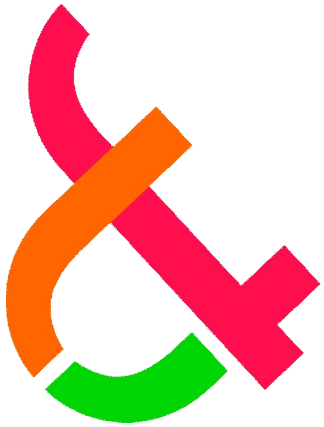


LUT
Lappeenranta
University of Technology

Demand response in the Finnish retail electricity market

Salla Annala, LUT

Stockholm, 24 Nov 2015

Contents

- Structure of Finnish retail electricity market and retail tariffs
- Market places for demand response in Finland
- Results from three DR questionnaires (retailers, DSOs, residential consumers)

Background

- ~70 retail suppliers
- ~80 DSOs
- All customers have been able to switch supplier free of charge since 1998
- No retail price regulation at any point after market opening
- About 10 % of customers switched supplier in 2014
- Government decree (66/2009) requires that at least 80 % of consumption places within a DSO's are have smart meters (remote reading, hourly consumption, execution of load control commands)
  - Over 90 % of consumers equipped with smart meters
  - Balance settlement is based on measured hourly consumption
  - About 1800 MW of electric heating load can be controlled via smart meters (~1000 MW by time-based relay, ~800 MW load reduction control relay, see Honkapuro et al. 2015b)
- (Peak demand in Finland in 2014 14.2 GW)

Retail contracts

- Commonly offered contract types
  - Flat
  - Time of use, TOU (day/night, winter weekday/other time), introduced in the early 1970s
    - Penetration in 2012 ~17 % of residential customers (see Ariu et al. 2012)
  - Spot (hourly prices)
  - Other indexed contracts (e.g. based on financial contracts of Nasdaq OMX Commodities)
- DSO tariffs typically flat or TOU

Market places for demand response

Market place	Amount of demand response in the Finnish market in 2015	Activation time	Minimum size
Elspot	200 – 600 MW (estimated)		
Balancing power market	100 – 300 MW (estimated)	15 min	10 MW
Strategic reserves (Energy Authority)	10 MW	10 minutes	10 MW

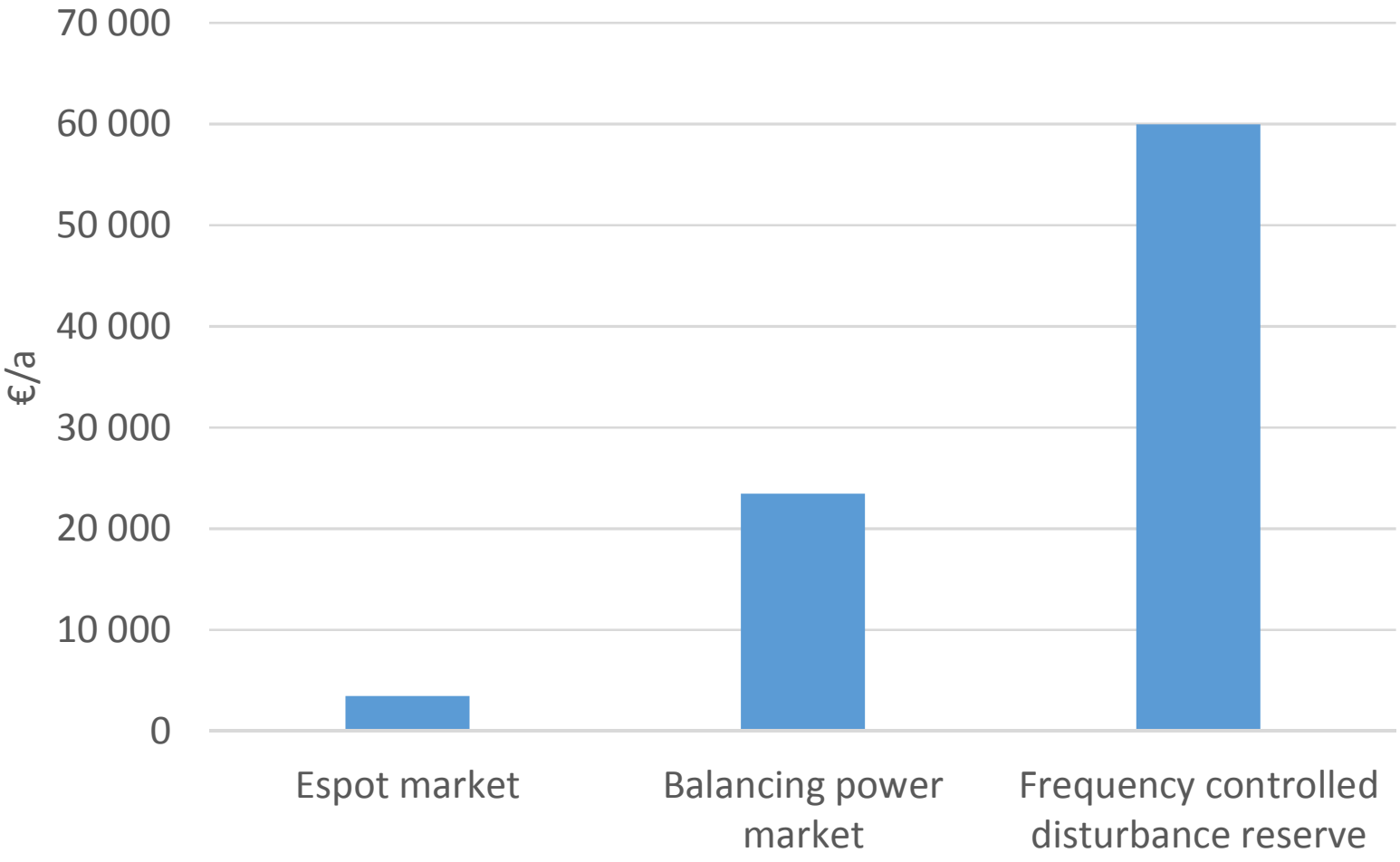
Sources: Fingrid and Energy Authority

Market places for demand response: Fingrid reserve market

Source: Fingrid

	Type of contract	Reserve obligations for Finland in 2015	Amount of demand response in the Finnish market in 2015	Activation time	Minimum size
Frequency Containment Reserve for Normal operation	Yearly and hourly markets	~ 140 MW		3 minutes	0.1 MW
Frequency controlled disturbance reserve	Yearly and hourly markets Long-term contracts	~ 260 MW	70 MW	5s/50%, 30s/100% when f < 49.9 Hz or 30s when f < 49.7 Hz and 5 s when f < 49.5 Hz (long-term contracts: instantly when f < 49.5 Hz)	1 MW (long-term contracts 10 MW)
Automatic Frequency Restoration Reserve	Hourly market	~ 70 MW		Must begin within 30s, fully activated in 2 minutes	5 MW
Fast disturbance reserve	Long-term contract	~ 880 MW	354 MW	15 minutes	10 MW

Simulated economic potential for control of electric heating loads (1 388 customers, 1 year)

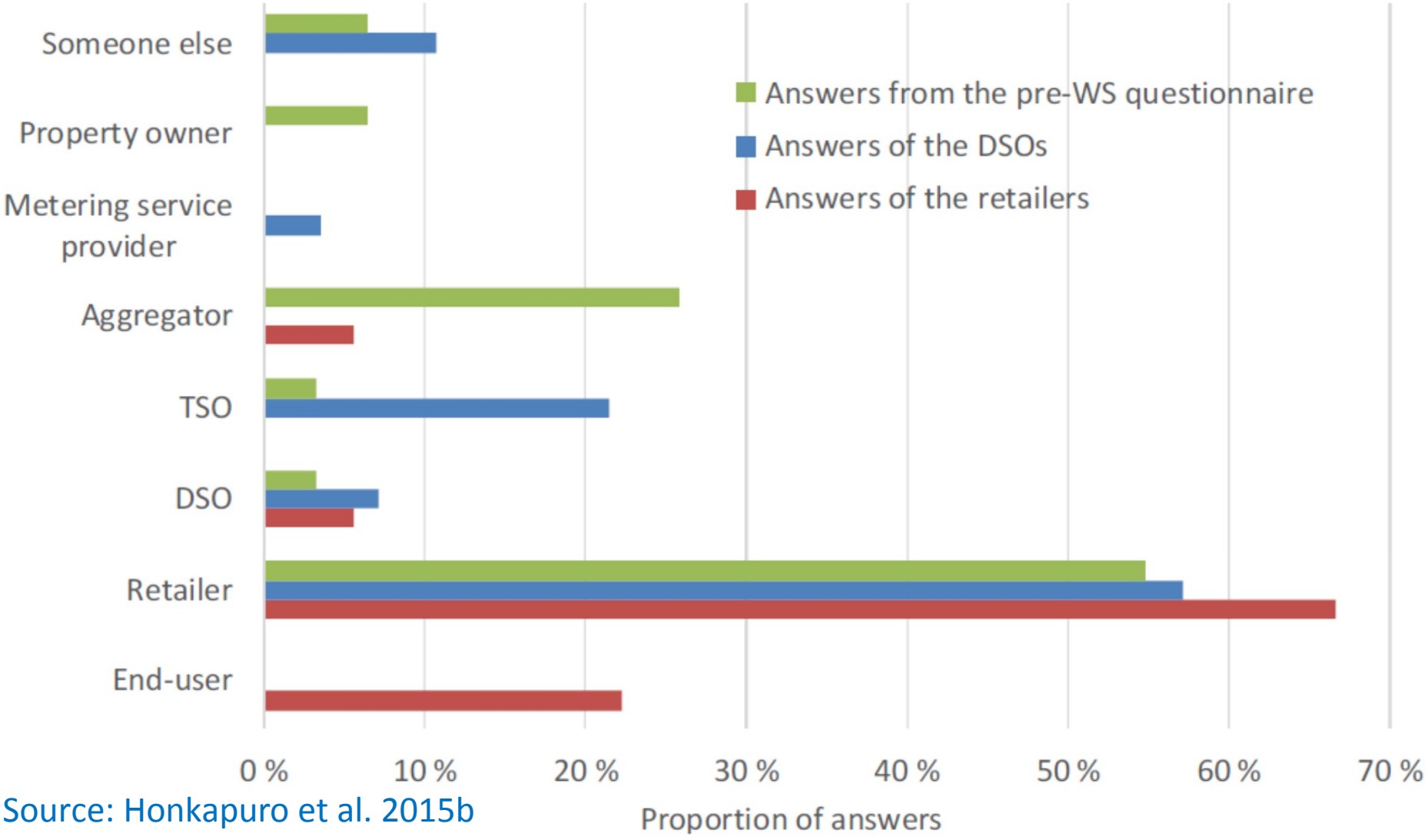


Sources: Valtonen et al. 2015, Honkapuro et al. 2015a

DR questionnaires

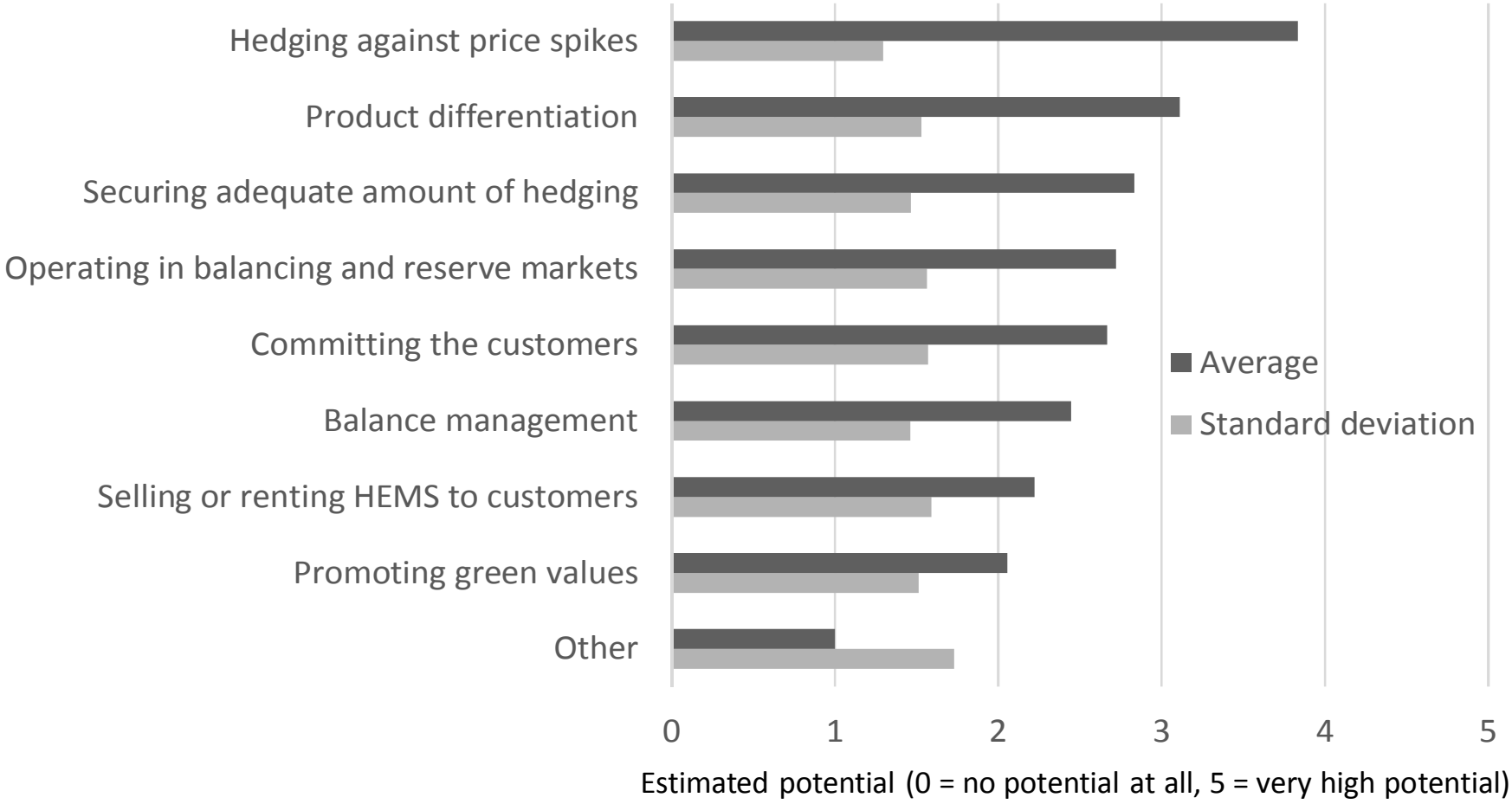
- DSOs
  - March 2014, responses from 30 DSOs
- Retail suppliers
  - September 2014, 18 responses from 16 companies
- Residential customers
  - December 2011, 2103 responses

Who should be most active in developing DR services?



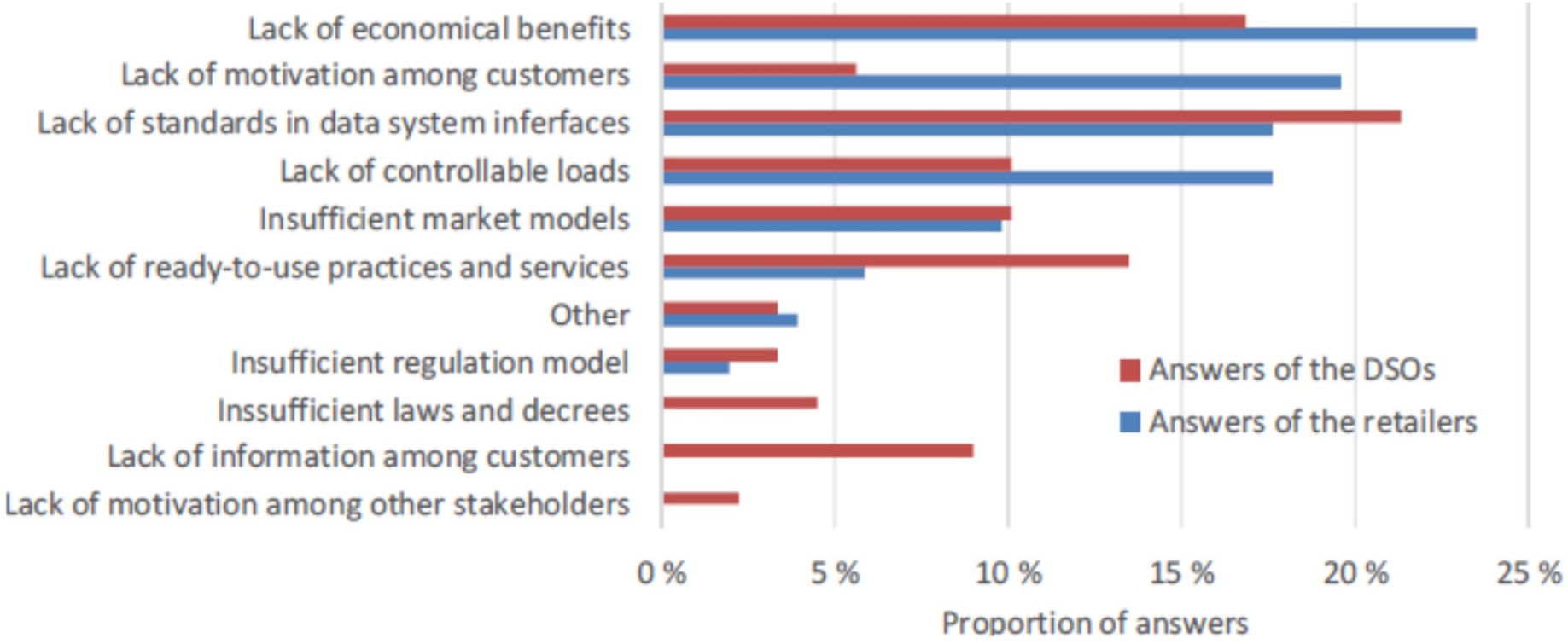
Source: Honkapuro et al. 2015b

The potential of the DR services, based on the answers of the retailer questionnaire



Source: Honkapuro et al. 2015a

Obstacles in DR implementation (Retailer and DSO questionnaires)



Source: Honkapuro et al. 2015b

Other challenges

- Currently, DSOs not able to control consumers' load without manual effort (delay varied from a couple of minutes to a couple of days)
- Conflict of interest
  - Market-based control of loads may increase peak powers in networks
    - Power-based distribution tariff? (see eg. Tuunanen 2015)
  - Balance error for retailers if other parties control their customers' loads

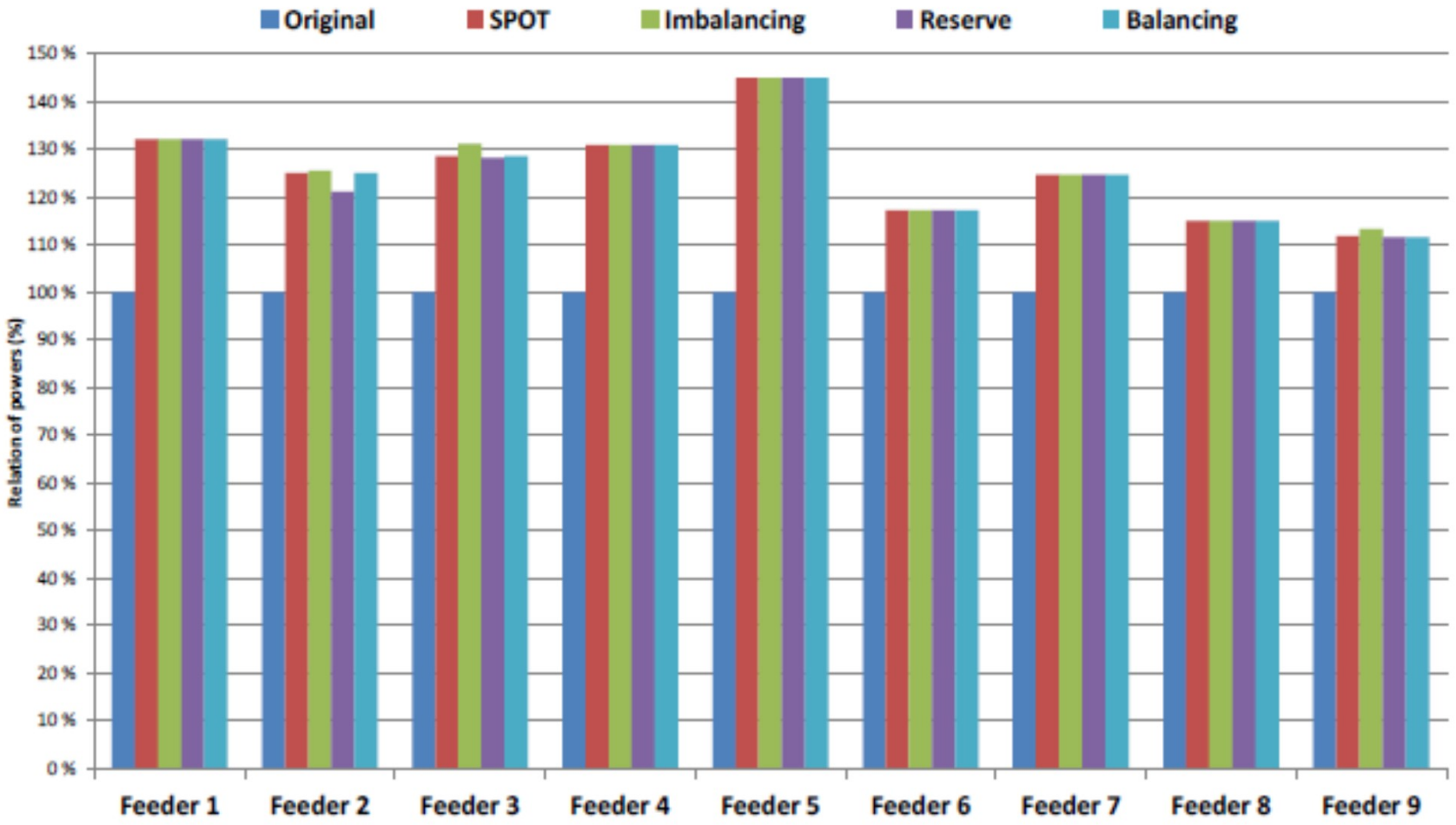


Figure 6.17. Effects of load control in different markets on the highest loads at the feeder level.

Source: Tuunanen 2015

Customer questionnaire

	All	Electric heating
On what bases would you allow remote load control of your electric appliances?		
Savings in electricity costs	74%	79%
Reduced emissions	29%	26%
Possibility to remote control yourself	32%	30%
For no reason	14%	12%

Source: Annala et al. 2012

Expected annual compensation for allowing direct load control

kWh	0-20 €	21-50€	51-100 €	101-200 €	201-500 €
<2000	25%	27%	26%	14%	9%
2000-4999	17%	18%	30%	23%	11%
5000-9999	9%	13%	30%	30%	18%
10,000-14,999	12%	11%	17%	29%	29%
15,000-25,000	11%	7%	17%	23%	39%
>25,000	5%	8%	13%	18%	53%

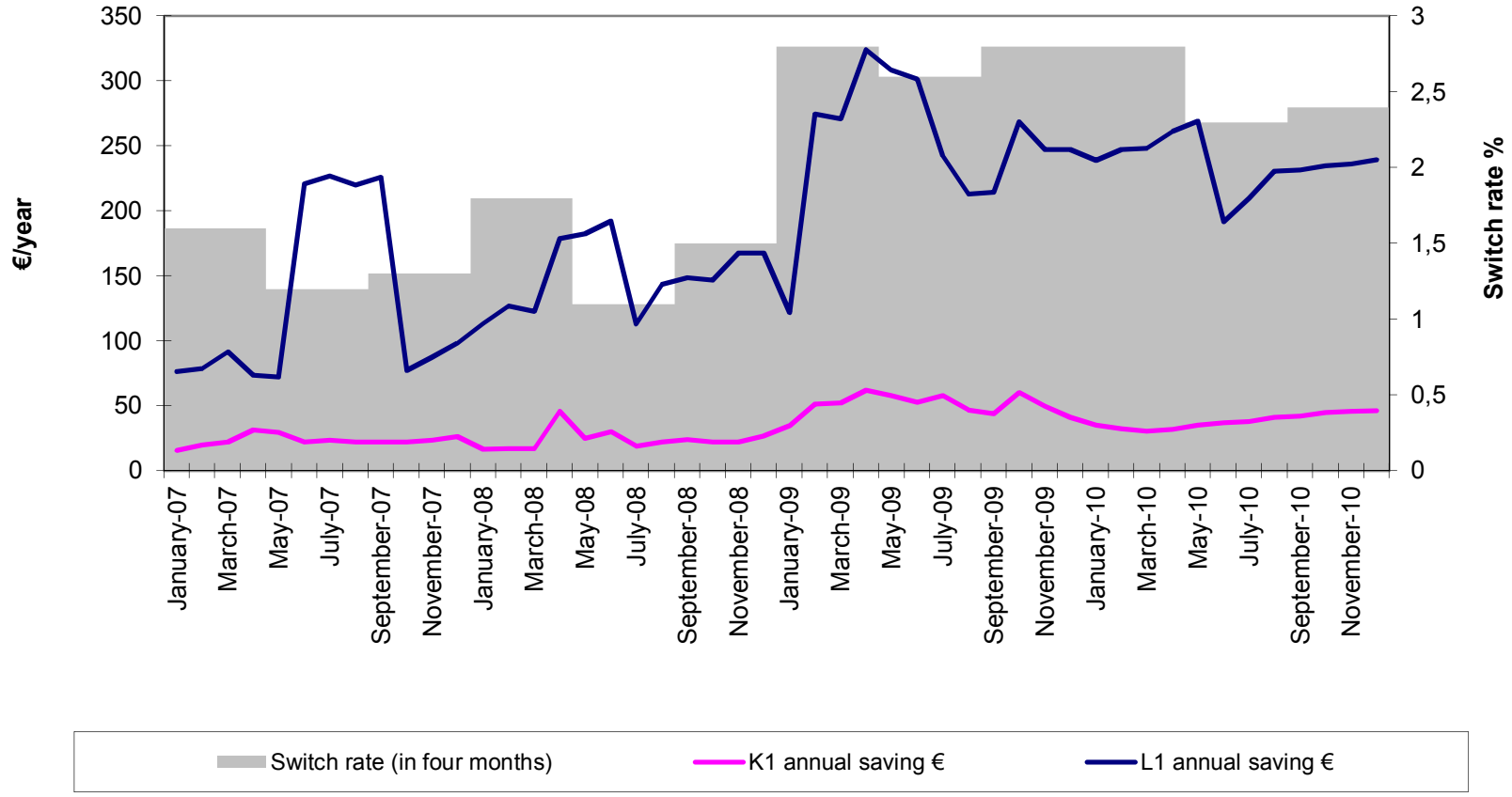
Electricity costs for customers on default tariffs (December 2011)

Annual consumption	Annual electricity cost
2000 kWh	355 €
5000 kWh	771 €
18,000 kWh	2300 €
20,000 kWh	2398 €

- Supplier switching rates in 2010
  - Residential customers <10,000 kWh per year 8.0%
  - Residential customers >10,000 kWh per year 10.5%
- Saving opportunity
  - 2000 kWh: ~40€
  - 20,000 kWh: ~240€

Source: Annala et al. 2012, Switching data from Energy Authority

Savings from supplier switching vs. switching rates



Source: Annala et al. 2013

- Consumers knowledge about electricity consumption and ability to shift it
  - Lack of knowledge about own consumption
  - Lack of consumption that consumers are willing to shift (most typically limited to dishwashers, washing machines, clothes dryers) (for a review see Annala 2015)
  - Previous studies have demonstrated that demand response enabling technologies boost the effects of pricing structures

- Are economic incentives sufficient
  - Valtonen et al. (2015): shifting of electric heating load from a high-price hour to the next hour (max 5 control actions per day) -> saving per customer 2.5 €/yer with 2011 prices
  - Calculations for Sweden: see e.g. Vesterberg et al. 2014
  - Required savings depend on type of electricity use (see Broberg et al. 2014)

Summary

- Acceptance of convenience-neutral control is high
- Consumers expect relatively large savings in electricity costs to participate
- Market places for demand response already exist
- Economic incentives from spot market limited
- Other market places may provide higher benefits
  - Require automated solutions for (small) customers
- Need for standardized interfaces

References

Annala, S., Viljainen, S., Tuunanen, J., (2012), Demand response from residential customers' perspective, Proceedings of 9th International Conference on the European Energy Market.

Annala, S., Viljainen, S., Tuunanen, J., (2013), Rationality of supplier switching in retail electricity markets, International Journal of Energy Sector Management, Vol. 7, No. 4, pp. 459-477.

Annala, S.. (2015), Households' willingness to engage in demand response in the Finnish retail electricity market: an empirical study. Doctoral dissertation, Lappeenranta University of Technology.

Ariu, T., Lewis, P.E., Goto, H., Dromacque, C., Brennan, S. , (2012), Impacts and lessons from the fully liberalized European electricity market – Residential customer price, switching and services. CRIEPI.

Broberg, T., Brännlund, R., Kazukauskas, A., Persson, L., Vesterberg, M., (2014), An electricity market in transition – Is consumer flexibility for sale, or even for real? http://ei.se/Documents/Publikationer/rapporter_och_pm/Rapporter%202014/An_electricity_market_in_transition_is_consumer_flexibility_for_sale_or_even_for_real.pdf

Energy Authority, (2015), Tehoreservikapasiteetin hankinta, http://www.energiavirasto.fi/documents/10179/0/Tehoreservin+hankintap%C3%A4%C3%A4t%C3%B6s+230415.pdf/d12eb349-f1b5-4327-99e7-783a95521f2e

Fingrid, (2015a), Reserves, http://www.fingrid.fi/en/powersystem/reserves/Pages/default.aspx

Fingrid, (2015b), Demand-side management, http://www.fingrid.fi/en/electricity-market/Demand-Side_Management/Pages/default.aspx

Fingrid, (2015c), Market places, http://www.fingrid.fi/en/electricity-market/Demand-Side_Management/Market_places/Pages/default.aspx

Honkapuro, S., Valtonen, P., Tuunanen, J., Partanen, J., Järventausta, P., (2015a), Demand side management in open electricity markets from retailer viewpoint, Proceedings of 12th International Conference on the European Energy Market.

Honkapuro, S., Tuunanen, J., Valtonen, P., Partanen, J., Järventausta, P., Heljo, J., Harsia, P., (2015b), Practical implementation of demand response in Finland, Proceedings of 23rd International Conference on Electricity Distribution, CIRED 2015.

Tuunanen, J., (2015), Modelling of changes in electricity end-use and their impacts on electricity distribution. Doctoral dissertation, Lappeenranta University of Technology.

Valtonen, P., Honkapuro, S., Partanen, J., (2015), Economic potential of load control in balancing power market, Proceedings of 23rd International Conference on Electricity Distribution, CIRED 2015.

Vesterberg. M., Khrisnamurthy, C.K.B., Bayrak, O., (2014), Residential end use electricity demand and the implications for real time pricing in Sweden, http://www.cere.se/en/research/publications/609-residential-end-use-electricity-demand-and-the-implications-for-real-time-pricing-in-sweden.html

Thank you!

salla.annala@lut.fi