

The Potential of Smart Appliances Operation

Smart-A Workshop
Berlin, Germany
15 June 2009

Gereon BROIL
(University of Bonn)
Rainer STAMMINGER
(Uni Bonn, WP2 Leader)



Intelligent Energy  Europe

The sole responsibility for the content of this presentation lies with the authors. It does not necessarily reflect the opinion of the European Communities. The European Commission is not responsible for any use that may be made of the information contained therein.

Overview

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

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

Scope

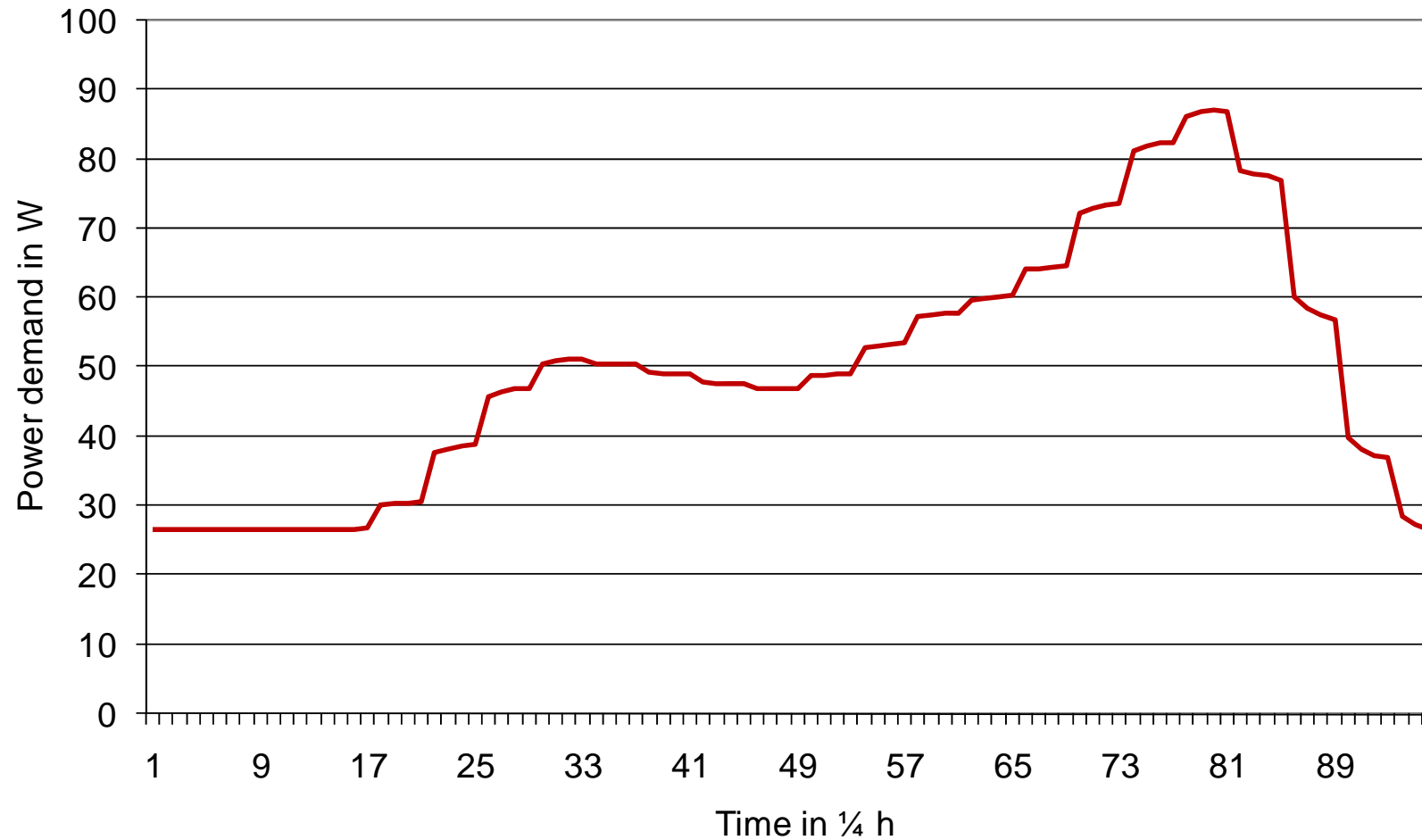
10 household appliances have been analysed with respect to

- Their demand on energy (electricity and hot water) with regard to time and amount of use
- The technical possibilities for a flexibility of usage
- Constraints due to a flexible use
- Additional costs and energy consumption
- Acceptance at consumer level

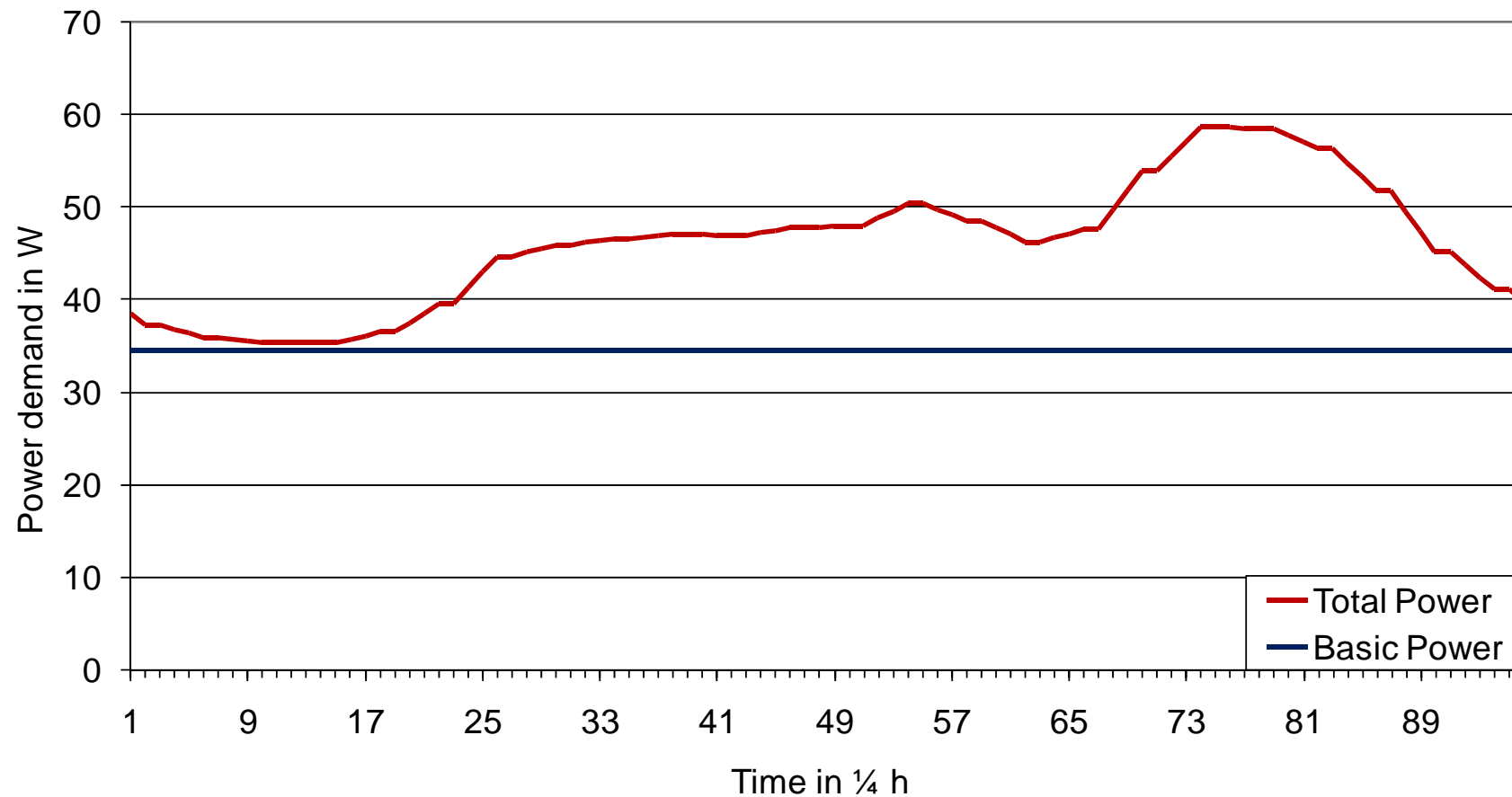
Appliance load curves

Average power demand of each
appliance during a day

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



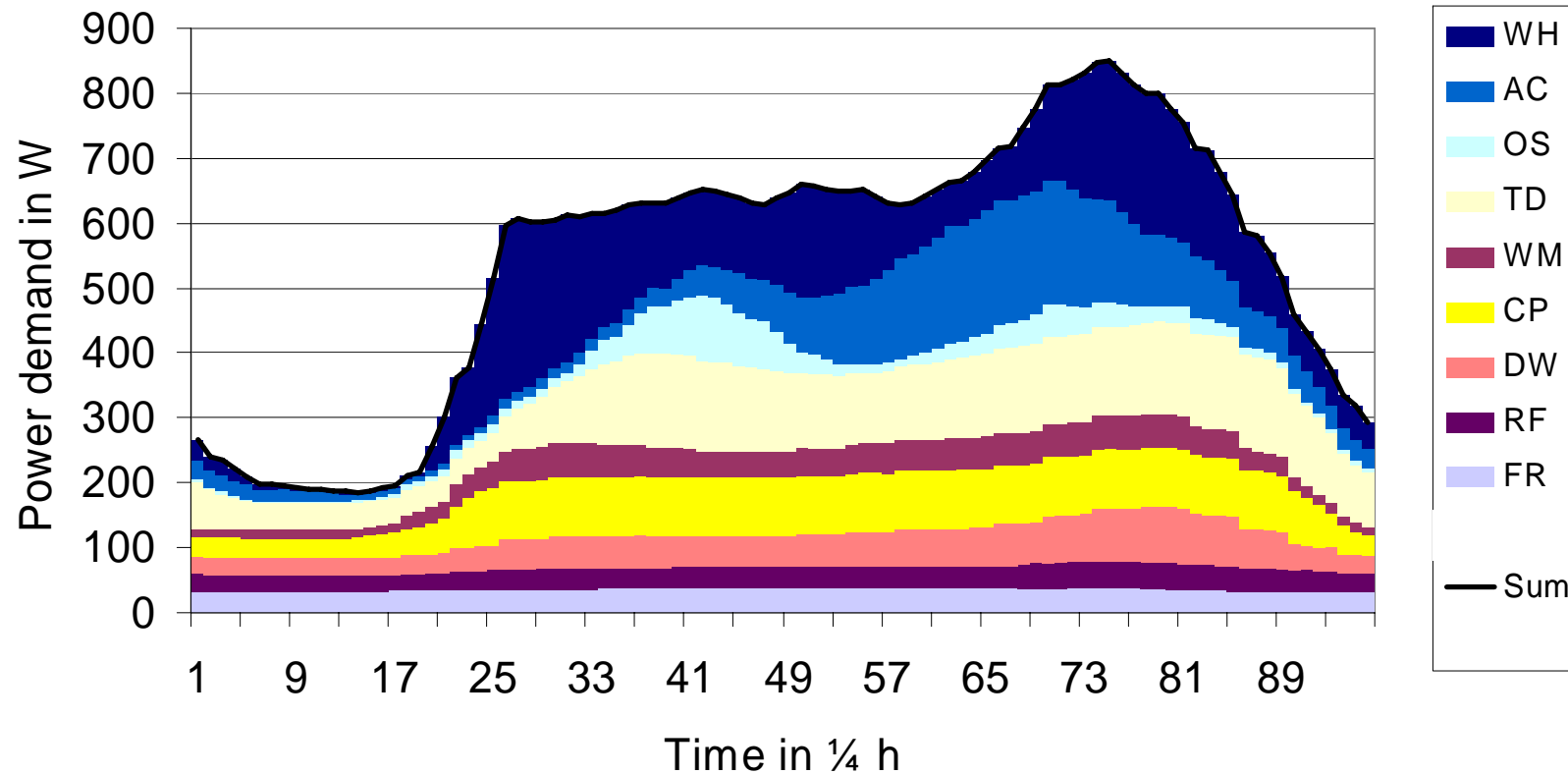
General pattern of a daily power demand curve of a RF:



Daily load curves for one EU household

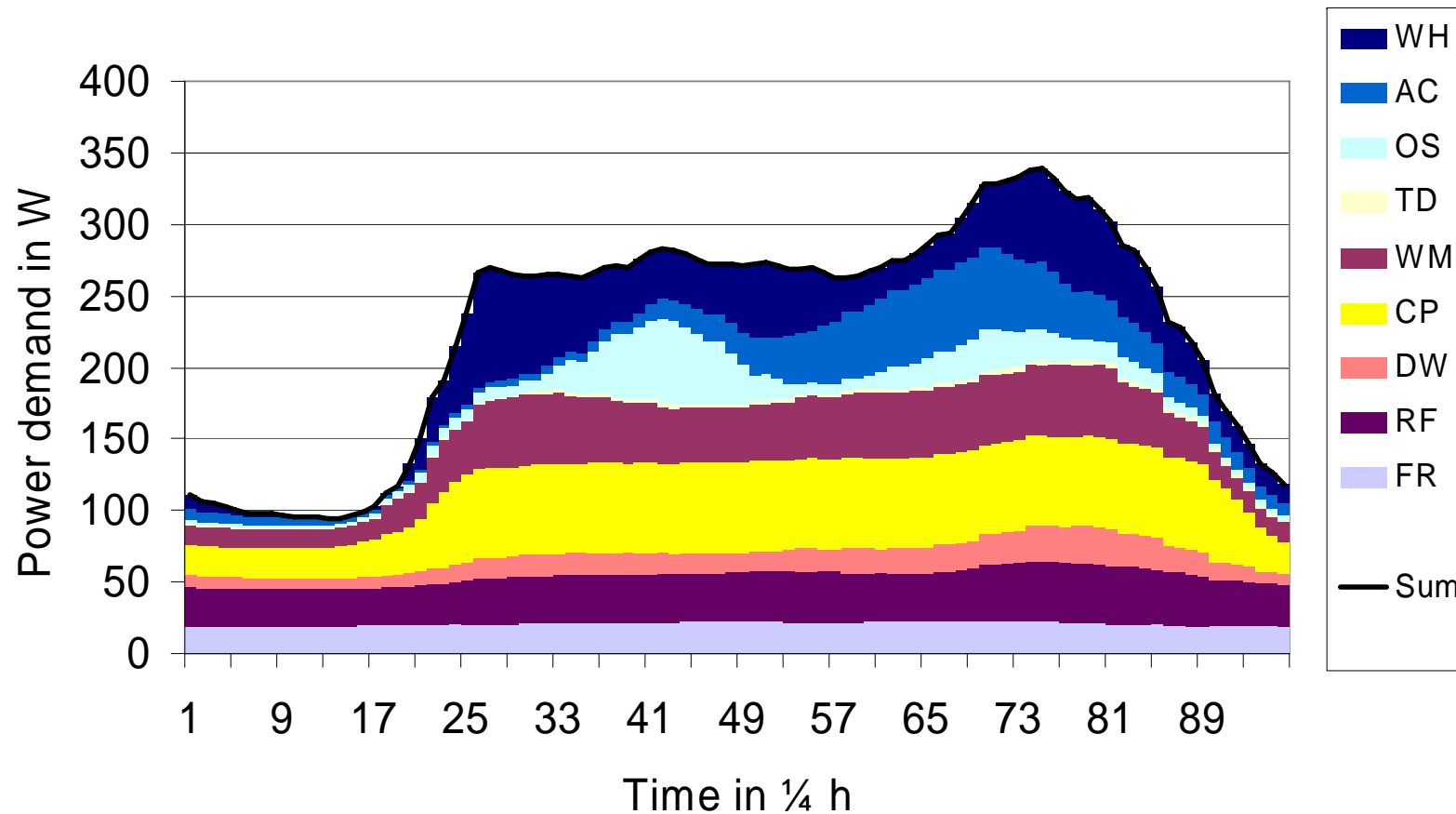
Average power demand of all appliances in
one EU household during one day

Estimated daily load curve with a market penetration of 100% for all devices in an average EU household:

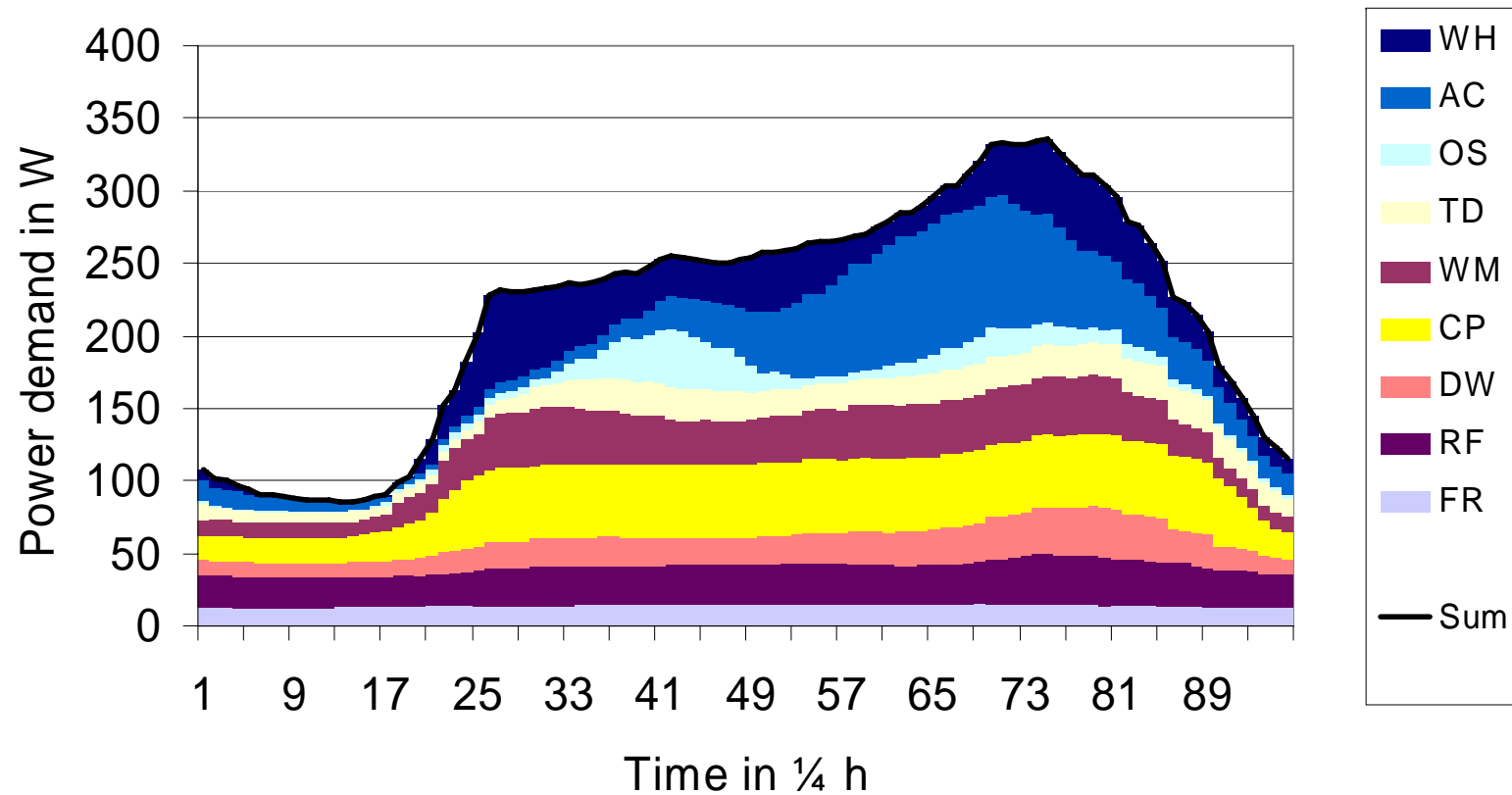


- Peak energy consumption in the evening of more than 800 W
- Drastic reduction to about 200 W during the night

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)

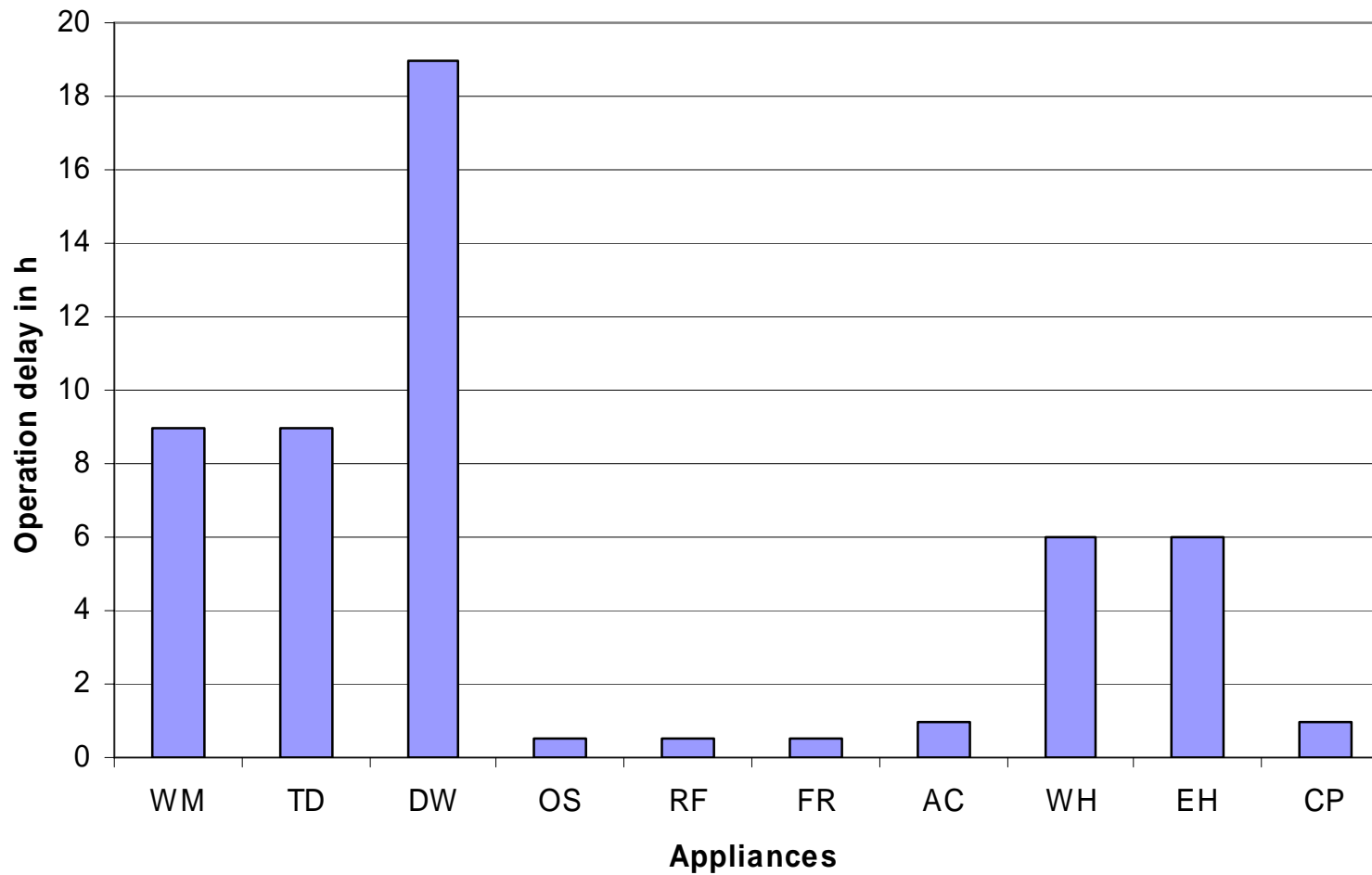
Level 2: Energy manager within the device shifts operation
(uni-directional communication – “broadcast”)

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

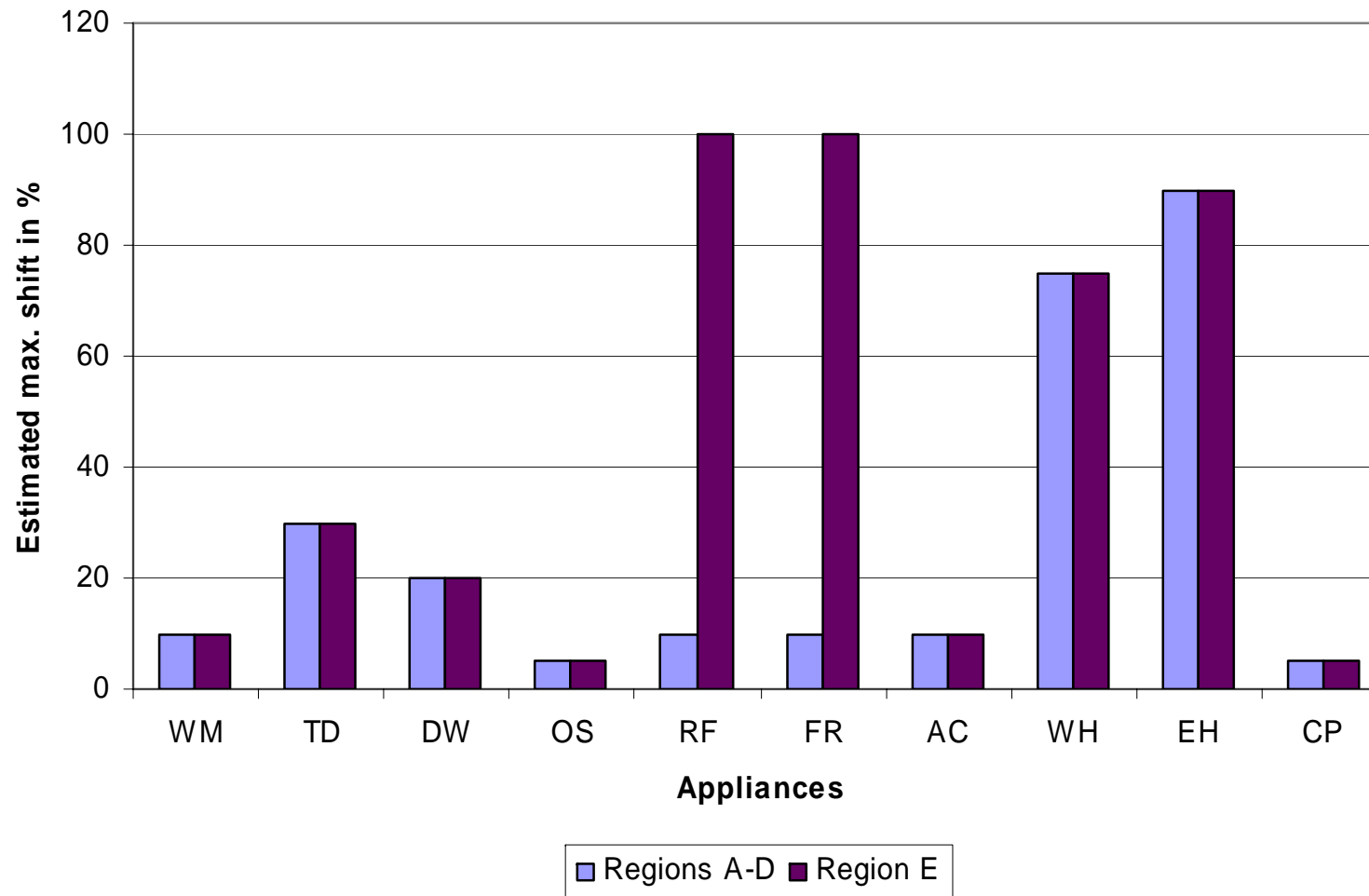
Level 4: Additional use options for renewable energies
(e.g. thermal storage)

→ Technical complexity increases from level 1 to level 3

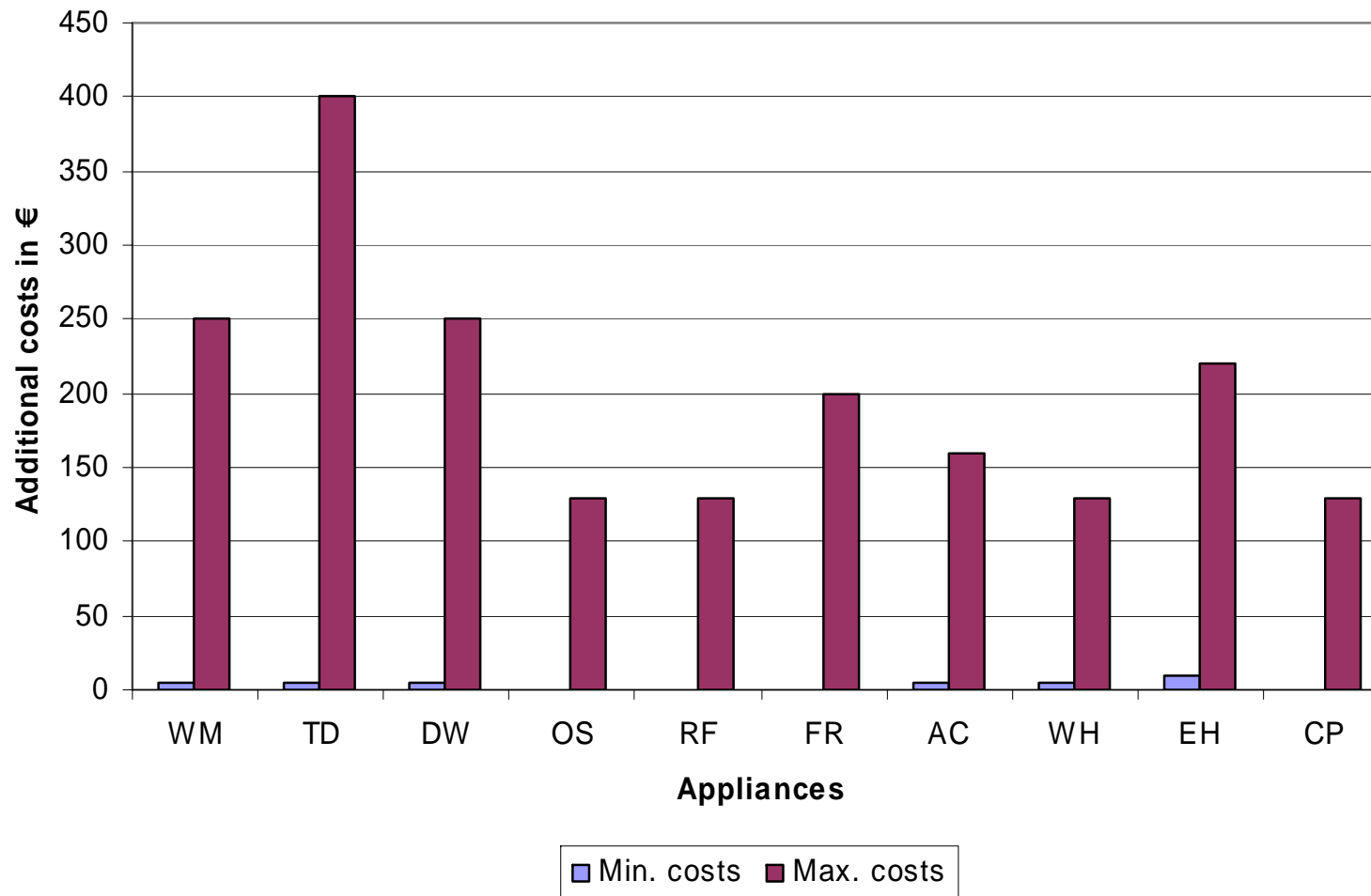
Max. time delay in the operation of the appliance:



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



© IBC <http://www.ibc-solar.de/kuehlgeraete.html>

Investigation and results: Energy storage in freezers

- Increasing temperature amplitude to +/- 7.5 K instead of +/- 1.5 K
 - Simulation of cold energy storage and rising temperature during interruptions of power supply
 - In all cases a temperature of max. -18 °C was assured
- Increase in energy consumption of 10% in comparison to normal amplitude of +/- 1.5 K
- Recording of mass and texture analyses, vitamin C content, peroxide values, sensory impressions for more than one year
 - Sample: peppers, bread and minced beef
- No significant quality differences between the storage temperatures and temperature amplitudes could be identified

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



© Vaillant



© Privileg [http://www.quelle.de/is-bin/INTERSHOP_enfinity/WFS/Quelle-
quelle_de-Site/de_DE/EURQ_Display/ProductInformation-
Start?ProductID=qp_m100000103617&AAID=100000103103&Category
Name=240891&PromoShopID=240885&Linktype=M](http://www.quelle.de/is-bin/INTERSHOP_enfinity/WFS/Quelle-
quelle_de-Site/de_DE/EURQ_Display/ProductInformation-
Start?ProductID=qp_m100000103617&AAID=100000103103&Category
Name=240891&PromoShopID=240885&Linktype=M)



Schriftenreihe der
Haushaltstechnik Bonn
Herausgeber: Prof. Dr. R. Stamminger

Rainer Stamminger (Ed.)

**Synergy Potential of
Smart Domestic Appliances
in Renewable Energy Systems**

Band 1/2009



Additional presentation on the EEDAL conference:
WS “Metering and Smart Grid” (18th June, 11:15)

Results about demand curves and shifting
potentials are available on:

www.smart-a.org

Results of constraints, consumer acceptance and
synergy scenario calculation are additionally
included in:

**“Synergy Potential of Smart Domestic
Appliances in Renewable Energy Systems”**

ISBN 978-3-8322-8082-6

Shaker Verlag GmbH

[http://www.shaker.de/online-
Gesamtkatalog/booklist.asp?ID=1375027&CC=661&Reihe=423](http://www.shaker.de/online-Gesamtkatalog/booklist.asp?ID=1375027&CC=661&Reihe=423)



Thank you for your attention!

Contact:

Prof. Dr. Rainer Stamminger

(Universität Bonn, WP Leader: +49(0)228-73 3117, stamminger@uni-bonn.de)

Supported by:

Intelligent Energy  Europe



Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

PTJ
Projektträger Jülich
Forschungszentrum Jülich

The sole responsibility for the content of this presentation lies with the authors. It does not necessarily reflect the opinion of the European Communities. The European Commission is not responsible for any use that may be made of the information contained therein.