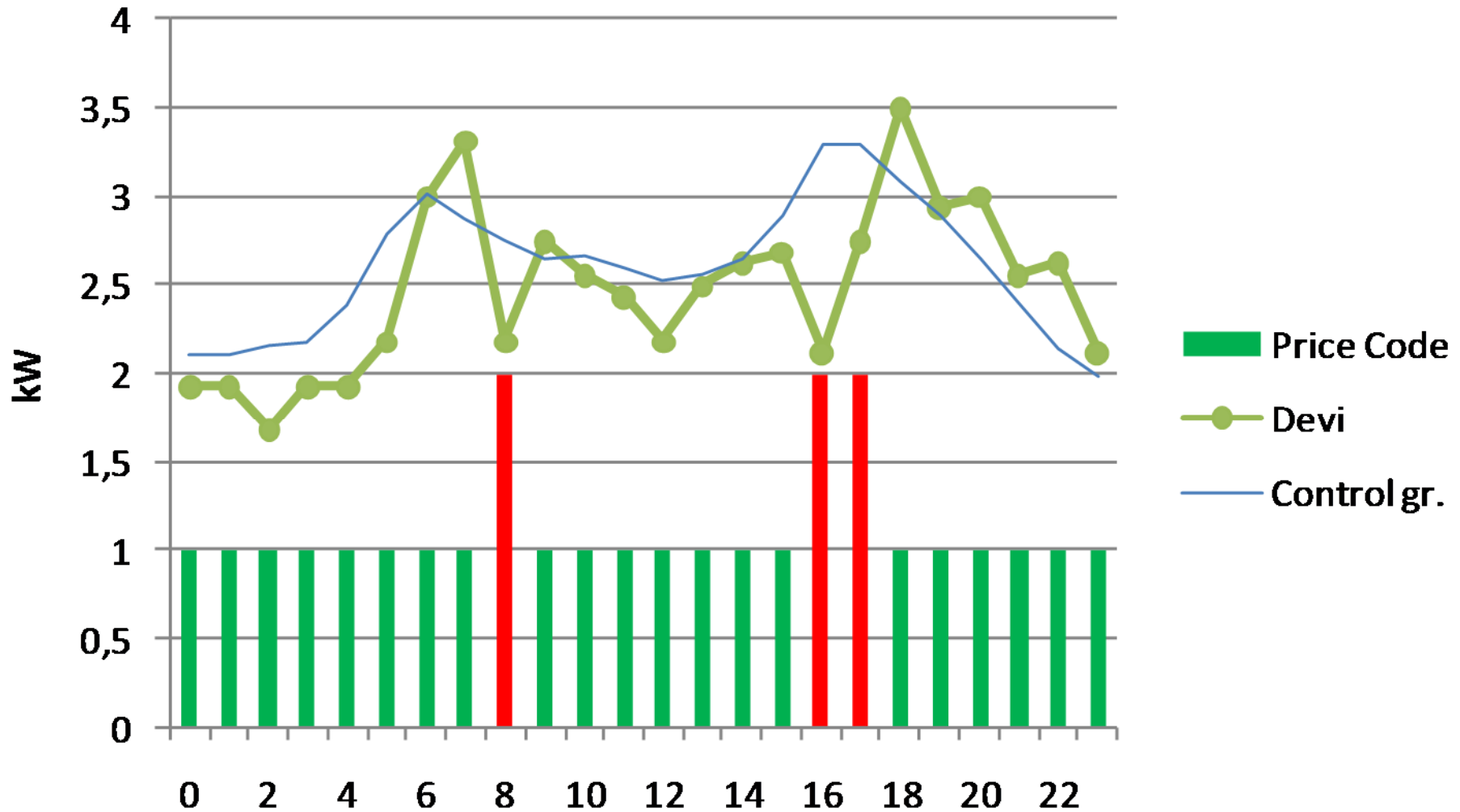
- Simple user interface
- Red price
 - Reduction of temperature set point on electric heating
 - E.g. -1°C , -2°C , -3°C
- Yellow price
 - Do nothing
 - Change set point
- Green price
 - Increase of temperature set point in the last green hour
 - E.g. $+1^{\circ}\text{C}$, $+2^{\circ}\text{C}$, $+3^{\circ}\text{C}$

Water heaters

- Red price
 - Disconnect for max duration
 - E.g. 1 hour, 2 hours, 3 hours
- Yellow price
 - E.g. 0 hour, 1 hour
- Green price
 - Do nothing

EFFECT OF PRICE CONTROL

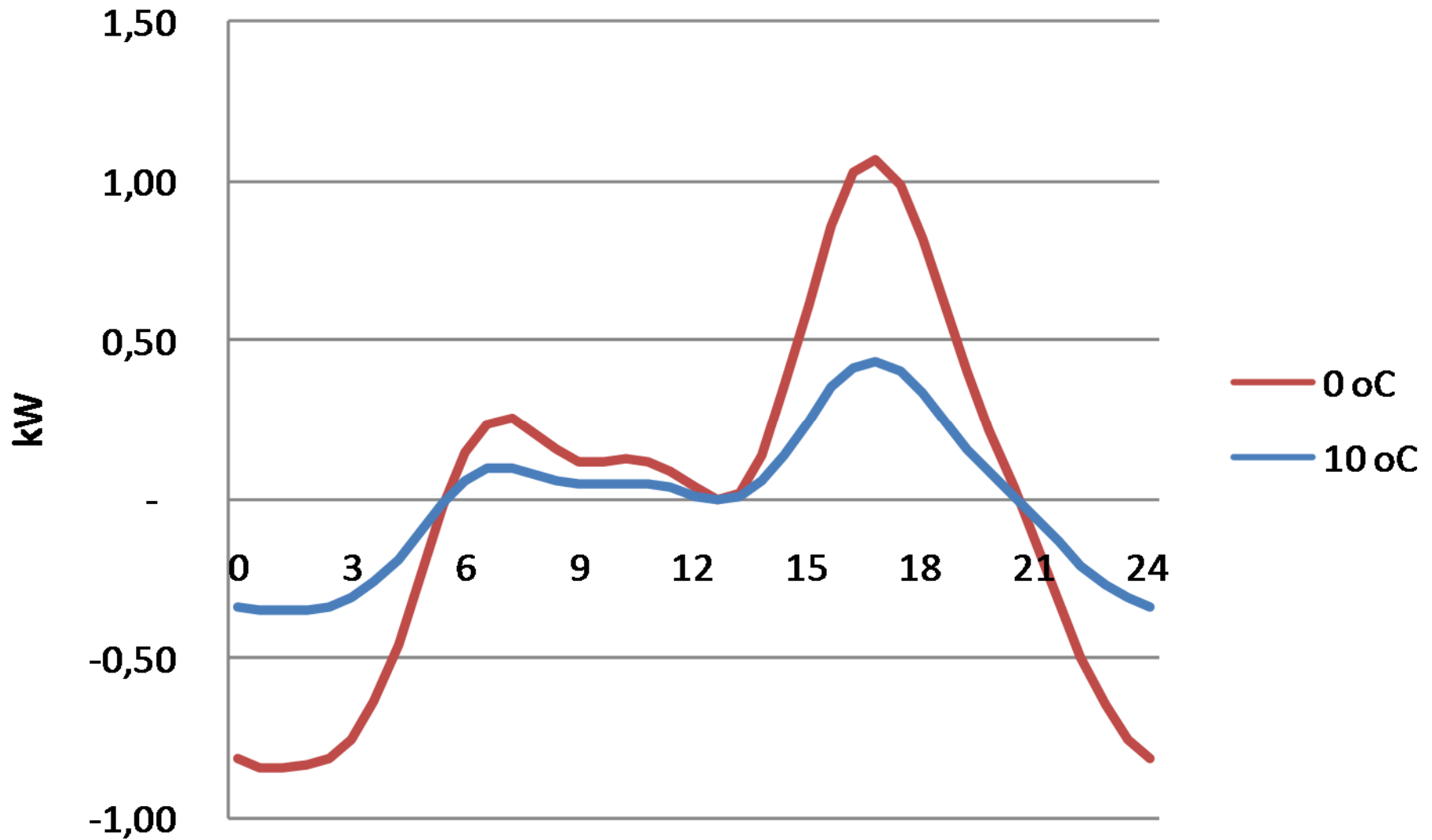
15. November 2007 (+1°C)



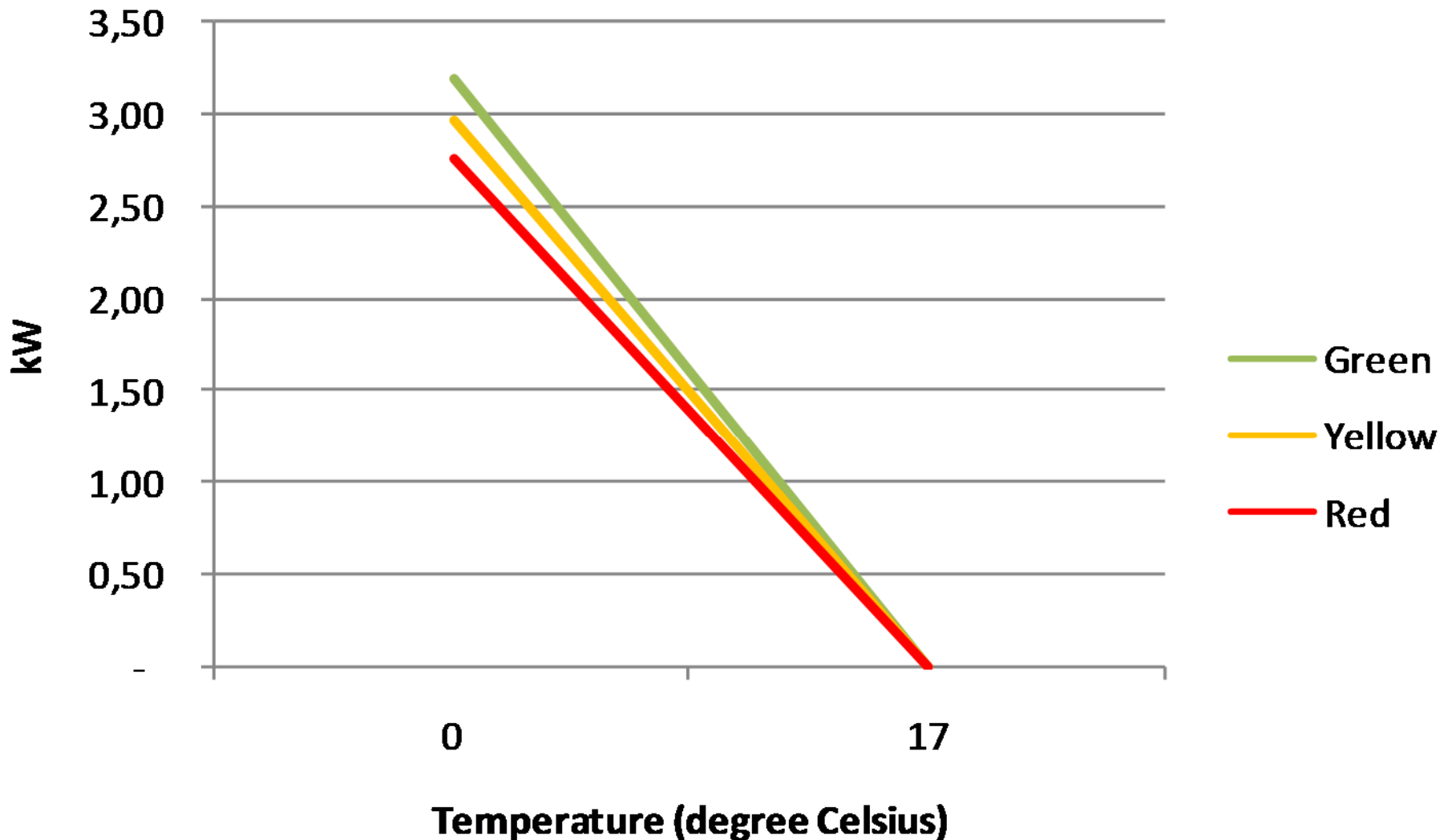
Fixed effect regression analysis

- Demand =
+ Constant_i
+ [$\alpha_{j,k}$ * GroupPrice_{j,k} + Fourier(Time of day)] *
DegreeDays
- i : 1..593 houses
- j : 1..6 groups
- k: 1..3 price intervals (green, yellow, red)

Fourier – Time of day



Impact of price for group with automatic price control



Effect

- Demand response:
 - With automatic price control
 - 430 W (at 0°C)
 - 32-43 € per year (@20,000 kWh/year)
 - No significant results for SMS and e-mail
- Profiling
 - +/- 50 €
- Financial contracts
 - +/- 50 €

Next steps

- Continue data collection so colder days can be included
 - Lowest temperature in current data set: -1.4°C
- Simplified installation has led to comfort problems and less ambitious set-points
 - In some cases only one thermostat (with communication) was used per house
 - All thermostats with communication
- If all tariff elements were dynamic, the incentive for demand response would increase