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The Potential of Smart Appliances Operation

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Overview

- Appliance load curves
- Daily load curves for one average EU household
- Synergy potential
- Additional use options for renewable energies

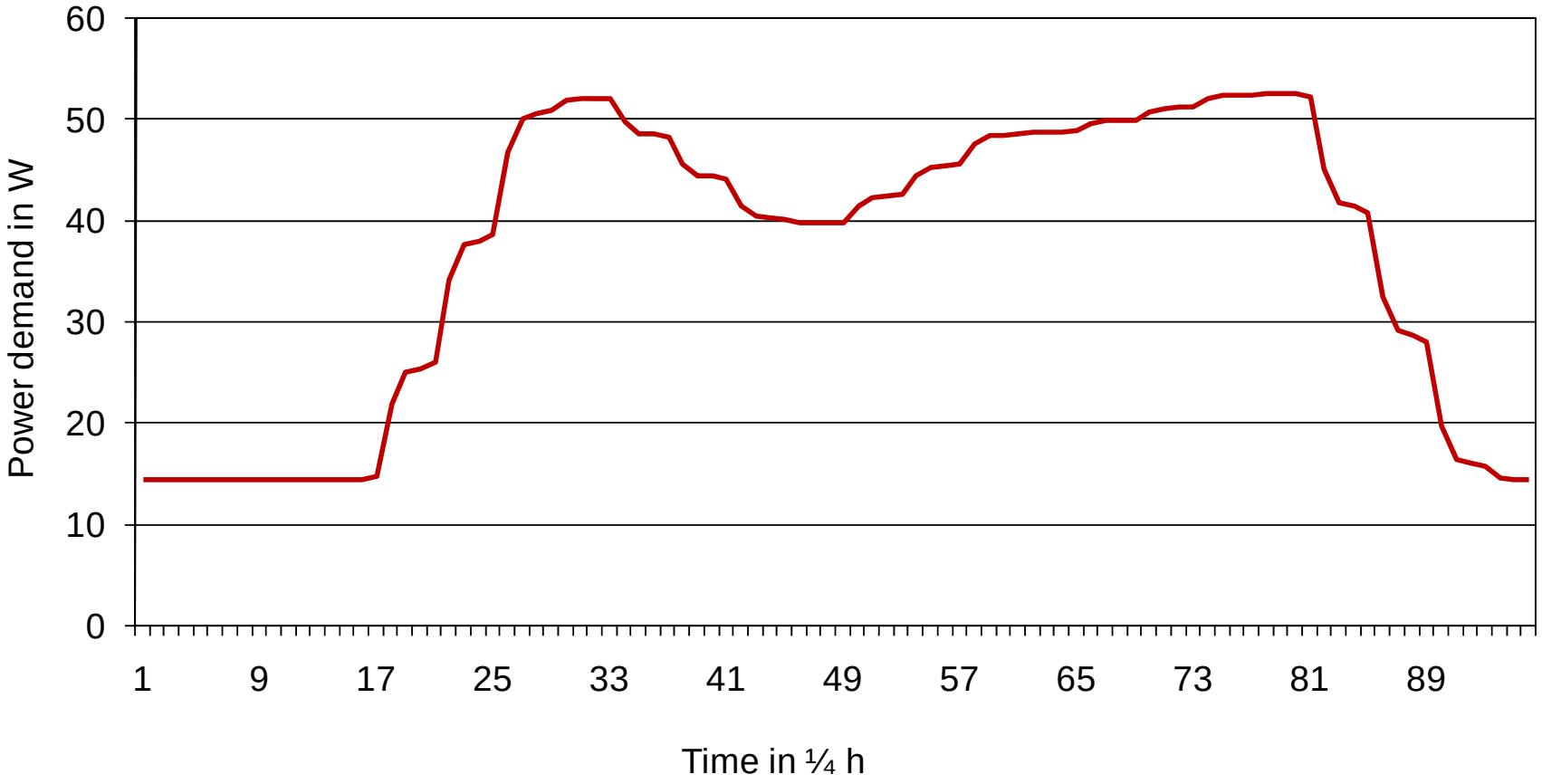
10 domestic appliances in focus:

- WM Washing machine
- TD Tumble dryer
- DW Dishwasher
- OS Oven & stove
- RF Refrigerator
- FR Freezer
- AC Air conditioner
- WH Electric water heater
- EH Electric heating (storage unit)
- CP Heating circulation pump

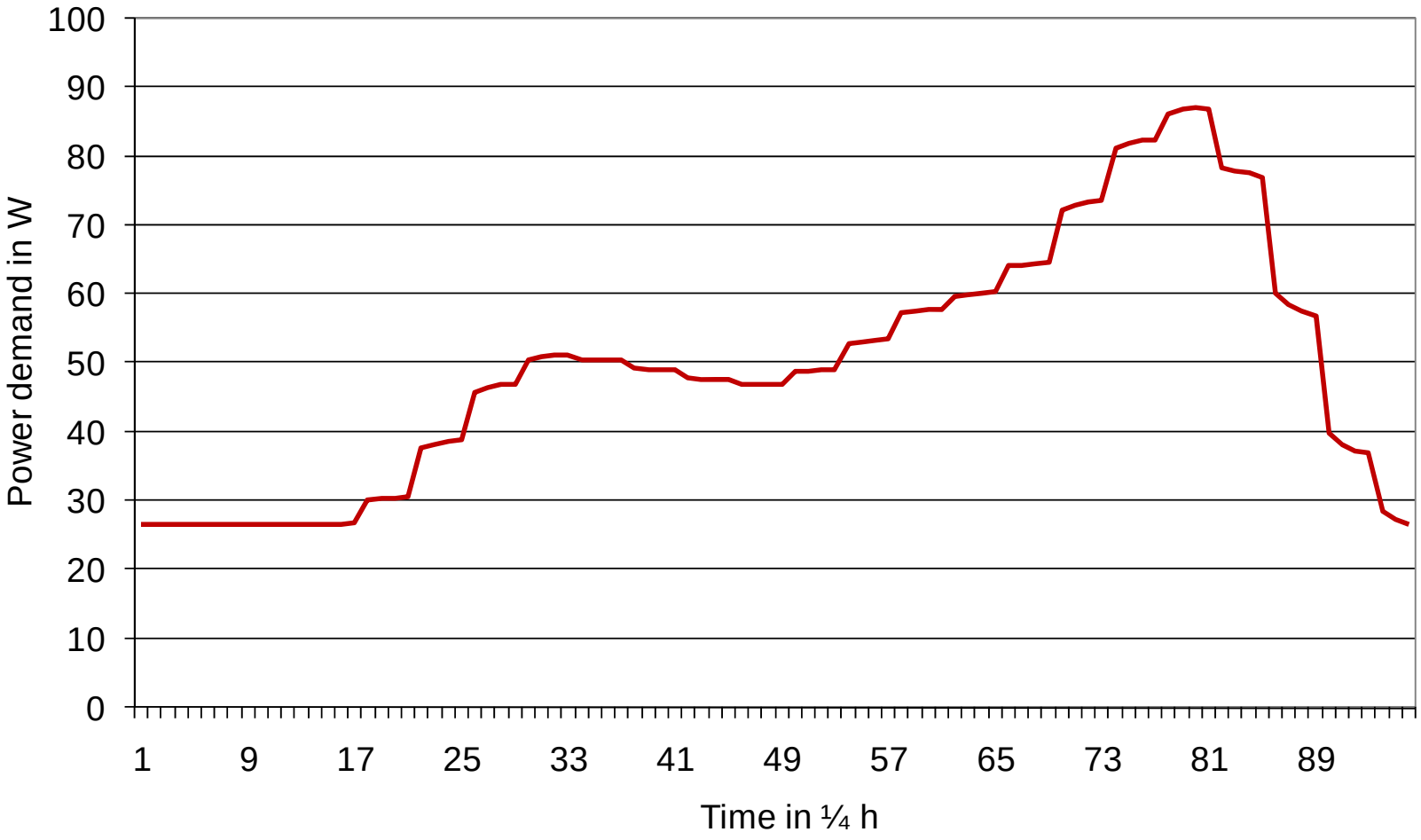
Appliance load curves

Average power demand of each appliance during a day

General pattern of a daily power demand curve of a WM:



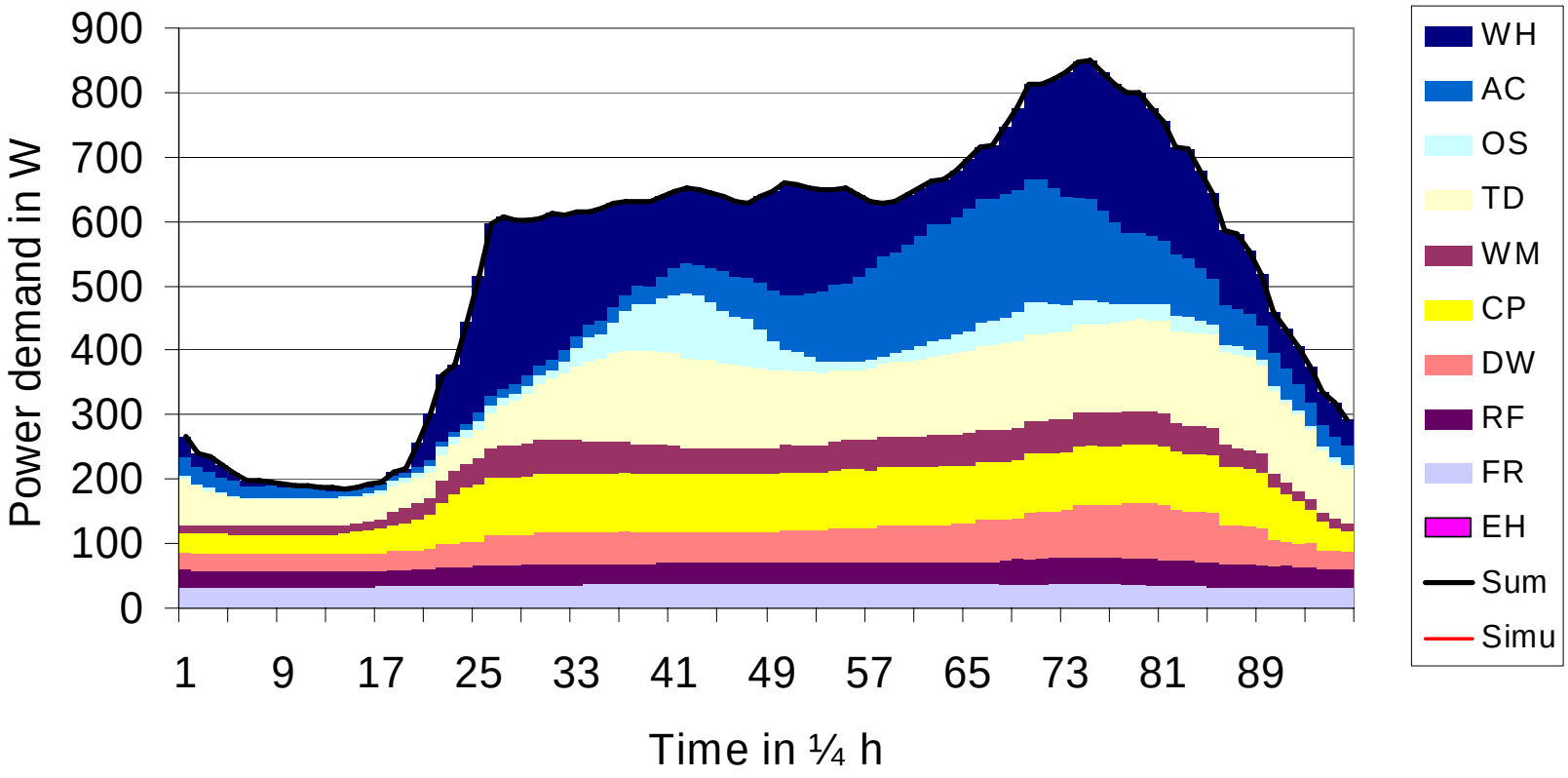
General pattern of a daily power demand curve of a DW:



Daily load curves for one EU household

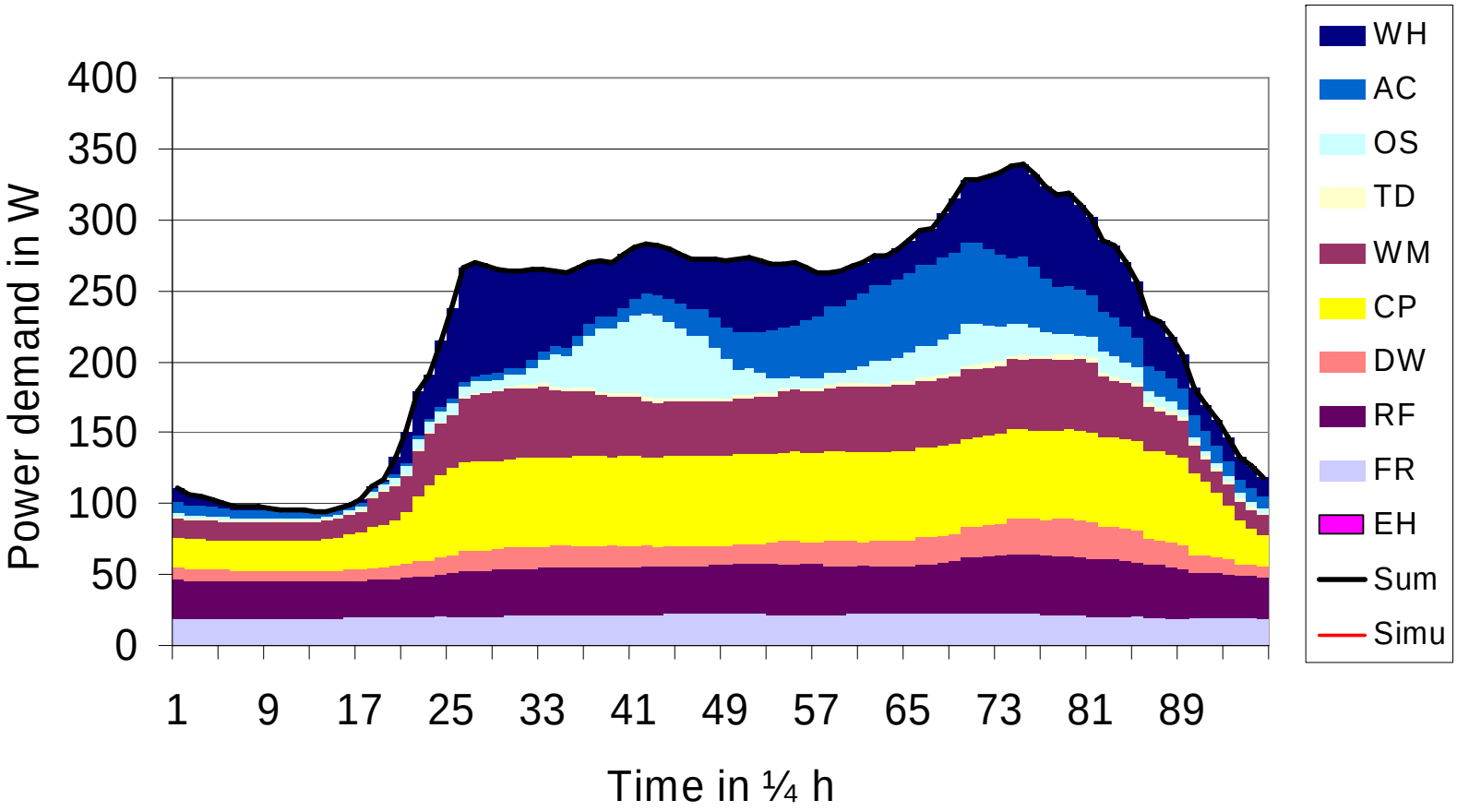
Average power demand of all appliances in one EU household during one day

Estimated daily load curve with a market penetration of 100% for all devices (no EH) in an average EU household:

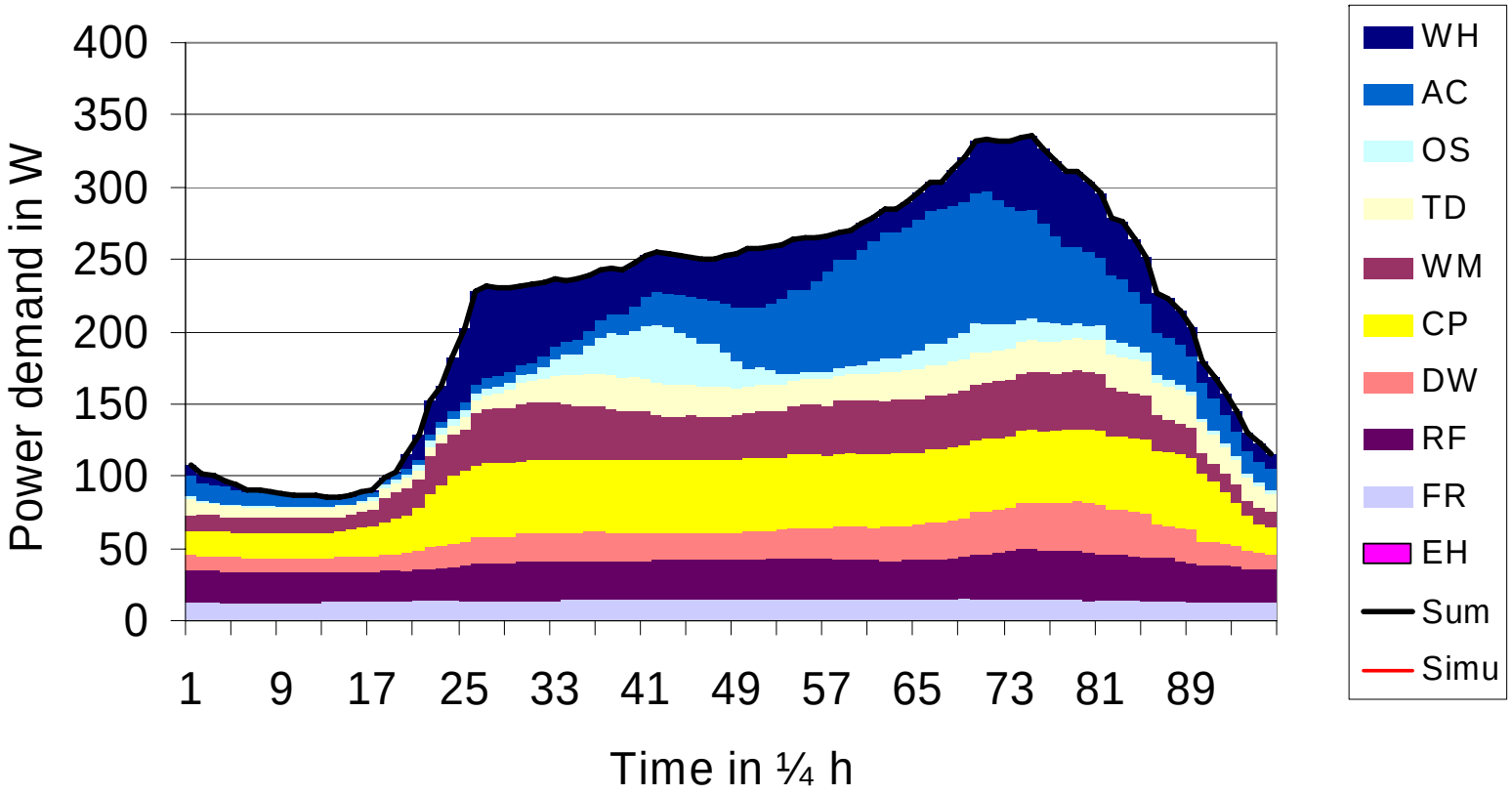


- Peak energy consumption in the evening of more than 800 W
- Drastic reduction to about 200 W during the night

Estimated daily load curve of an average household in region A “South Europe” in 2010:



Estimated daily load curve of an average household in region A in 2025:



Assumption: Reduction of the power demand of 20% in 2025!

Energy consumption per day of an average household in region A in 2010: ~ 5,5 kWh

Energy consumption per day of an average household in region A in 2025: ~ 5,2 kWh

Peaks mainly in the evenings due to power demand of AC

Synergy potential

Estimation of time, probability of acceptance and costs

Definition of 4 levels for gaining synergy effects:

Level 1: Consumer shifts appliance operation in time
(no communication to appliance)

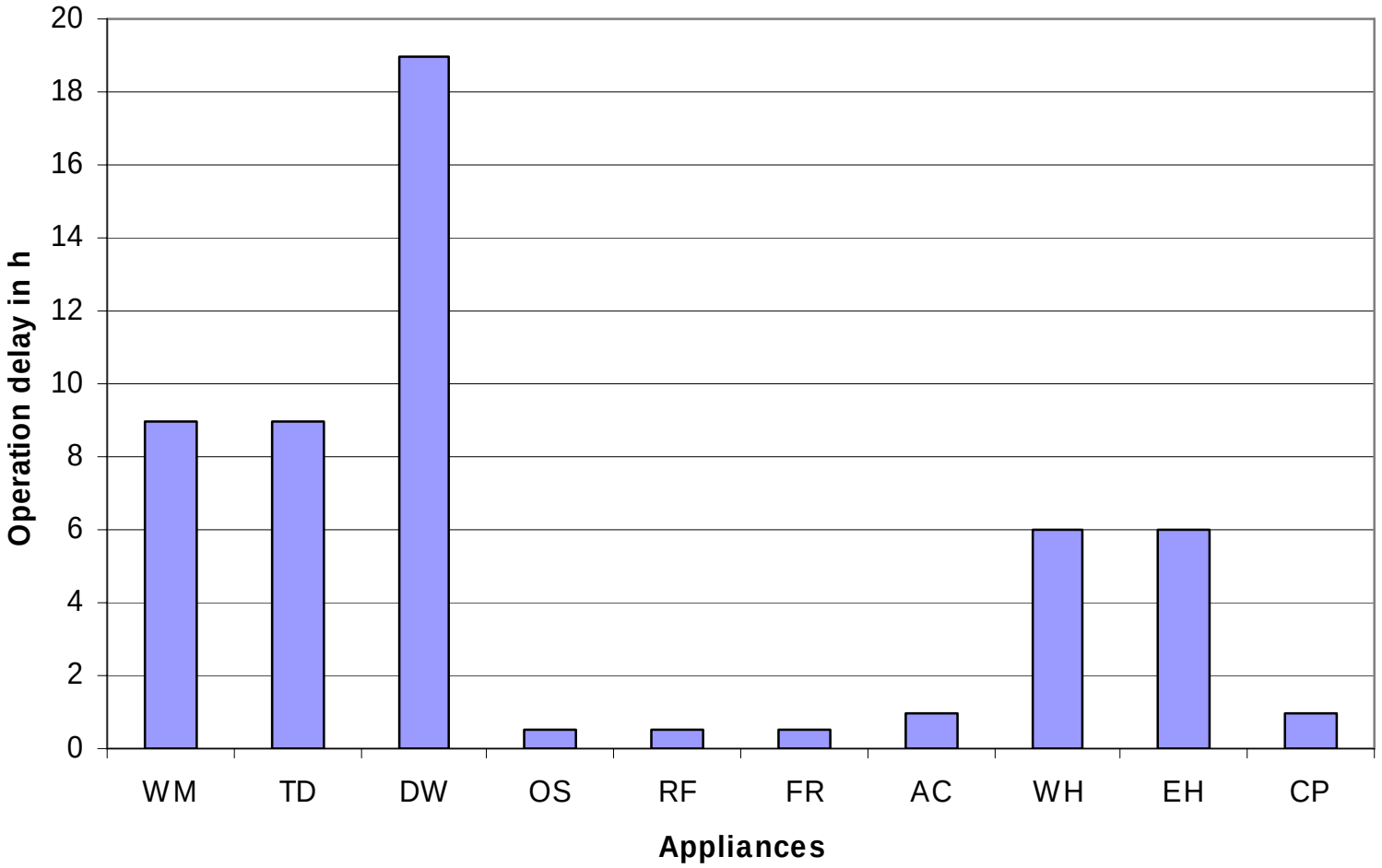
Level 2: Energy manager within the device shifts operation
(uni-directional communication – “broadcast”)

Level 3: External energy demand manager operates appliance
(bi-directional communication – “network”)

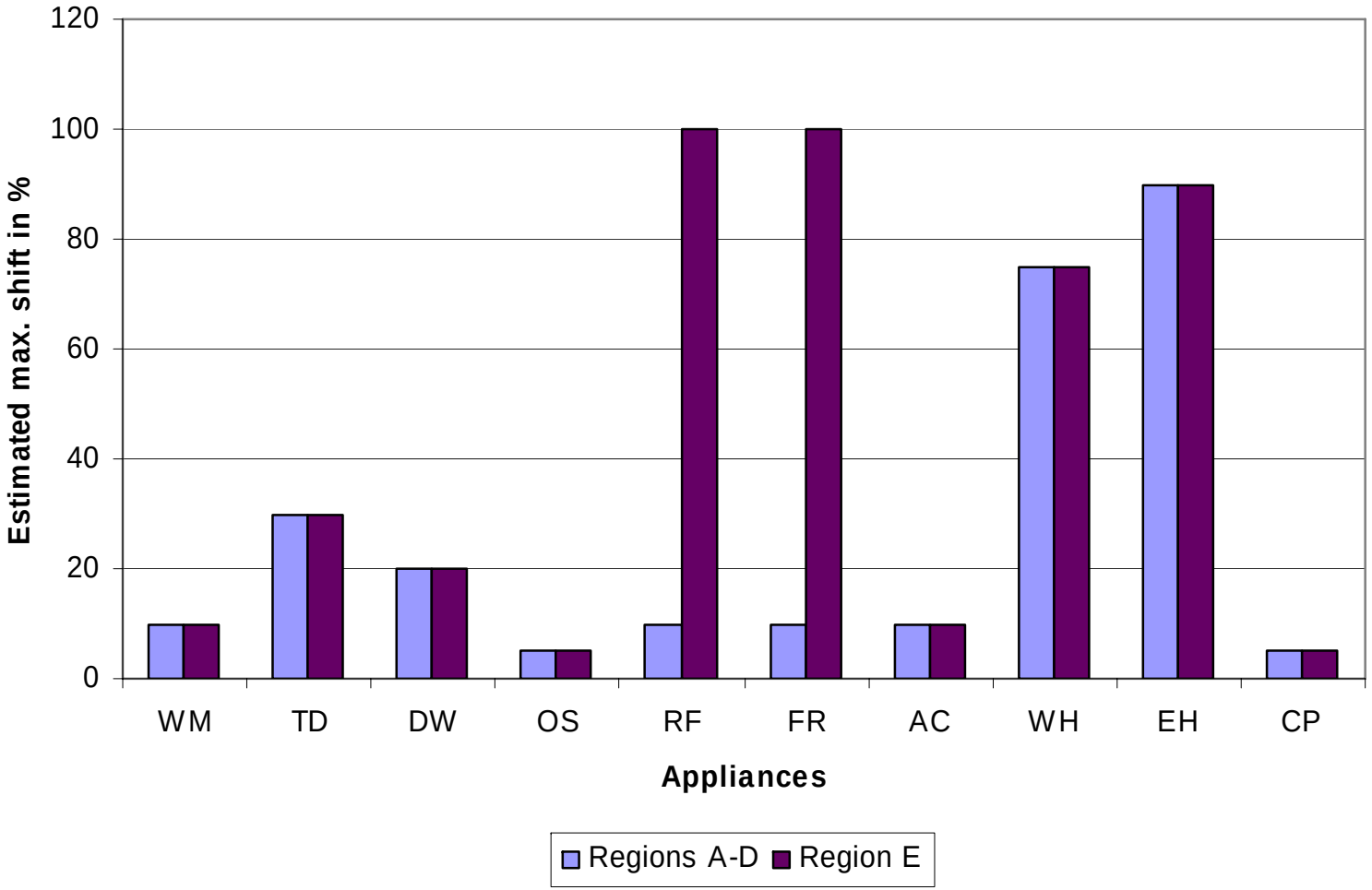
Level 4: Additional use options for renewable energies
(e.g. thermal storage)

→ Technical complexity increases from level 1 to level 3

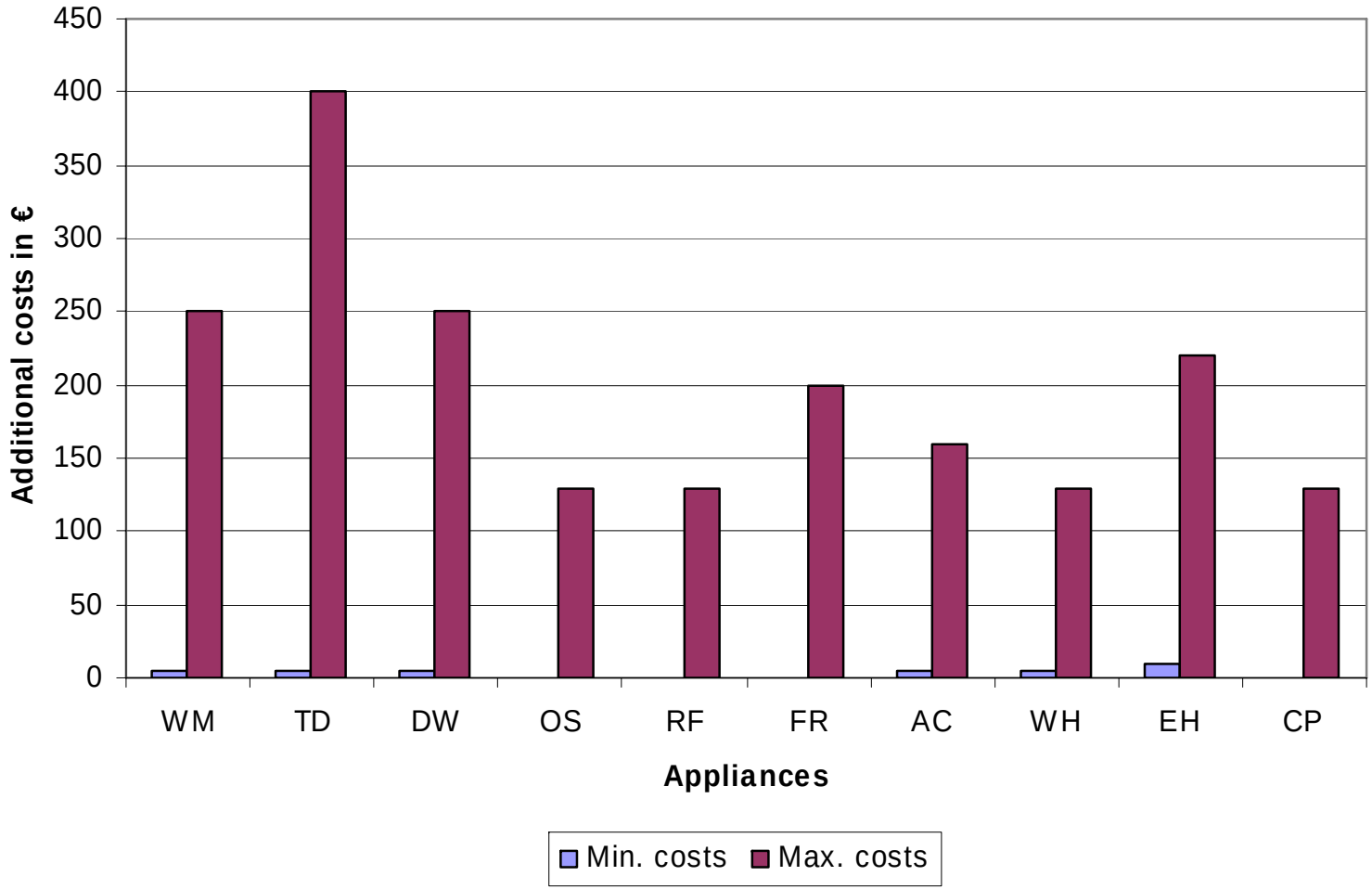
Max. time delay in the operation of the appliance:



Max. participation on time shifting of all scenarios:



Min. and max. costs of all scenarios:



Additional use options for renewable energies

Synergies of level 4

Outcome of an analysis of the potential for an additional use of renewable energies:

- Energy storage: WM, RF, FR, AC
- Heat by CHP or solar power: WM, TD, DW, WH
- Solar energy: AC, EH
- Use of hot water: WM, DW
- Absorber technology: RF, FR, AC

No findings for OS and CP

Additional research is needed to verify the potential and technical feasibility – outside of SMART-A –

Example 1: energy storage

- Freezer receives information that a surplus of renewable electricity is available
- Surplus of renewable electricity:

  stored by lowering the temperature
- Afterwards use of stored energy thus avoiding conventional energy

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Example 2: heat of CHP or other systems

- Connection of e.g. a tumble dryer to a CHP or solar system
- Heating up the heating rods of the device
- Reduction of energy consumption in heating phase: 100%
- Electricity needed only for basic functions
- Drying time might be prolonged

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Example 3: cold storage

- Connection of e.g. an air conditioner to a heat exchanger
- Renewable energy is available but no room cooling needed:

  cold storage by e.g. freezing water to ice (in special tank)
- Need for cooling: ventilator transports air over frozen surface and blows it into the room

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Thank you
for your attention!

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