TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Electrical and Computer Engineering Chair of Electrical Power Systems

Prospects of Electricity Demand and Demand Side Management Potentials of Residential Customers

Jörg Dickert

Enerday 2016

Introduction

Definition

Demand Side Management

process that is intended to influence the quantity or patterns of use of electric energy consumed by ***end-use customers***

ensure save operation of grid

integrate renewables

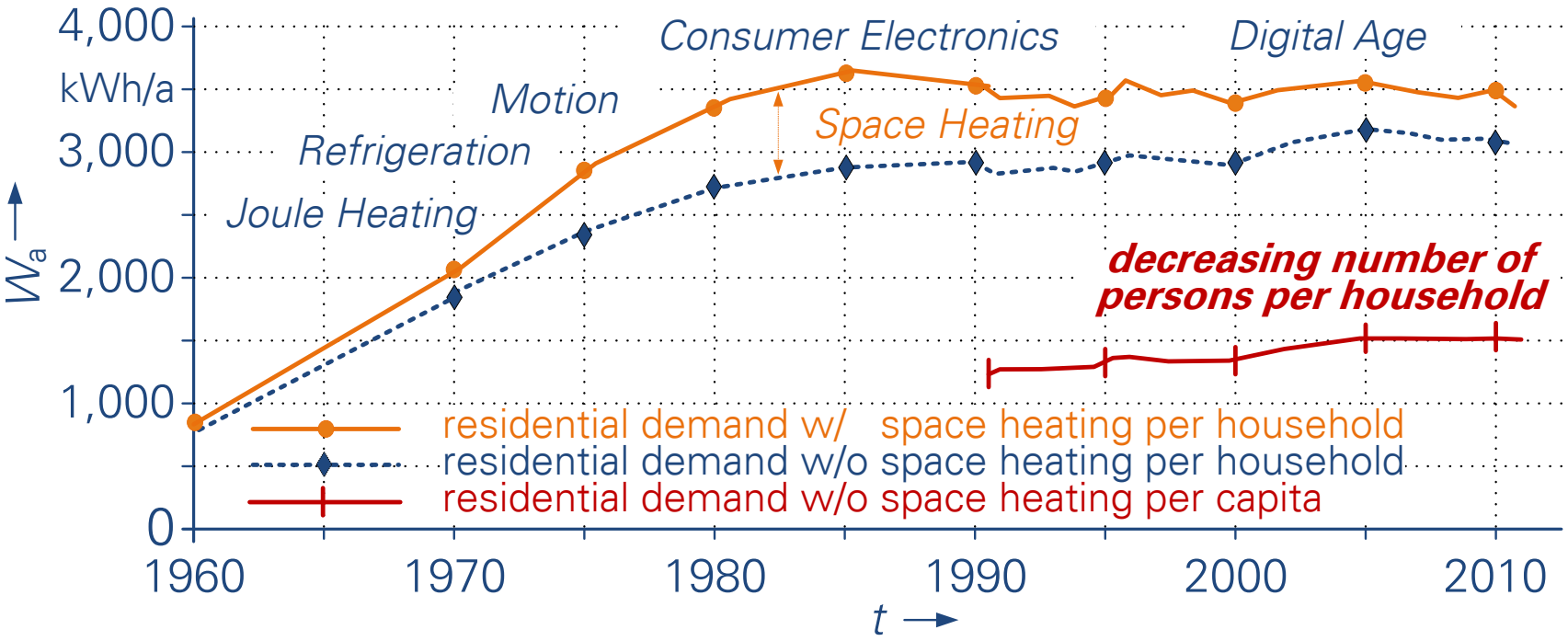
Demand Response

action resulting from management of the electricity demand in response to ***supply conditions***

Source: Electropedia

Introduction

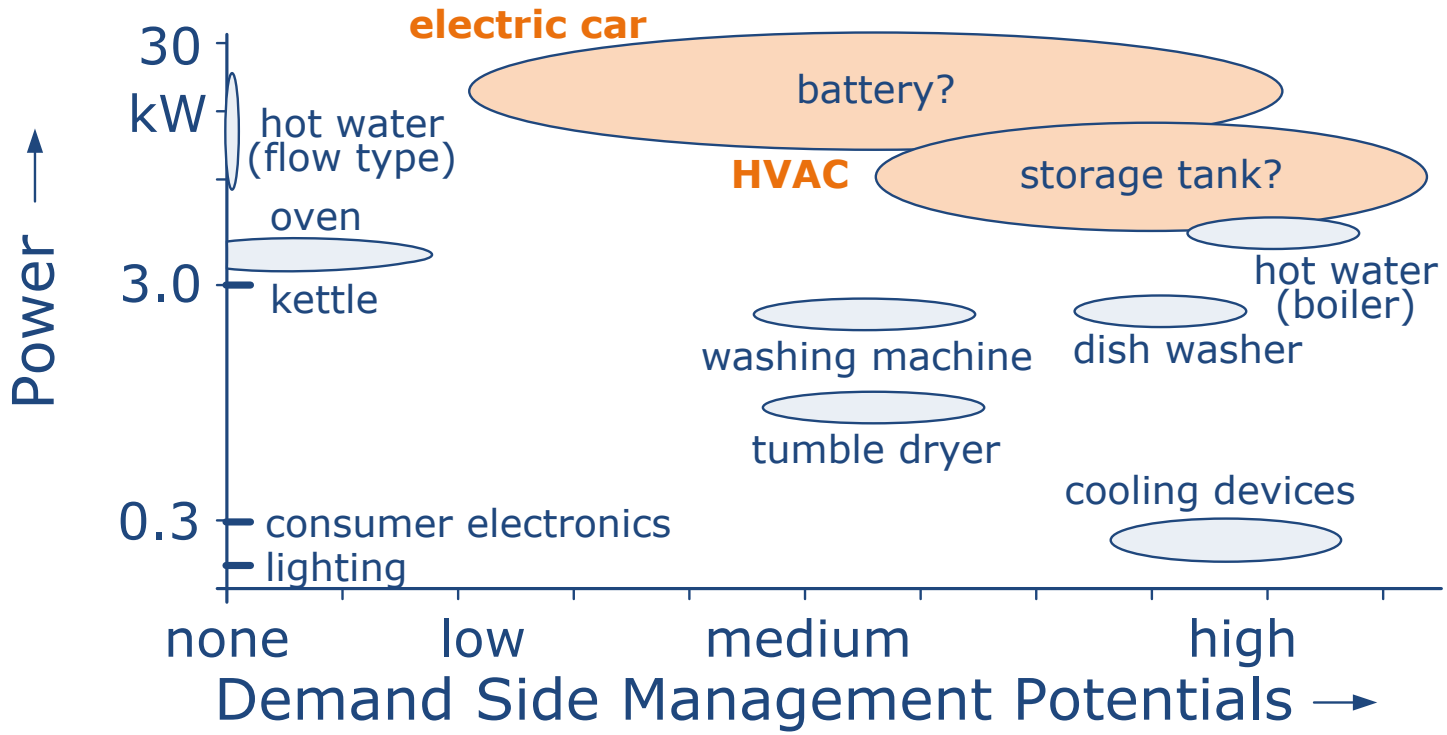
Residential Electricity Consumption



- per household: stagnation for last 30 years
- per capita: increase of 0.8% pa over the last 25 years

Demand Side Management Potentials

Overview



- *today:* heating and cooling
- *prospective:* + mobility and HVAC (heating, ventilation, air conditioning)

Demand Side Management Potentials

Characterization

Direct Demand Side Management

- appliances are turned ON or OFF
  -> usage is shifted

Virtual Demand Side Management

- intermediate storage for energy – electricity or thermal energy

… with central batteries or e-cars

… with central thermal storage tank

- combinations with direct heating, heat pump, solar heat or CHP

… with decentral thermal reservoir

- intermediate storage within the appliance

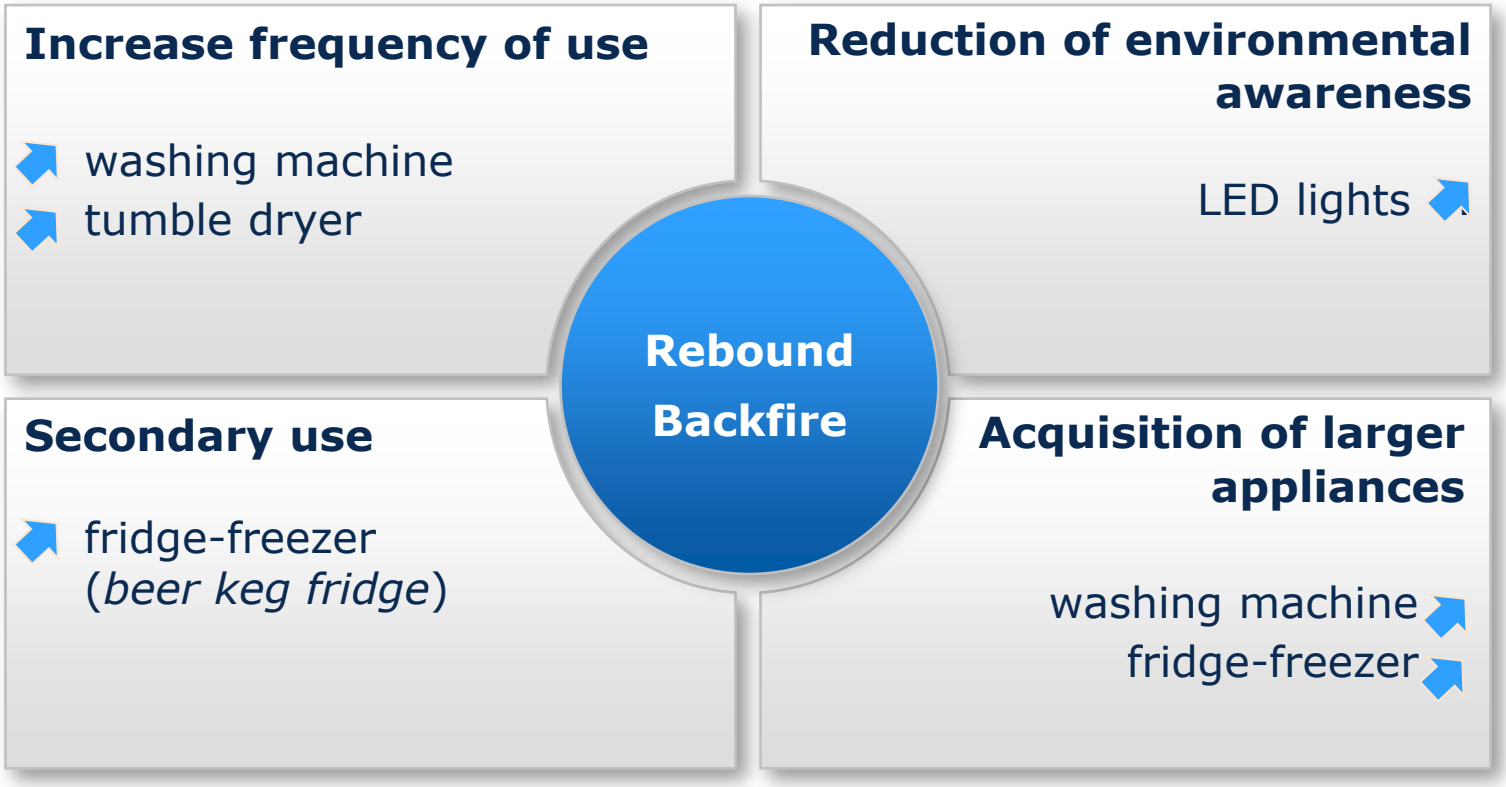
Evolution of Electricity Demand

From 1978 via 2016 to 2040

Appliance	1978	1999	2016	Reduction 1978-2016	Prospective
	in Wh (per use)				
fridge	900	490	60	**-93%**	**-50%**
freezer	1.100	480	120	**-89%**	**-50%**
dish washer	210	100	50	**-76%**	**-50%**
washing machine	420	190	70	**-83%**	**-50%**
tumble dryer	900	640	140	**-84%**	**-25%**

Evolution of Electricity Demand

Rebound effect & backfire



Evolution of Electricity Demand

Electricity Consumption Per Capita

- appliances: comfort
- usage: intensive
- efficiency: up-to-date appliances

Appliance	DSM	*usage*	*P* or *E*	E_a in kWh
fridge	yes	365d	200 Wh/d	72
freezer	yes	365d	75 Wh/d	28
washing machine	yes	104x	350 Wh	36
tumble dryer	yes	104x	850 Wh	88
dish washer	yes	104x	250 Wh	26
hob	no	104x	500 Wh	52
backing oven	no	104x	630 Wh	66
kettle	no	365x	100 Wh	37
micro wave	no	365x	100 Wh	37
vacuum cleaner	no	52x	500 Wh	26
iron	no	52x	1.000 Wh	52
hair dryer	no	104x	200 Wh	21
lighting	no	4 h 365x	20 W	30
consumer electronics	no	4 h 365x	100 W	146
small appliances	no			50
communication	no	8760h	10 W	88
no-load losses	no	8760h	10 W	88
annual electricity consumption				**940**

250 kWh → **Prospective 200 kWh**

690 kWh → **500 kWh**

Performance

Evaluation

DSM potential Germany

home appliances	• 250 ⇨ 200 kWh/a • loss of comfort • *DSM with decentral thermal reservoir*	16 TWh/a
e-cars with batteries	• 6 Mio. e-cars by 2030 • distance: 20.000 km pa • consumption 15 kWh/100 km	18 TWh/a
HVAC central storage tanks	• heating in winter • air-conditioning in summer • storage tank for load shifting	?

Performance

Comparison

	direct DSM	virtual DSM: battery	virtual DSM: central storage tank	virtual DSM: decentral reservoir
comfort	**low**	**high**	**high**	**high**
potential	high	high	lower	lower
losses	none	low	low	high
costs	low	very high e-car: anyway costs	anyway costs	integrated in appliances
installation	low	very high	low	low

Conclusion

Efficiency gains for home appliances

⇨ reduction of overall electricity consumption

Direct demand side management for appliances

⇨ loss of comfort

⇨ *potential for virtual DSM with decentral thermal reservoir*

Virtual demand side management with e-cars

⇨ 6 million cars vs. 200 million appliances

HVAC (heating, ventilation, air conditioning)

⇨ electricity as energy source

⇨ high DSM potential especially with central storage

Thank you!

Joerg Dickert

TU Dresden – IEEH

+49 351 463 43201

joerg.dickert@tu-dresden.de