EEDAL '09

Energy Efficiency in Domestic Appliances and Lighting

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Smart Domestic Appliances

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Project Website:

http://www.smart-a.org

Intelligent Energy Europe

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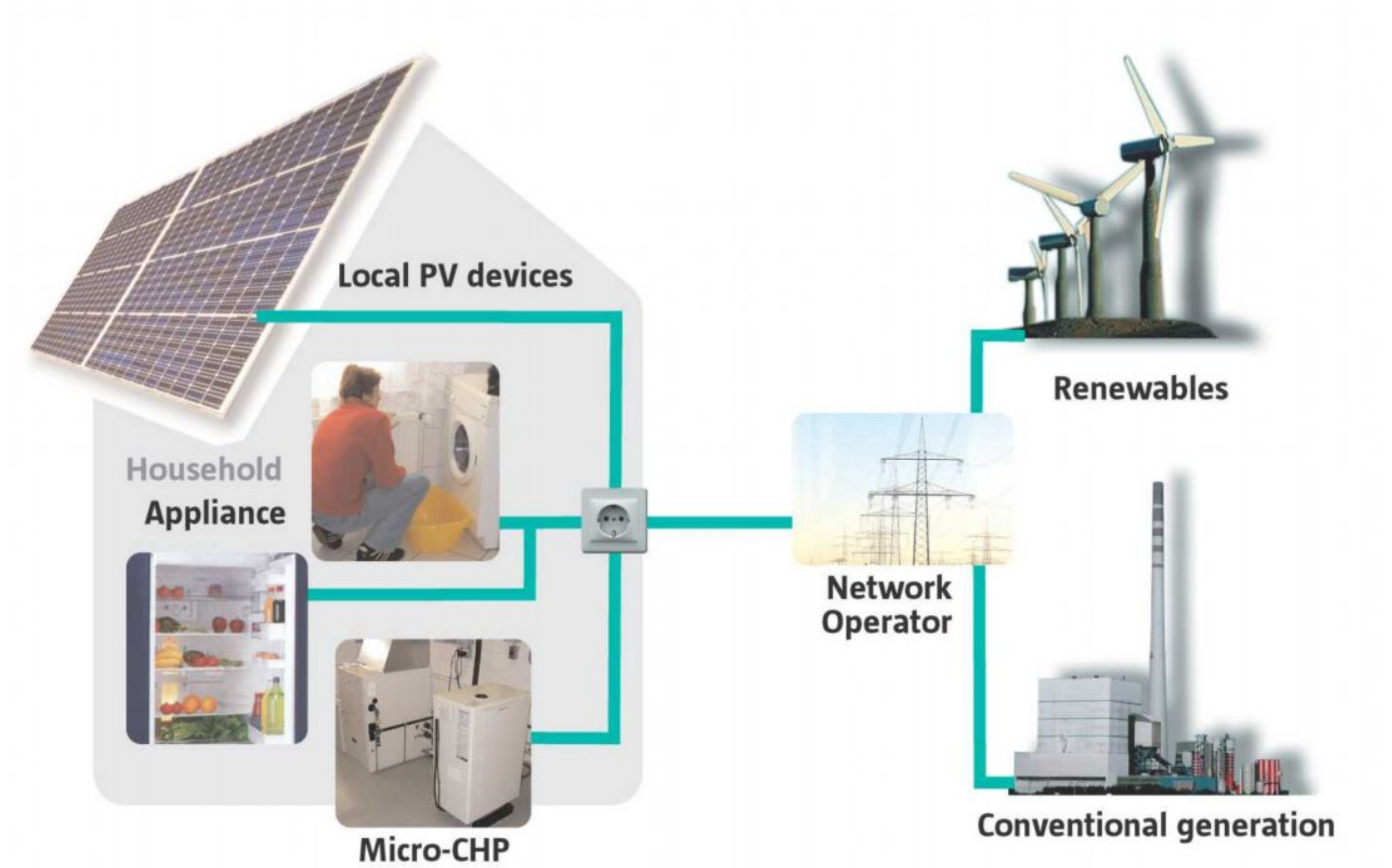
Overview

- The Smart Appliances Vision
- Demand Response Options by Smart Appliances
- Consumer Acceptance of Smart Appliances
- Model Results for the Value of Smart Appliances in Electricity Networks
- Incentivising Smart Appliances
- Conclusions

The Smart Appliances Vision



Examples Illustrating the Smart-A Vision

- The freezer receives a signal from the local electricity network operator that a load peak is expected around noon, and therefore it stores cold in the morning to avoid operation during peak time.

  Automatic smart operation

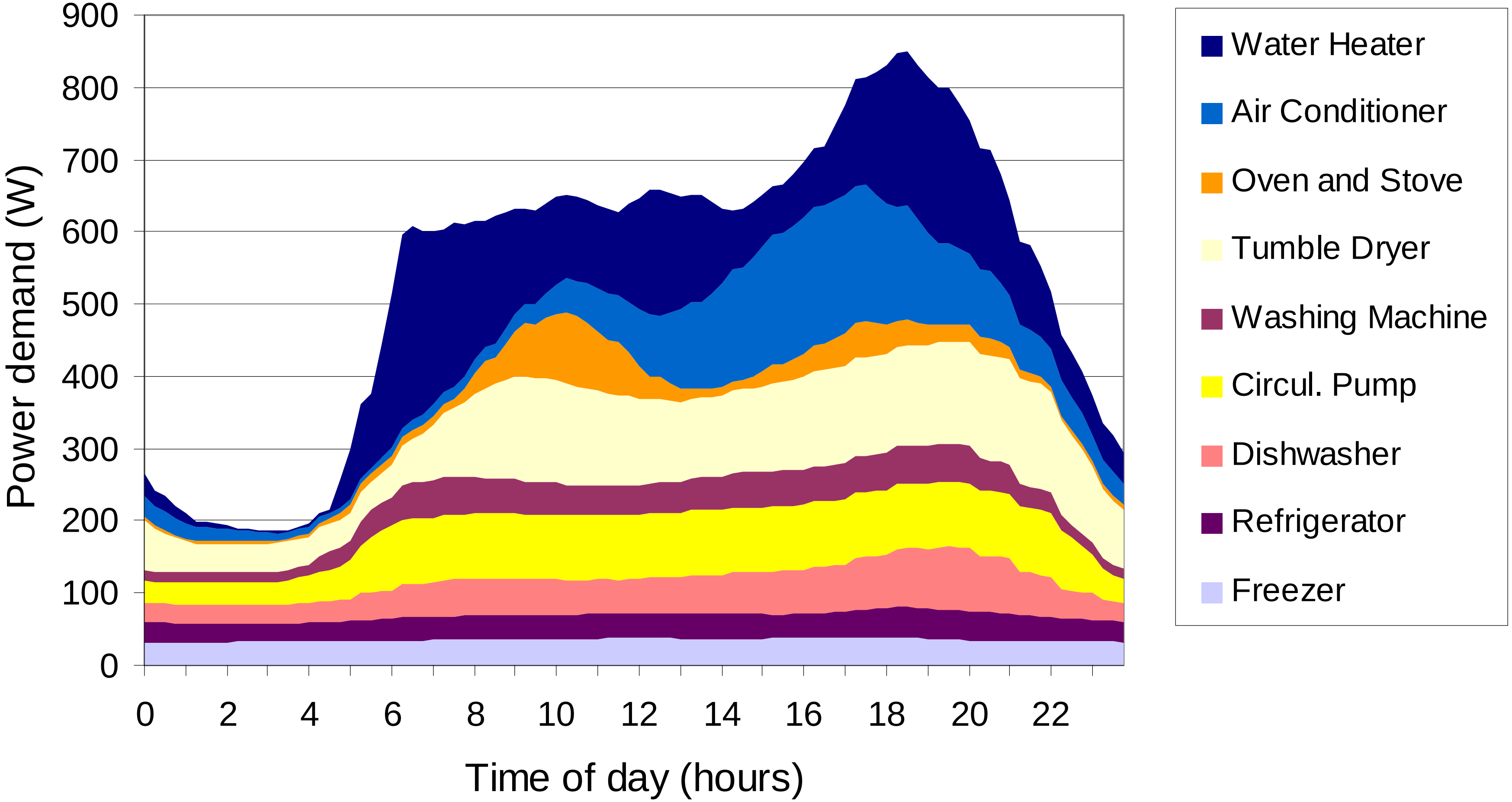
- The user switches on the dishwasher in the morning and leaves for work. The appliance optimises the timing of its operation based on heat supply from the solar heat system.

  Low-level consumer interaction

- The washing machine checks the weather forecast from the Internet and signals to the user that a sunny day allows for the use of a programme with higher temperatures.

  Complex consumer interaction

Appliance Load of a Generic European Household



Demand Response Options

Smart Timing of Appliances Cycles

Washing Machine, Dryer:	Typical 3 hrs.; Maximum 9 hrs.
Dishwasher:	Typical 6 hrs.; Maximum >12 hrs.
Refrigerator, Freezer:	n/a
Other Appliances:	Typical 15 mins. – 1 hr.

Interruptions of the Appliance Cycle

Washing Machine:	Typical 15 mins.
Dryer:	Typical 30 mins.
Dishwasher:	Typical 15 mins.
Refrigerator, Freezer:	Typical 15 mins.
Other Appliances:	Typical 15 mins.

Consumer Acceptance of Smart Appliances

- In theory high acceptance of smart appliances, but ...
- Economic benefits required as a trigger:
  - Ecological reasons are also important, but viewed as a positive side effect.
  - Incentives should result in short amortisation periods (< 3yrs.).
  - Preference for rewards for each smart cycle.
- Consumers do not want to change their habits and routines.
- If data protection is ensured, remote monitoring of consumption can be accepted.

Consumer Objections and Wishes

- Higher investment cost
- Consumers want to be able to retain full control over their appliances
- Health and safety issues (fire, flooding, food might be compromised)
- Doubts about maturity of the technology
- Scepticism about the ecological benefits

- Economic Incentives
- Enhanced safety functions
  - Overloading signal
  - Temperature surveillance
  - Water stop
  - Detection of technical faults
- Enhanced comfort and usability
- High quality service & support
- Attractive design

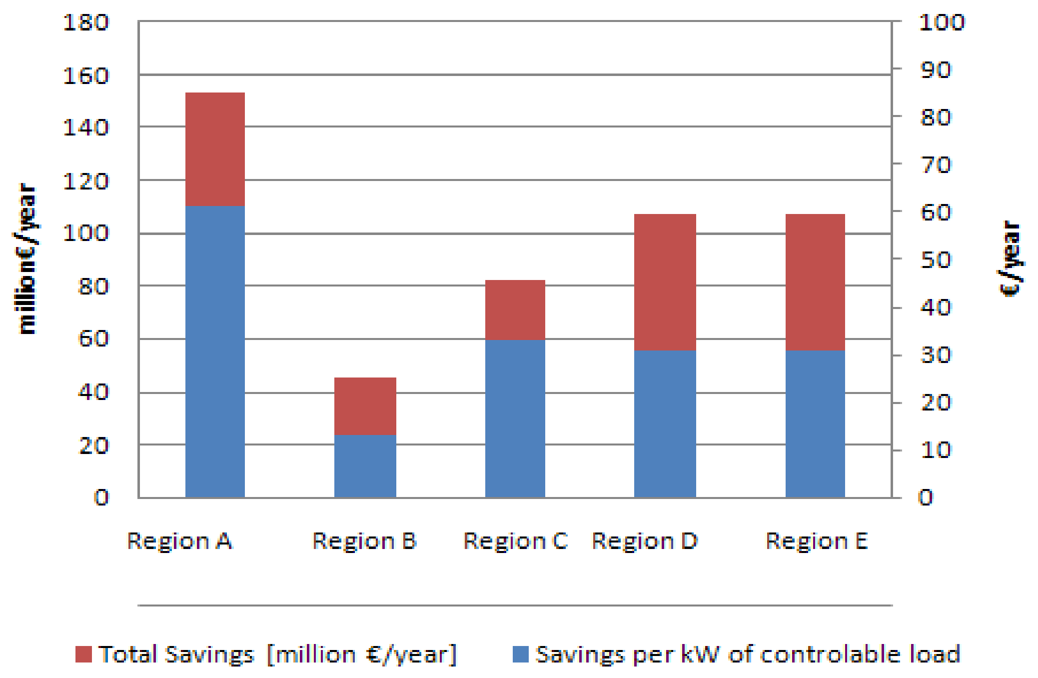
Determining the Value of Smart Appliances in Electricity Networks

Step 1:
Value of Smart Appliances for Balancing Wind Generation in Different Power System Cases

SMART-A Regional Classification

	Region A "South of Europe"	Region B "Scandinavia"	Region C "New member states"	Region D "Germany/ Austria"	Region E UK
Generation Flexibility	**Low**	**High**	**Medium**	**Medium**	**Medium**
Demand Profile	Summer Peak	Winter Peak	Winter Peak	Winter Peak	Winter Peak
Intermittent Generation Installed	Medium (rising)	Low (rising)	Low (rising)	High	Low (rising)

Balancing Value of DSM in Different Regions



Value per appliance (~50 W) and year: 0,7 … 3,0 EUR

	Region A	Region B	Region C	Region D	Region E
***Reduction in fuel costs*[1]**	[3 – 6] %	[0.05 – 0.32] %	[0.1 – 1] %	[3 – 5] %	[0.5 – 3] %
***Reduction in wind spillage*[2]**	[30 – 50] %	0%	[0 – 70] %	[36 – 70] %	[0 – 70] %

(1) Percentage of the total system fuel costs

(2) Percentage of the total wind spilled

Determining the Value of Smart Appliances in Electricity Networks

Step 2: Value of Different Smart Appliances for Balancing Wind Generation in a Generic Power System

Generic Case Study System

110 generator system: $P_{INSTALL}$=20.502GW $P_{g,max}$ =700MW

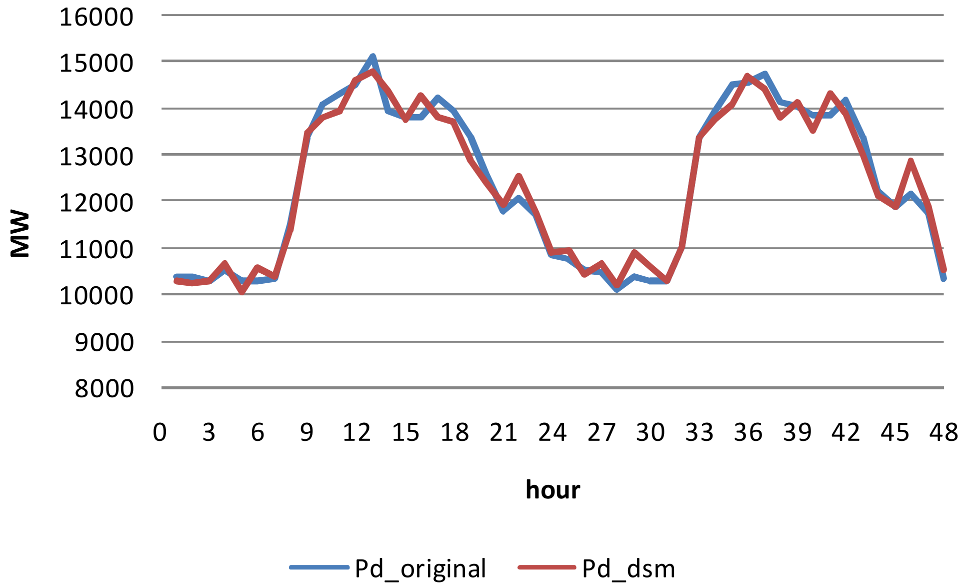
Max. forecasted demand: 19.8GW Installed wind capacity: 5 GW

Nr of households: 8 million

Type of appliance	Penetration rate	Shifting capability (max.)	Duration of consumption pattern
Washing Machine 1h	32%	1 h	2 h
Washing Machine 2h	32%	2 h	2 h
Washing Machine 3h	32%	3 h	2 h
Dish Washer	30%	6 h	2 h
Washing Machine + Tumble Dryer	20%	3 h	4 h

Value per Type of Appliance

Type	Value per appliance and year
Washing Machine	3,1 EUR
Dish-washer	6,3 EUR
Washer +Dryer	14 EUR



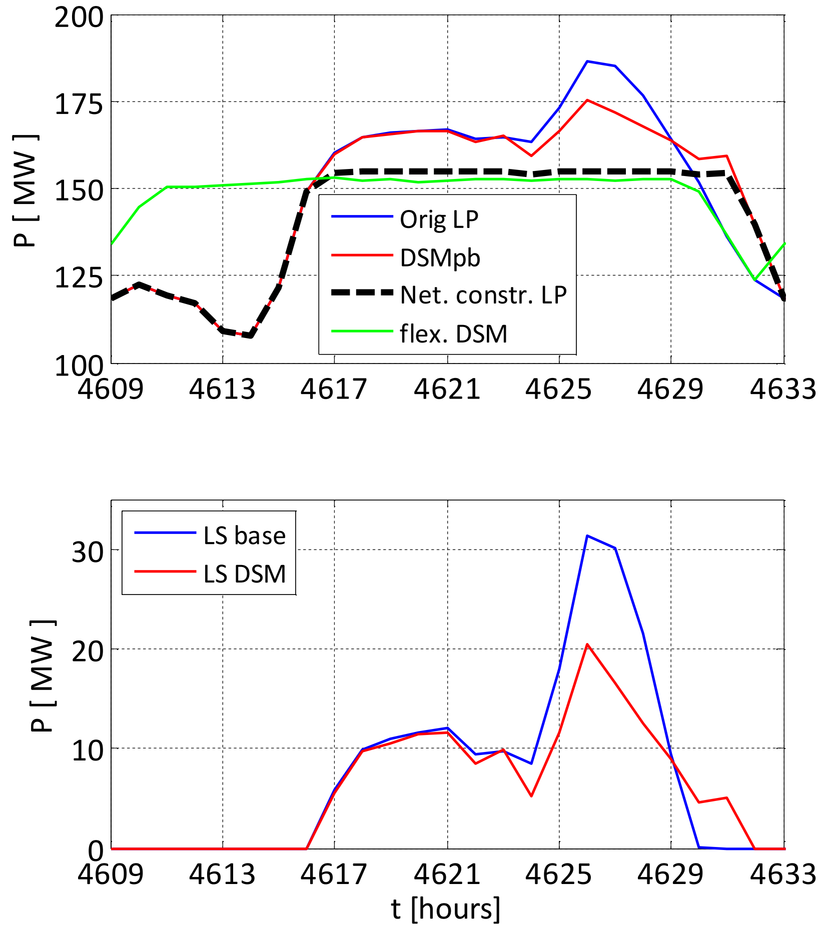
	Reduction in %
Total Fuel Costs	4.35 %
Wind Curtailed	53 %

Determining the Value of Smart Appliances in Electricity Networks

Step 3:
Case Study for the Value of Smart Appliances in a Congested Network

Network Congestion Case Study

- Case Study based on IEEE Test System (max load 155 MW) with several congested branches.
- Smart Appliances are used in order to reduce the peak load in congested lines.
- Under extreme conditions, load shed occurs in congested systems. This can be reduced or avoided by Demand Response.
- Under this condition, Smart Appliances have a significant value.



Incentivising Smart Appliances

- An overall economic benefit is a precondition for implementing certain Smart Appliances strategies.
- However, distributional effects might need to be corrected:
  - Additional cost of Smart Appliances borne by users?
  - Reduced cost for balancing power might be passed on from the system operators to all consumers (not only the smart ones).
  - System operators might not be able to include incentives for Smart Appliances in the system cost accepted by regulators.
- Proposals for incentivising measures will be developed:
  - Compensate Smart Appliance users through time-of-use tariffs, real time pricing, cycle-based and/or lump sum incentives.
  - Use reduced cost for balancing etc. as a resource for this.

Conclusions on Smart Appliances (SA)

- Fully automatic control of SA operation is a robust resource for Demand Response. Direct consumer interaction offers additional potentials.
- Consumers tend to accept SA if their daily routines are not changed and comfort and safety are maintained.
- From a system perspective the value of SA is driven by the flexibility of the conventional generation mix and the share of wind & solar energy.
- Typical values of SA are moderate. Higher values can be obtained for devices shifting larger volumes of energy over a longer time.
- SA can have significant value, when contributing to congestion relieve and reducing congestion costs.
- Incentive mechanisms are needed to give the right signals to the actors involved in Demand Response through SA.

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