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Impacts of DER for planning and operation of electricity distribution grid and business

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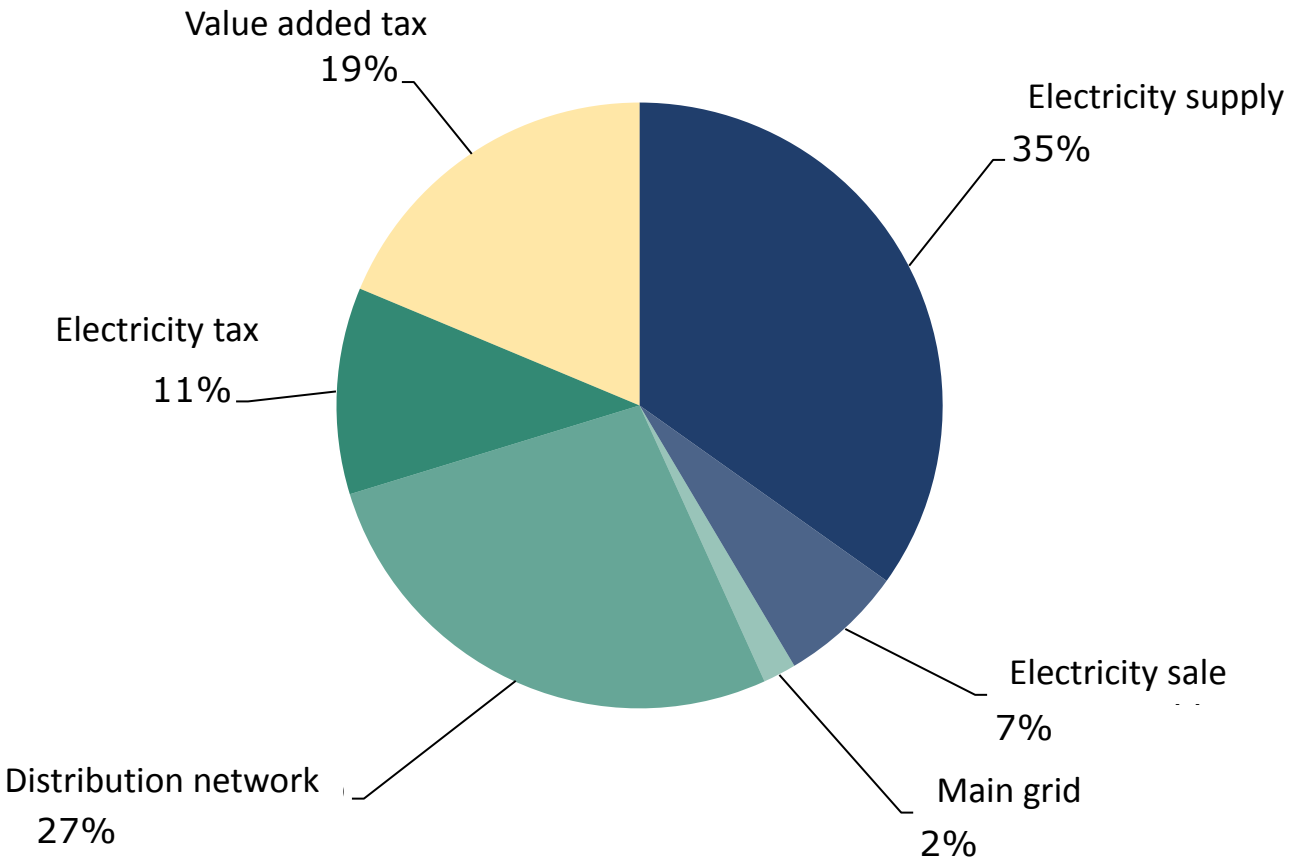
- Present situation; tariff and cost structure of DSOs
- Typical impacts of DER for DSOs' costs and revenues
- Needs and possibilities for renewing the tariff structure
- Case analysis: the impacts of the heat pumps on DSO's revenues

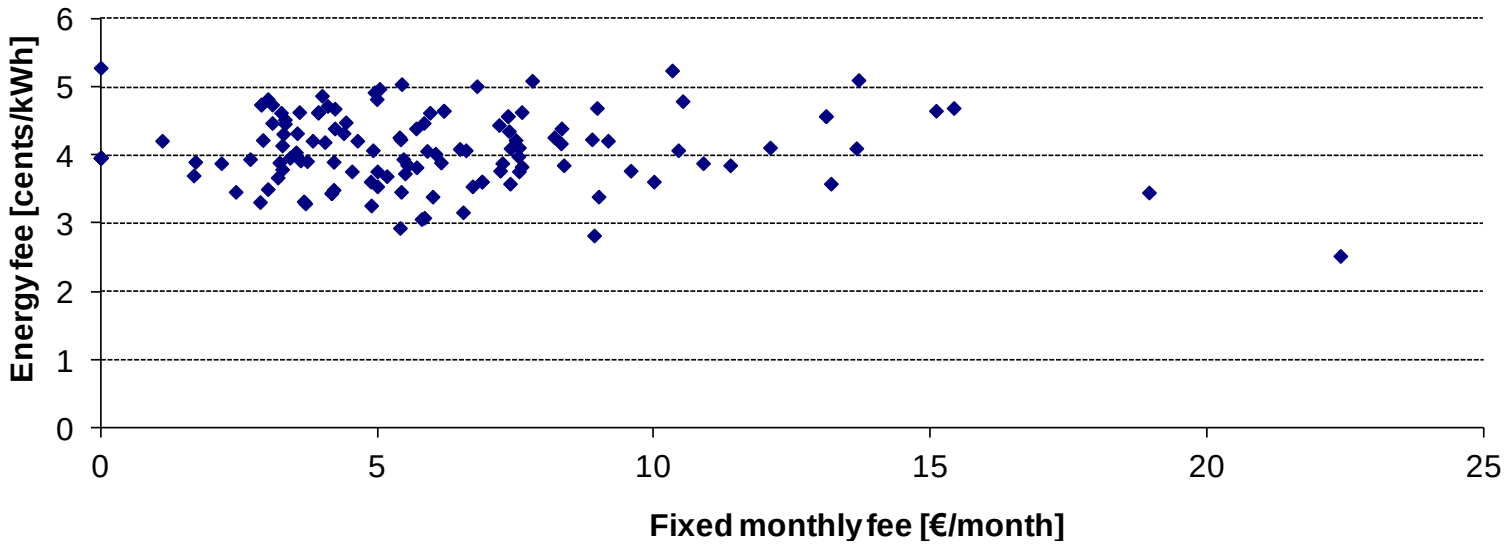
Total electricity price for a household customer 1.3.2012

(In total 15,46 snt/kWh K2) SOUCE: ENERGY MARKET AUTHORITY



Typical DSO tariffs in Finland

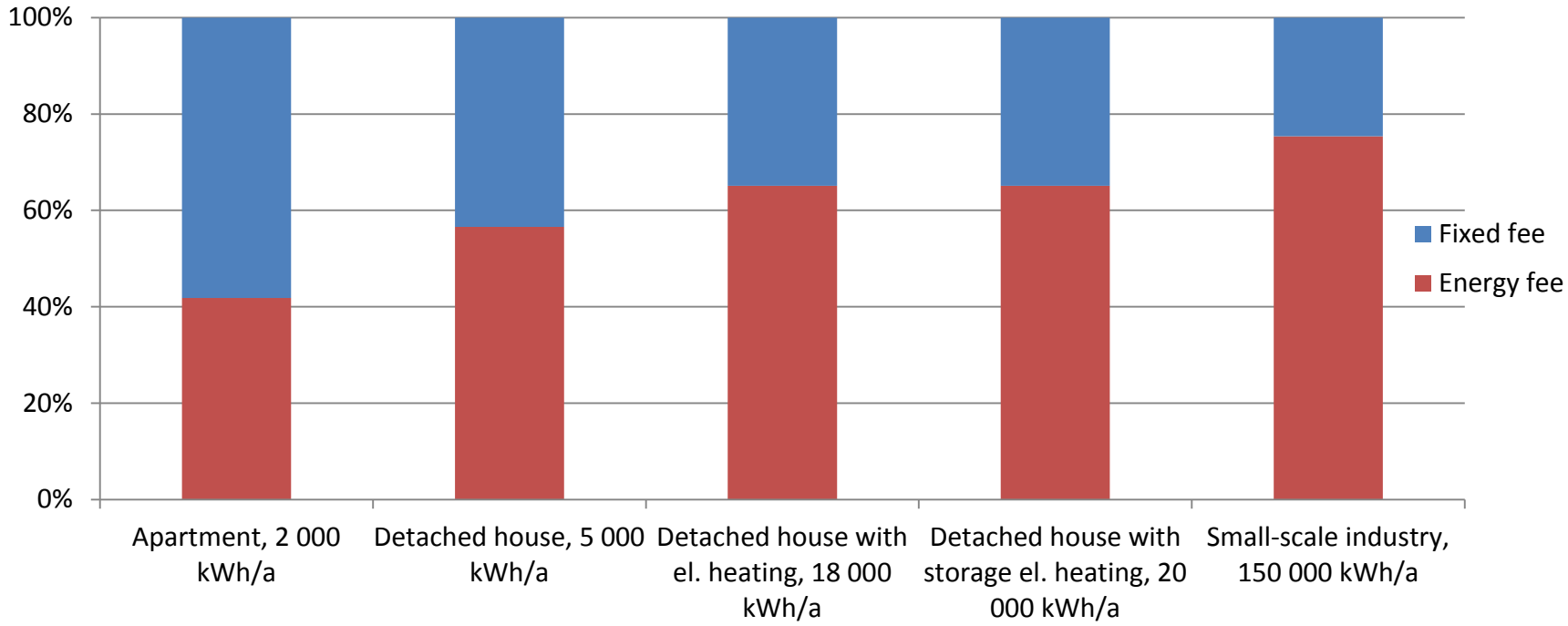
- Typical tariff structure of a Finnish DSO is energy based tariff combined with a fixed fee, which is typically dependent on the size of the main fuse (cents/kWh + €/month)
- The proportion of the fixed and energy based fees vary between the companies and customer types
- The revenue of the DSOs is regulated by the authority, but DSOs may decide their tariff structures freely



DSO tariffs of Finnish distribution companies (90 companies, 138 tariffs) for typical residential customers (main fuse 3*25 A)
Source: Finnish Energy Market Authority

Typical DSO tariffs in Finland

- In average, the proportion of the energy based fee varies between 40 % and 75 %, depending on the customer type
- The proportion of the fixed fee has increased during the past years

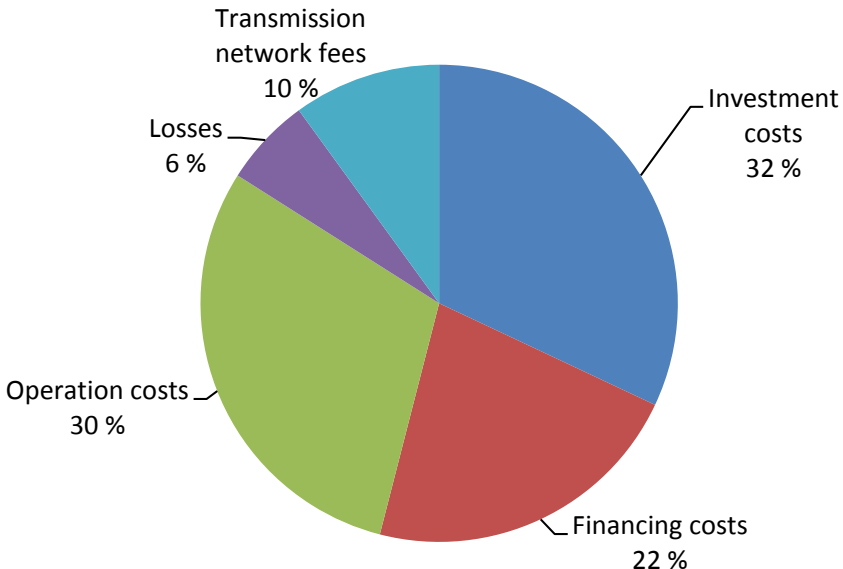


Average proportion of energy based fee and fixed fee for different customer types in Finnish DSOs in year 2010.
Source: Finnish Energy Market Authority

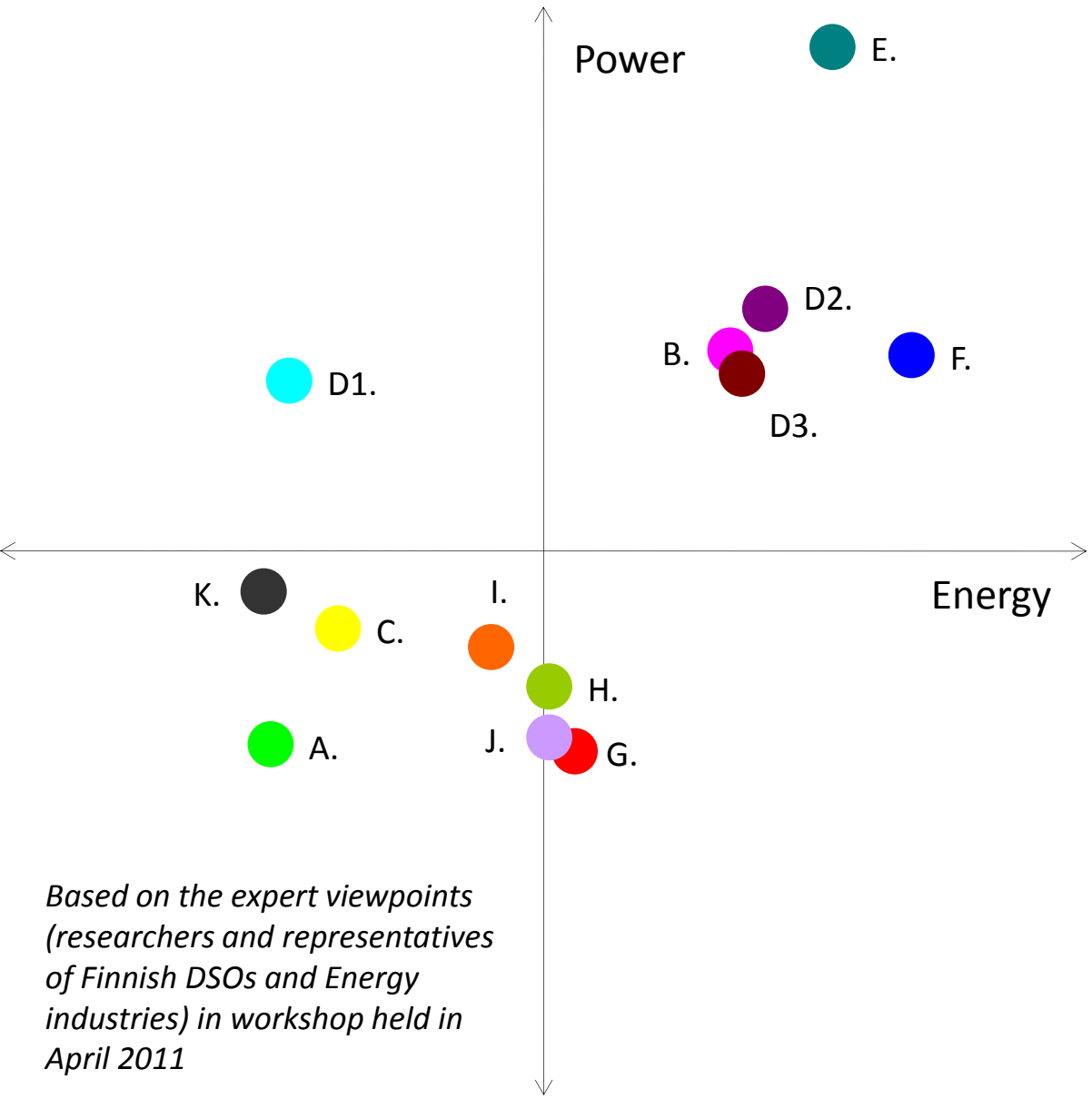
Cost structure in electricity distribution

- The dimensioning of the grid components (lines, transformers, etc.) is based on the peak power → Investments and financing costs are based on the power demand
- Operational costs (operation, maintenance, repair) are based on the size and type of the network → no direct dependency on the energy or power demand
- Losses are mainly based on the amount of the delivered energy
- Metering and billing (included in operational costs) are based on the amount of the customers
- Administration costs (included in operational costs) are mostly based on the size of the company
- Transmission network fees depend on the tariff structure of the TSO, e.g. in Finland, they are energy based. However, the costs of the TSO are mainly power based

The majority of the DSOs' costs are based on power demand, while incomes are mostly based on energy demand.



Impacts of different actions on energy and power transmitted through electricity distribution network



Based on the expert viewpoints (researchers and representatives of Finnish DSOs and Energy industries) in workshop held in April 2011

- A . Electrical devices (e.g. LED-lamps) energy efficiency
- B . Number of the electrical devices
- C . Energy saving as an attitude to life
- D 1. Heat pumps in electric heating buildings
- D 2. Heat pumps in other buildings
- D 3. Using electricity in heating other ways
- E . Electric vehicles; uncontrolled recharging
- F . Electric vehicles; smart recharging
- G. Customer's energy storages
- H. Load control by retailer/aggregator
- I. Load control by customer
- J . Load control by DSO
- K . Customer's own electricity production

Impacts of DER for DSO

- Most challenging for a DSO are such actions, which decrease the amount of the delivered energy more than power demand
- In such case, the revenues of the DSO will decrease, while costs remain the same or even increase
- To ensure that incomes will cover the costs, more cost reflective tariff structures must be developed
- AMR meters are currently being installed widely and they provide functionality, which supports the development of the tariff structures
- For instance, in Finland:
  - At least 80 % of the customers will have AMR-meter at the end of the year 2013 (Government decree)
  - Energy measurements have to be based on hourly measurements and DSOs are obligated to read meters once a day
  - Energy meters have to be able to receive, transmit and execute load control commands

Demands for DSO tariff structure

- Cost reflective, understandable, transparent
- Customer have possibilities to impact on his/her electricity bill
- Does not include contradictory incentives
- Enables and provides incentives for distributed generation and energy efficiency

- Supports the energy and climate policy of EU
- Provide energy efficiency incentives
- Is in-line with the demands of directives and laws
- Enables market based demand response
- Supports the functioning of the electricity markets

- Ensures adequate and predictable revenues, also in future operational environment
- Cost reflective
- Provide customers with incentives to optimize their electricity usage based on the demands of the distribution network
- Technically and economically possible to implement (metering and billing)

- Enables market based demand response
- In-line with the sales tariff
- Does not yield to conflict of interests between DSO and retailer

Power based tariff

- Billing is based on the subscribed capacity or metered peak power (kW)
- Could be also based on the current (A), in such approach, also reactive power is included in the billing, but modifications for AMR meters and meter reading systems may be needed
- In the case of the capacity subscription, certain procedure for exceeding the capacity limit (e.g. penalty fee)

Benefits of power based tariff:

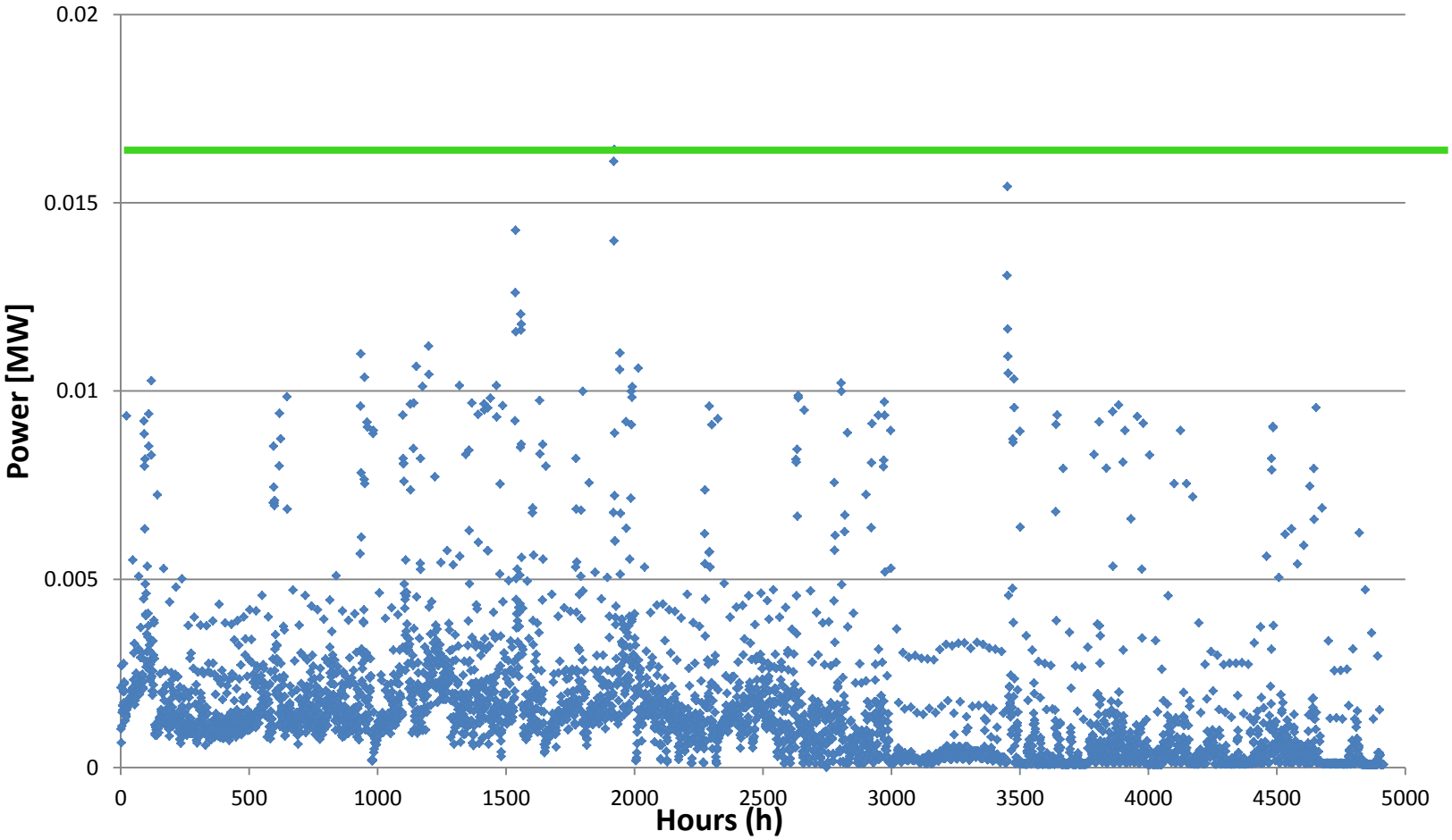
- Cost reflective for DSO
- For customers, incentives to decrease peak power (e.g. by optimal dimensioning of DER)
- In long run, increases capacity utilization rate in distribution network => decreases the costs of the electricity distribution

Example of power bands

Main fuse [A]	Power (kW)	Power band (kW)
		5
		10
3*25	17	15
		20
3*35	25	25
		30
3*50	35	35
		40
3*63	44	45

Power based tariff – an example

- Hourly power of a residential customer;
  - Present peak power is 16 kW => customer has to order 20 kW power band
  - However, customer have possibilities, and with power based tariff also incentives, to decrease the peak power to 15 kW, or even to 10 kW.



Heat pumps – business impacts for DSOs

- In Finland, heat pumps are mainly used as heating purposes – cooling is more extra feature than primary objective of the heat pump
- Air-source heat pump can only be used as a supportive heating method in Finnish climate, primary heating method is typically electricity, oil, or wood

  => Installing of air-source heat pump decreases the energy consumption, but does not affect the peak-power demand
- Ground-source heat pump can be used as a primary heating method, support of electrical heating is needed only occasionally

  => Ground-source heat pump decreases also the peak-power demand

Annually installed heat pumps; statistics and penetration scenario of Finnish heat pump association

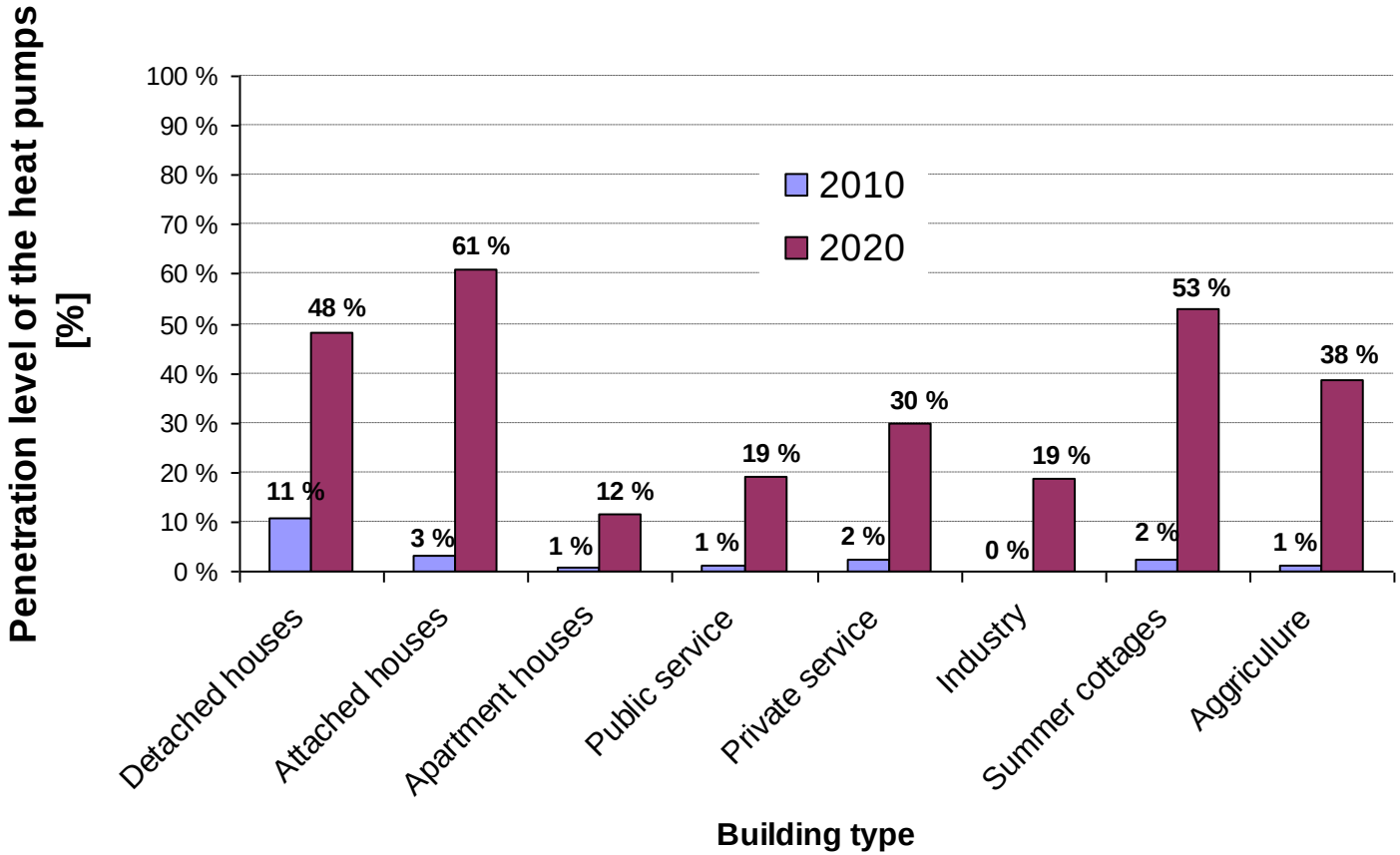
Type	2009	2010	2011	2015	2020
Ground source	6 137	8 091	13 941	15 000	20 000
Exhaust air	1 819	1 988	1 648	3 000	4 000
Air-to-water	1 819	1 150	992	5 000	6 000
Air-to-Air	57 977	53 821	55 286	50 000	40 000
Total amount of annually installed heat pumps	67 752	65 050	71 867	73 000	70 000

Total amount of heat pumps; statistics and penetration scenario of Finnish heat pump association

	2009	2010	2011	2015	2020
Total amount of heat pumps	340 000	390 000	465 000	750 000	1 000 000

Heat pumps – business impacts for DSOs

- Penetration scenario for heat pumps in the area of one distribution company (rural area in eastern Finland)



Tuunanen, Jussi. "Lämpöpumppujen vaikutukset sähköverkkoliiketoiminnan kannalta" (The effects of the heat pumps from the perspective of the electricity network business). Master's thesis. Lappeenranta University of Technology. 2009 (In Finnish)

Heat pumps – business impacts for DSOs

- Based on the basic penetration scenario of heat pumps for the case DSO, it was estimated that the amount of the annually delivered energy would decrease by 10 % by the year 2020
- With the present tariff structure of DSO, annual revenue would decrease by 5 %, while costs remain the same
- In the maximum impact scenario, the delivered energy would decrease by 25 %, which would yield to 12 % decrease in the annual revenues of the DSO, if the present tariff structure is applied
- From the viewpoint of DSO, such development mean that incomes do not cover the costs, which jeopardize the business, although such development is highly desirable, since it increases the energy efficiency in the heating of the buildings
- Solution for avoiding negative impacts for DSO is to develop more cost reflective tariff structure
- Best solution seems to be power based tariff, which is cost reflective for DSO and provide customers with incentives to optimize their power consumption

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