SoLAR - Living Quarter Energy Pilot Achieving Maximum Self Sufficiency

Baden-Württemberg
MINISTERIUM FÜR UMWELT, KLIMA UND ENERGIEWIRTSCHAFT

SoLAR
Smart Grid ohne Lastgangmessung Allensbach - Radolfzell

Contract Partners Funded Project

ISC International Solar Energy Research Center Konstanz · eifer · kaufmann bau.com

Associated Partners

Easy Smart Grid GmbH · WEIDER WÄRMEPUMPEN · B/S/H/ BSH HAUSGERÄTE GMBH

NaturEnergie von Energiedienst · stadtwerk haßfurt · SWT

Supporting Partners

ALLENSBACH am Bodensee · GEMEINDEWERKE BODANRÜCK · Miele · Buderus · E3/DC ENERGY STORAGE

STADTWERKE RADOLFZELL ...immer vor Ort! · Netze BW · inpuncto Küchen und Möbel · TEC Technik · cfaed CENTER FOR ADVANCING ELECTRONICS DRESDEN · Hochschule Offenburg offenburg.university

SmartGridsBW Energien intelligent vernetzen. · Technische Universität München · TUM · TECHNISCHE UNIVERSITÄT DRESDEN

... and others

Solving the Storage Problem with "Virtual Batteries"

How to power a process with renewables?

1 kWh capacity
≡ 800 € / ca. 20 ct/kWh

1 kWh energy consumption

flexibility use
≡ < 1 ct/kWh

Power

200%

150%

100%

50%

0

wind

sun

electricity demand

Storage

Flexibility

00:00   03:00   06:00   0900   12:00   15:00   18:00   21:00   00:00

time of a day
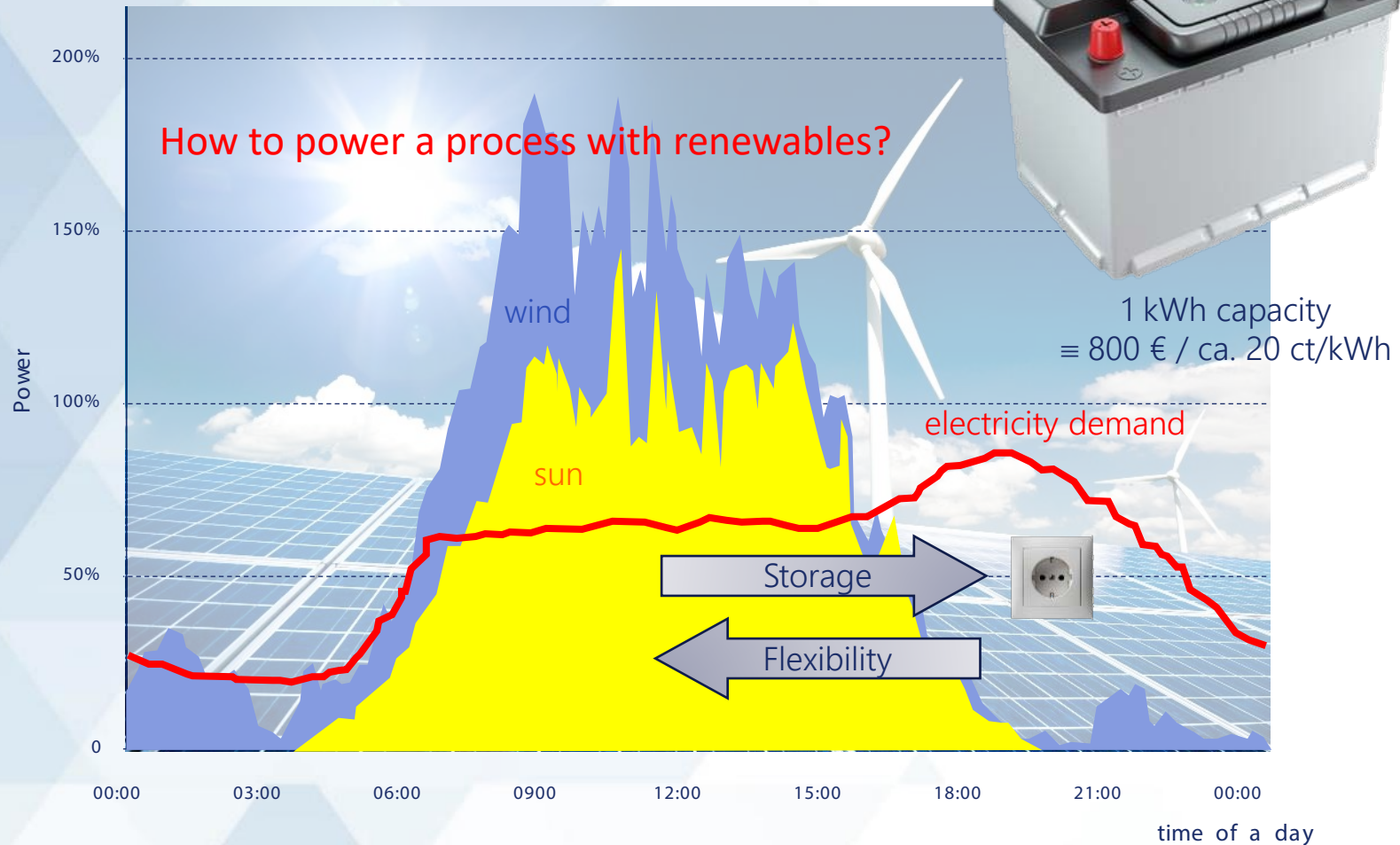
Sector Coupling for more Efficiency –
und for more „Virtual Batteries"

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Electric Devices
- Load shifting as „Virtual Battery"
- Control power possible

Heat Pumps
- Energy storage by heat
- 4 x more efficient than gas heating

CHP and Fuel Cells
- Electricity <u>and</u> heat lead
- Efficient heat use
- High feed temperatures

Electric Vehicles
- 75% less energy consumption compared to gasoline and diesel
- Smart Charging - „Virtual Battery"

Electricity

Heating/Cooling

Traffic

Efficiency gains for heating and traffic
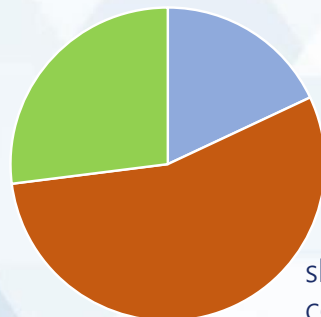
shares at current energy consumption

80%

50%

100%
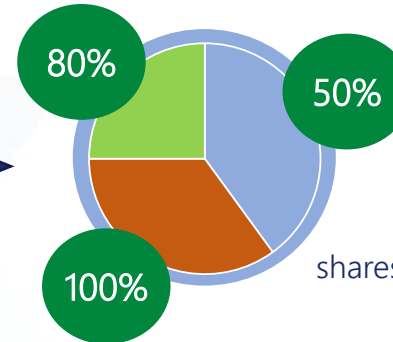
shares in electrified scenario

Flexibility Potential in sum about 80%
(80% of electric demand may be shifted in time using „Virtual Batteries")

SoLAR:
Decentral Energy Management

Price Signal

☀ surplus

„Balance Indicator" BI
-1 to + 1

out of grid state,
e.g. frequency, voltage, current .....

🌧 shortage

time →

on

off   off

Price = Basic Price - BI * Flexibility Bonus

WEIDER
WÄRMEPUMPEN

Easy
Smart
Grid
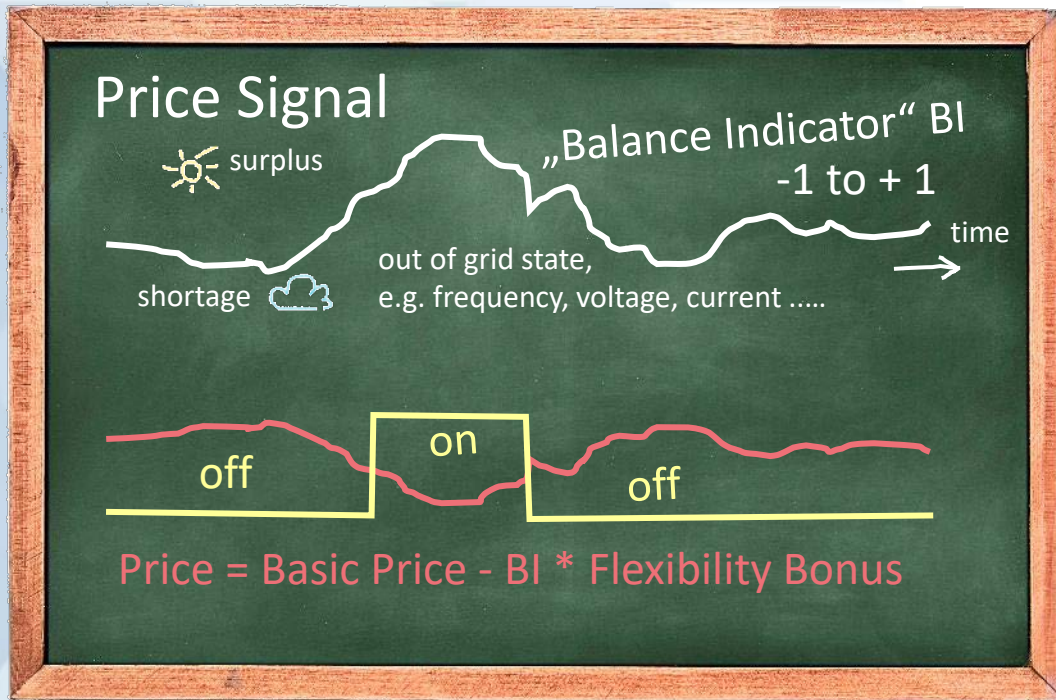
electronic meter

smart meter 2.0 with BI generator

forgery-proof plug with rules

BI →

heat pump

Real Estate and Flexible Devices

North
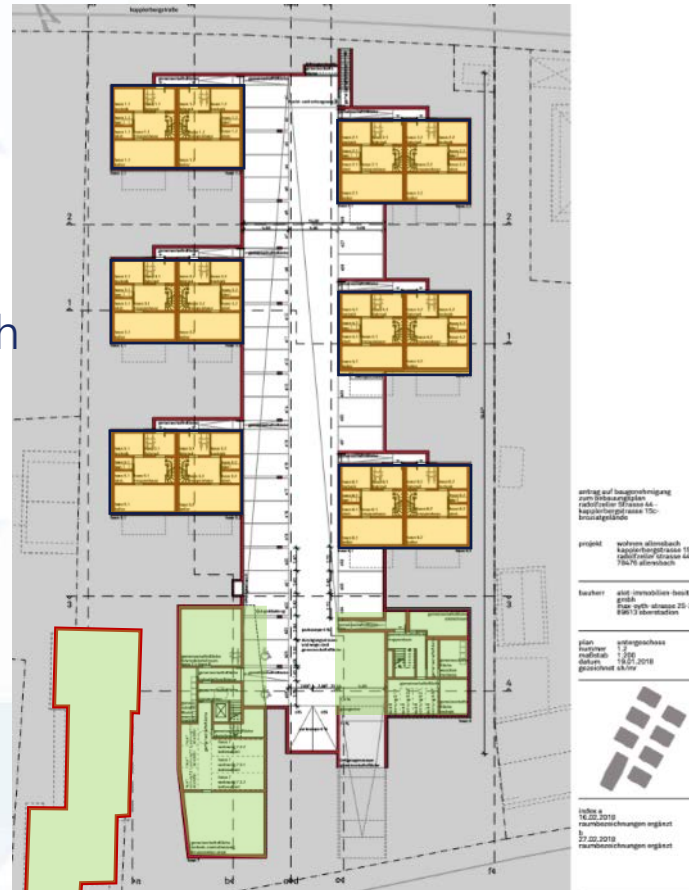
existing building

- 9 houses with 25 apartments
- KfW 40 insulation standard (new buildings)
- 14 PV plants (Σ 70 kWp)
- 12 heat pumps 5 kW$_{th}$ (ground water)
- 1 CHP 21 kW$_{el}$, 46 kW$_{th}$
- charging stations for electric vehicles
- battery storages (SDH, KfW 40+)
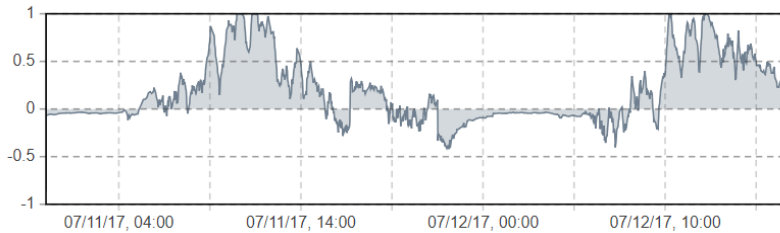- flexible home appliances for 25 apartments (e.g. washing machine, dishwasher, tumble dryer, refrigerator, freezer)
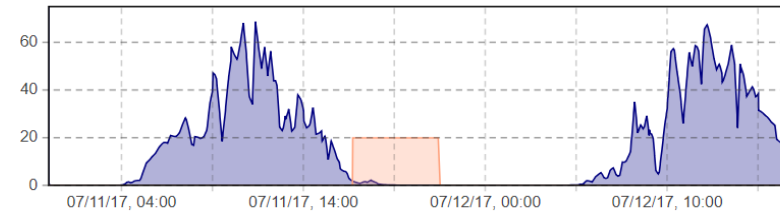
➜ More then 100 controlled devices

Virtual Demonstrator
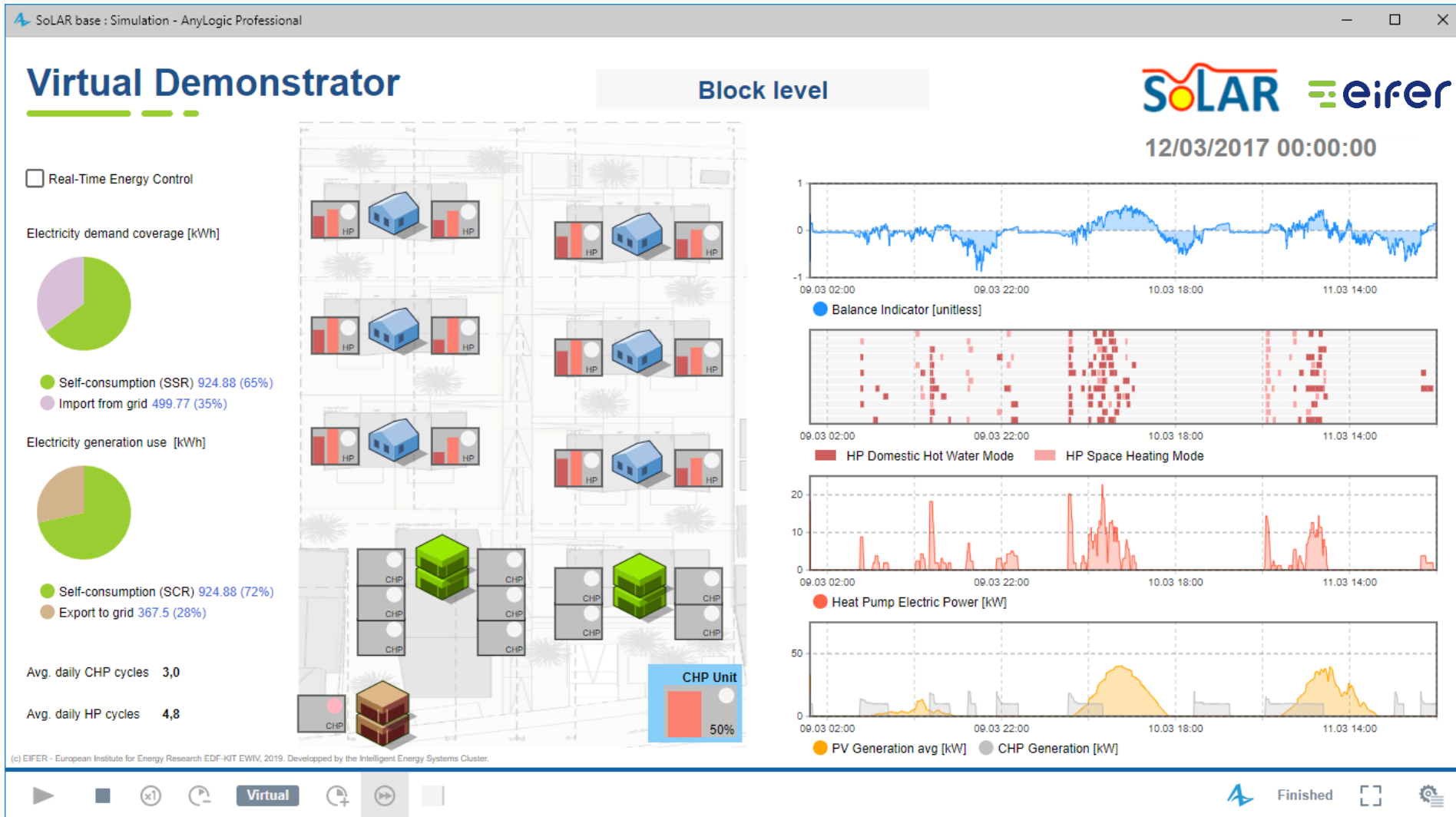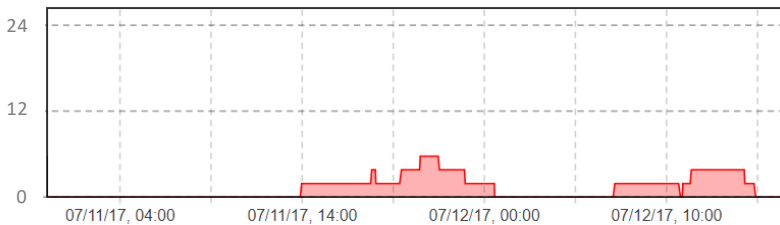
Decentral Energy Management Scenario Summer

Balance Indicator

Calculated with power at grid connection point.
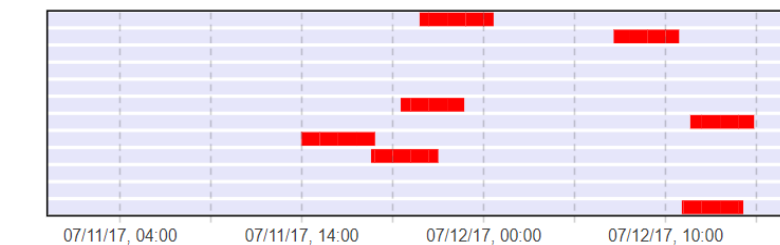+1 = maximum feed
-1 = maximum supply

Generators

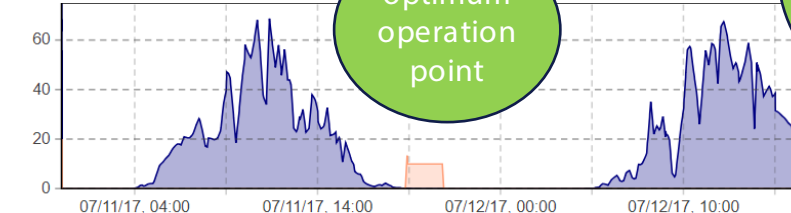Electricity generation of PV plants ( ) and CHP ( )

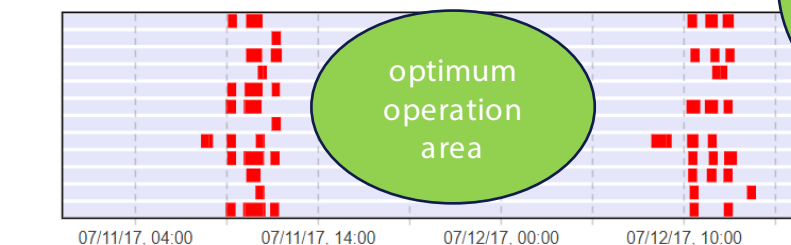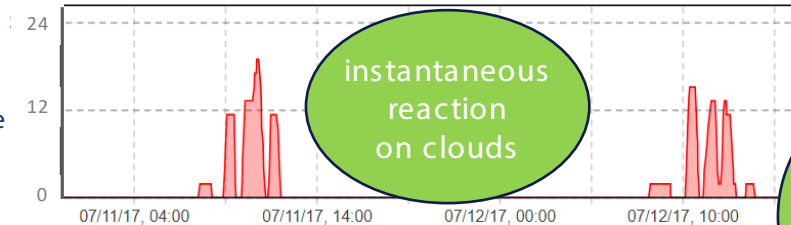heat lead → Easy Smart Grid

Σ Heat Pumps

Sum of power consumption of the heat pumps in 12 private houses

Heat Pumps

Switching decisions of the heat pumps in 12 private houses (warm water supply)

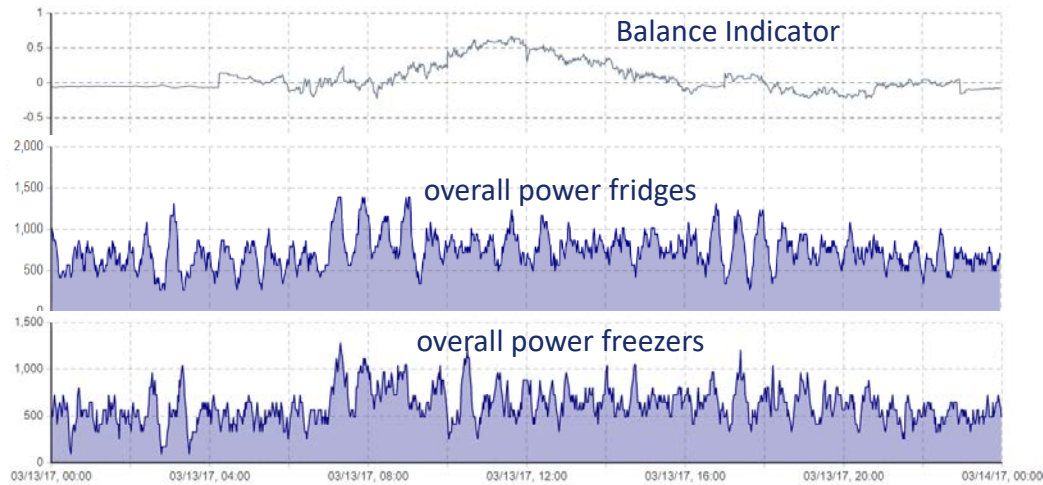CHP **100%** self supply

optimum operation point
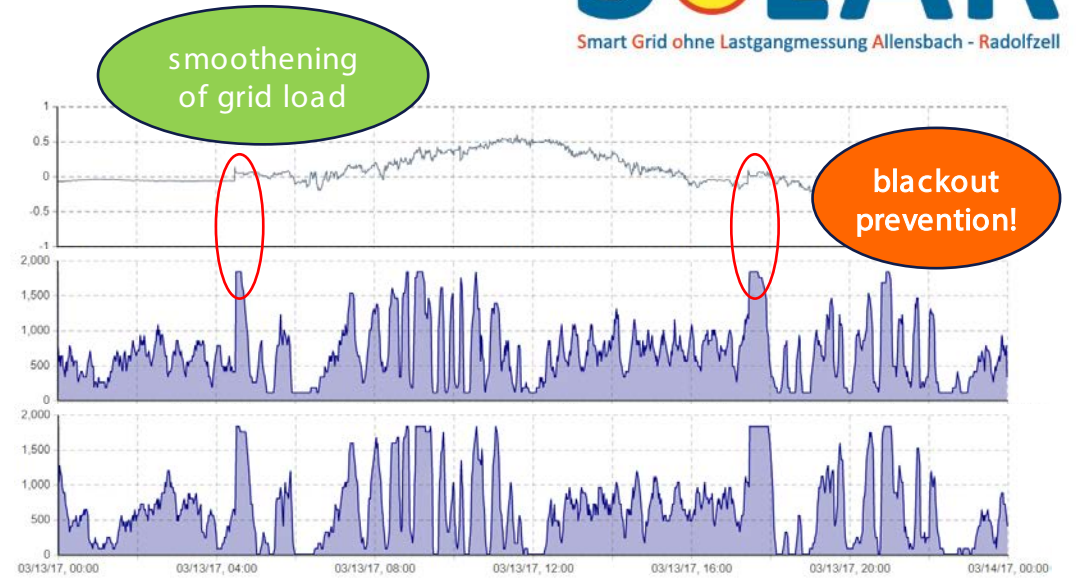
instantaneous reaction on clouds
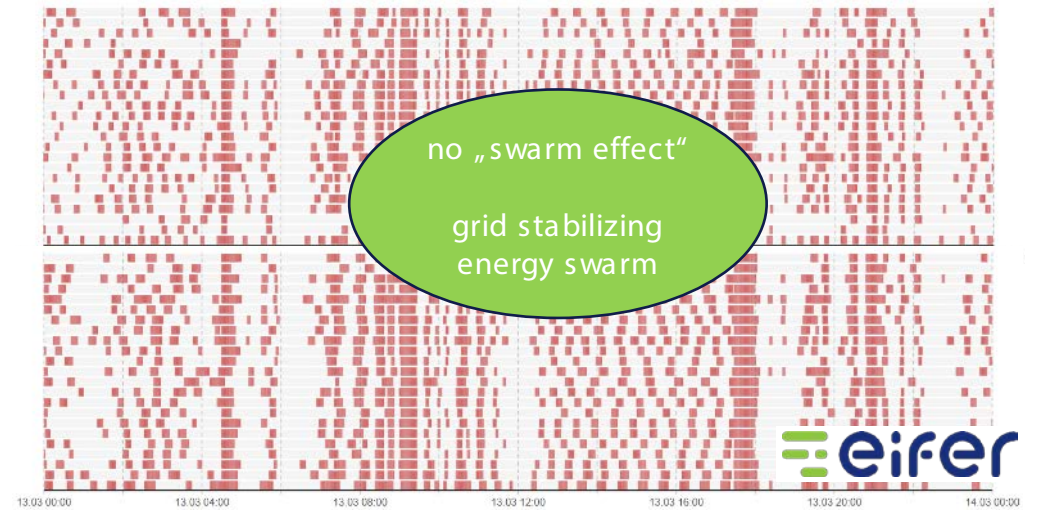
optimum operation area

heat pumps **100%** PV energy

Control of devices with short term storage
e.g. fridges and freezers

Balance Indicator

overall power fridges

overall power freezers

Control via
Balance Indicator

smoothening of grid load

blackout prevention!

no „swarm effect"

grid stabilizing energy swarm

Easy Smart Grid GmbH
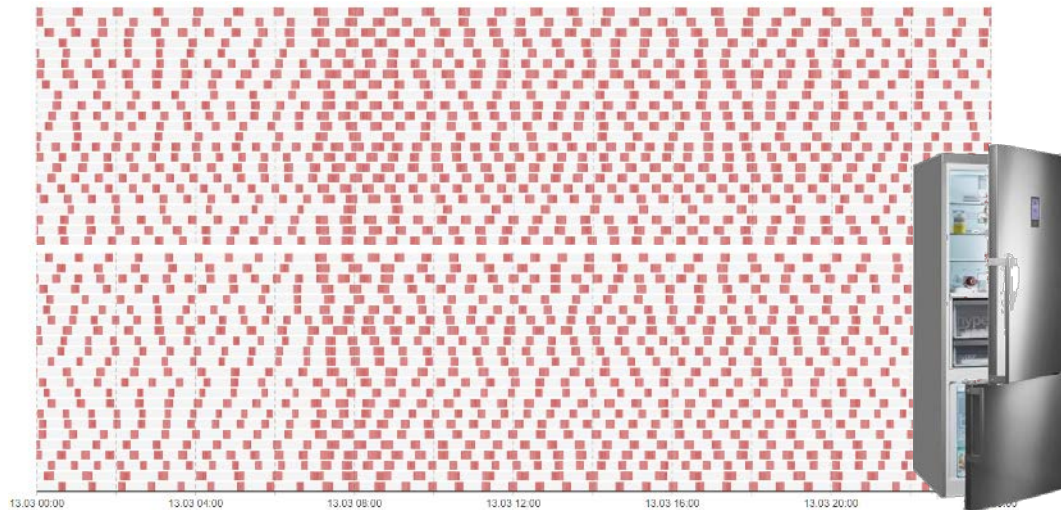
Next Step: Real Time Energy Tariff

transformer

North
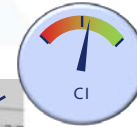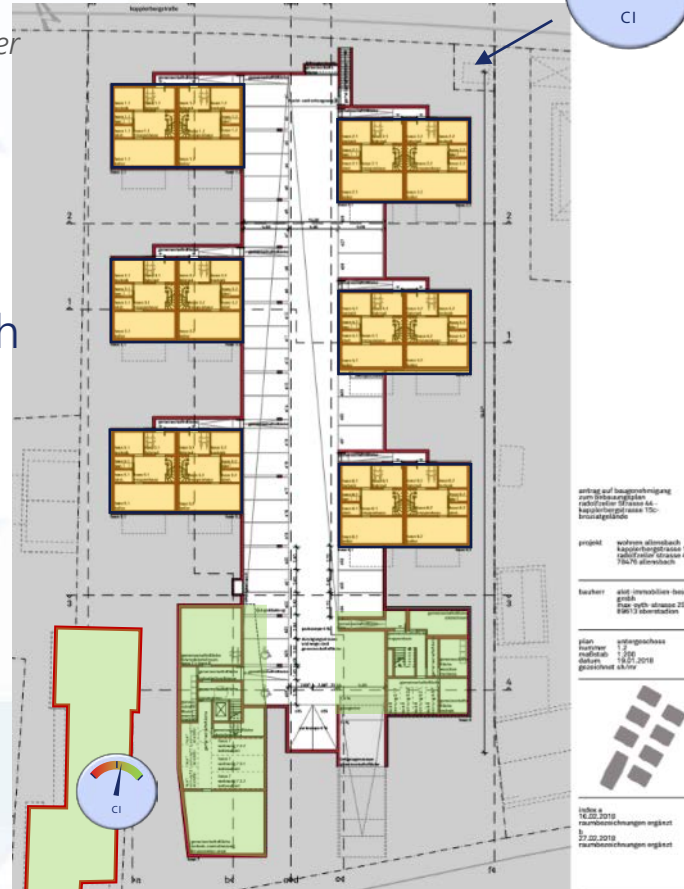
European grid frequency
(Virtual Demonstrator)

Current load of
MV/ LV transformer
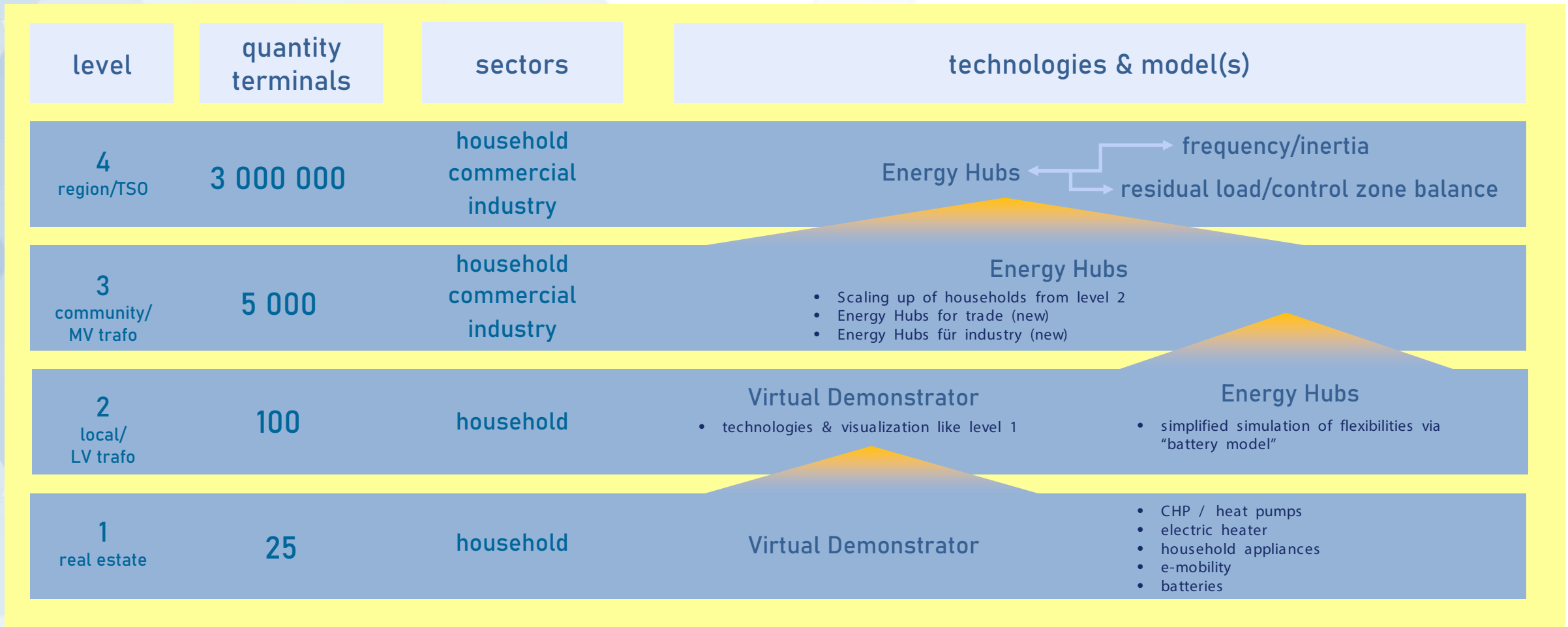
… voltage at grid terminal

Goals:
- Stabilizing of the electricity grid
- Consistent tariff system

Prospect: Extrapolation Concept

level	quantity terminals	sectors	technologies & model(s)
4 region/TSO	**3 000 000**	household commercial industry	Energy Hubs → frequency/inertia ← residual load/control zone balance
3 community/ MV trafo	**5 000**	household commercial industry	Energy Hubs • Scaling up of households from level 2 • Energy Hubs for trade (new) • Energy Hubs für industry (new)
2 local/ LV trafo	**100**	household	Virtual Demonstrator • technologies & visualization like level 1 Energy Hubs • simplified simulation of flexibilities via "battery model"
1 real estate	**25**	household	Virtual Demonstrator • CHP / heat pumps • electric heater • household appliances • e-mobility • batteries

Energy System

Source follows demand

Central Control

Energy System Transition

Demand follows source

Swarm intelligence

Thanks a lot for your attention!