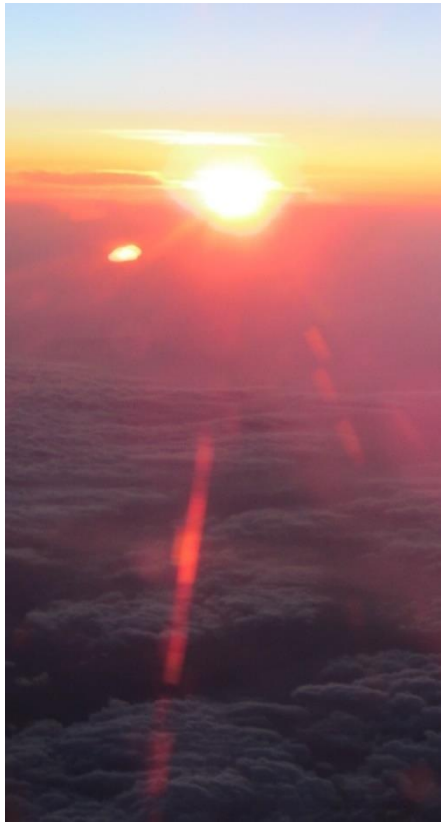
More Value from Heat Pumps by Smart Operation as “Virtual Batteries”

ehpa webinar: New business models

Easy Smart Grid GmbH, May. 5th, 2021
Dr.-Ing. Thomas Walter



Reference project

Real world demo Allensbach/Germany

Project supported by: Baden-Württemberg

Contract Partners:

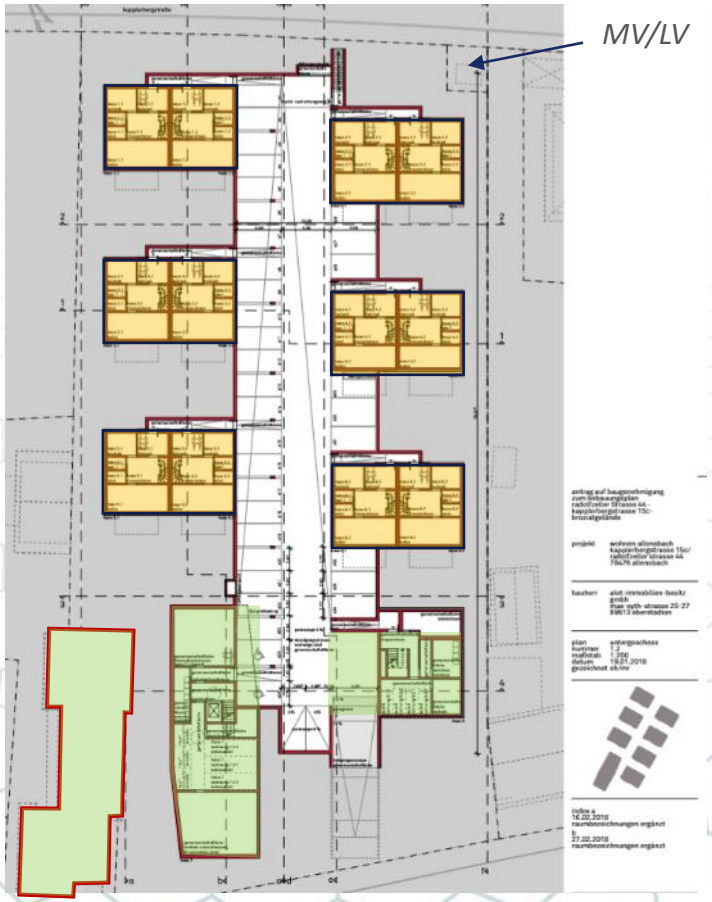
Associated Partners:

Supporting Partners:

Project page: www.solarlago.de/solar-allensbach/

Reference project

Objective: Minimize Carbon Footprint

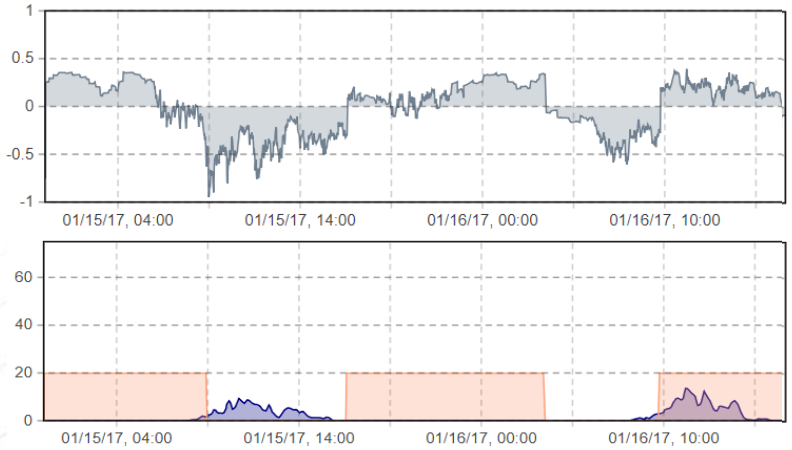


- 8 houses with 22 apartments
- High insulation standard
- 14 PV rooftop plants (~80 kWp)
- 12 heat pumps
- 1 CHP
- Parking for up to 24 EVs
- Optional Batteries
- Flexible household appliances (washing machines, dish-washers, dryers, fridges, freezers)

➔ Challenge:
Co-ordinate ~100 actors

Reference project

Simulation: Scenario in Winter

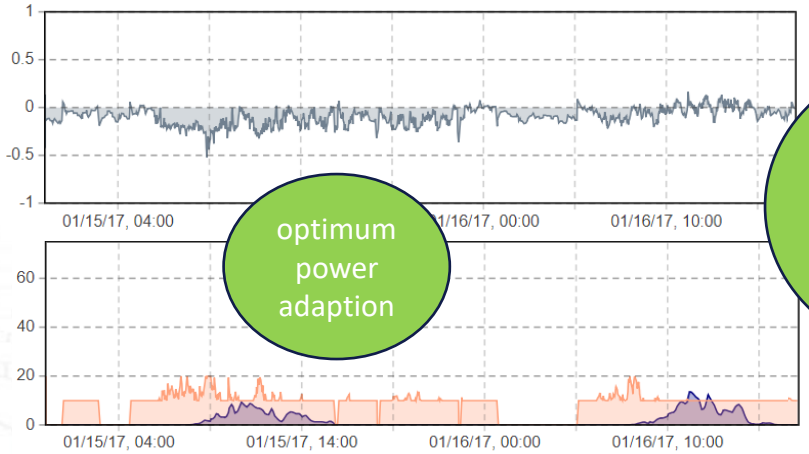


Balance Indicator

Calculated from power at grid connection
+1 = maximum feed
-1 = maximum supply

Generators

Electricity generation of
PV plants ( ) and CHP ( )

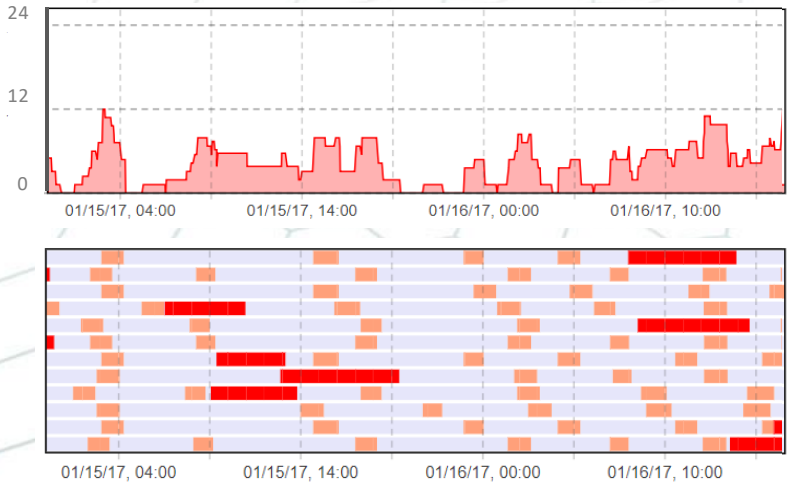


optimum power adaption

CHP **100%** self supply

Control by heat demand only

Control by heat demand and price signal BI

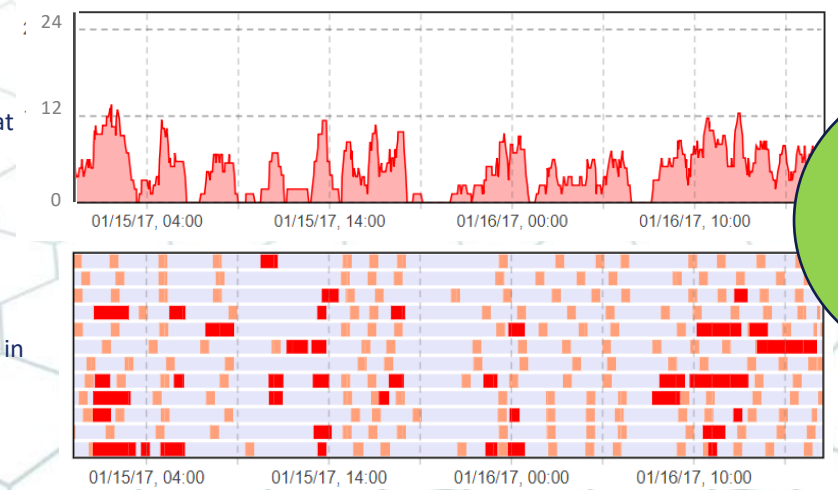


Σ Heat Pumps

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

Heat Pumps

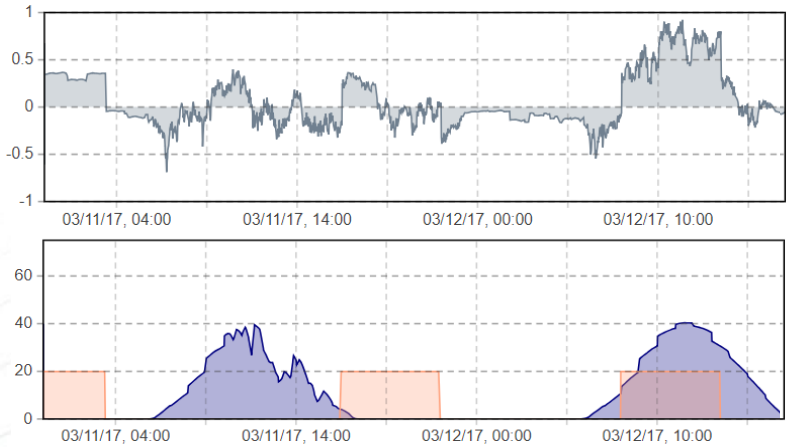
Switching decisions of the heat pumps in 12 private houses
(warm water, heating)



Heat pumps **smooth** demand

Simulation: Scenario in Spring

household appliances

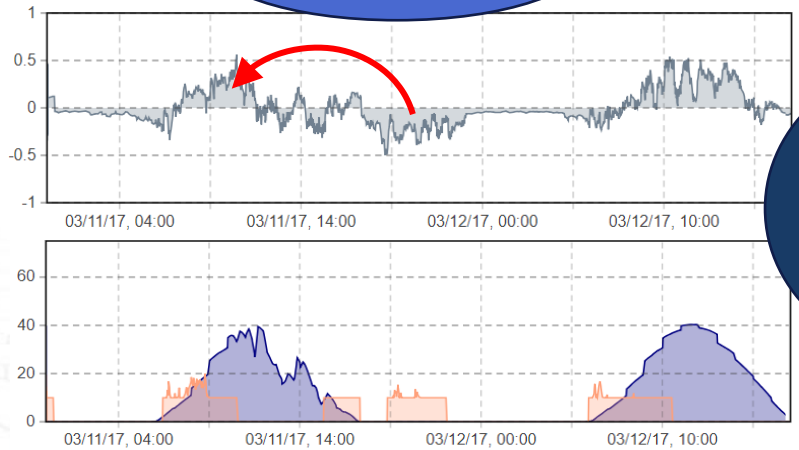


Balance Indicator

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

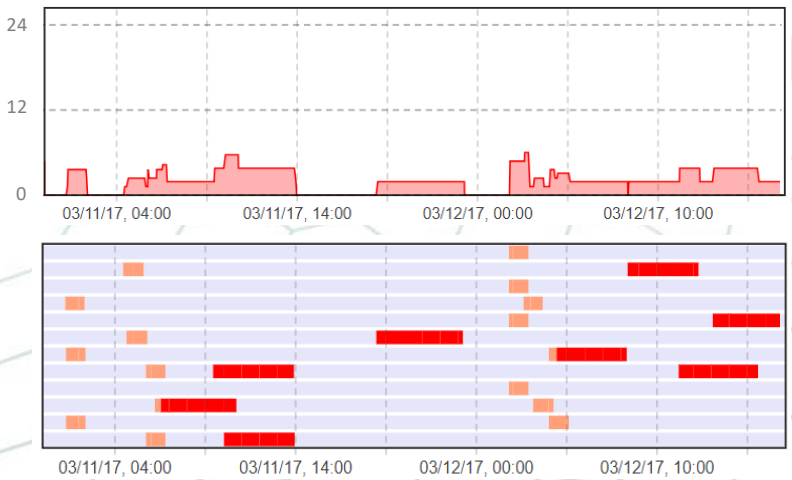
Generators

Electricity generation of PV plants ( ) and CHP ( )



50% more self consumption

Control by heat demand only



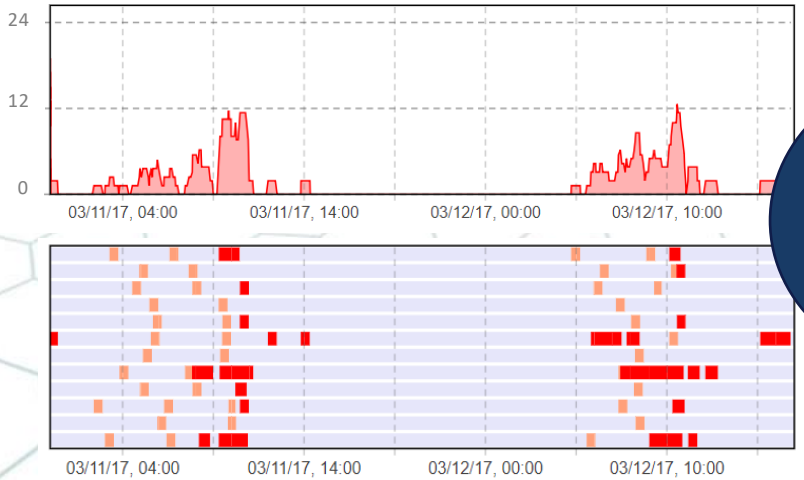
Σ Heat Pumps

Total heat pump power (12 houses)

Heat Pumps

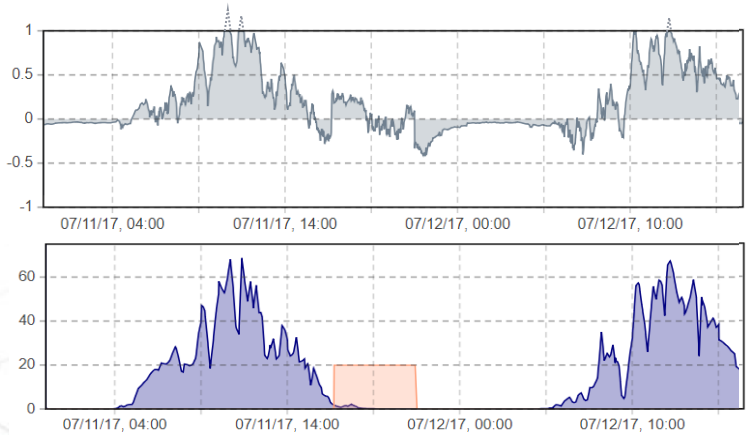
Operation of 12 heat pumps
In private houses
(warm water, heating)

Control by heat demand and price signal BI



heat pump optimum operation

Simulation: Scenario in Summer



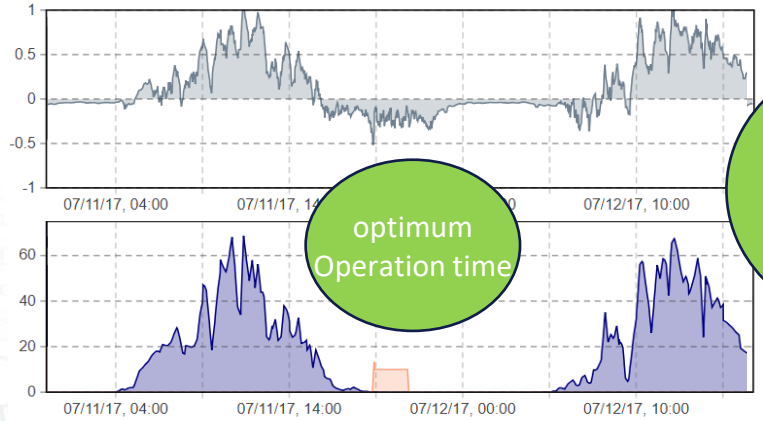
Control by heat demand only

Balance Indicator BI

Calculated from **power** at grid connection
+1 = maximum feed in
-1 = maximum supply

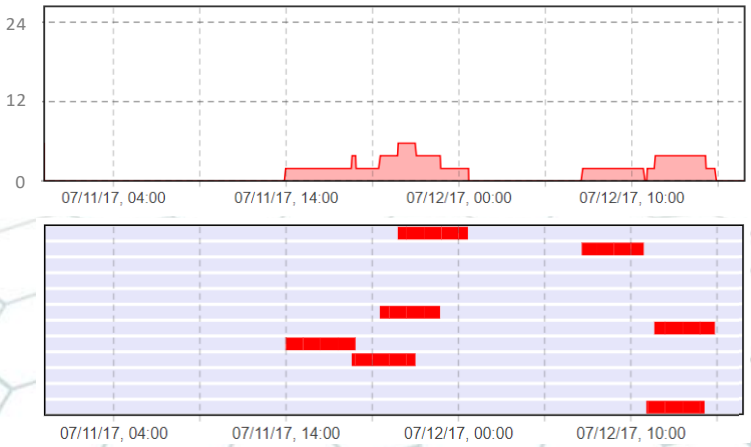
Generators

Electricity generation of PV plants ( ) and CHP ( )



CHP: 100% self supply

Control by heat demand and price signal BI

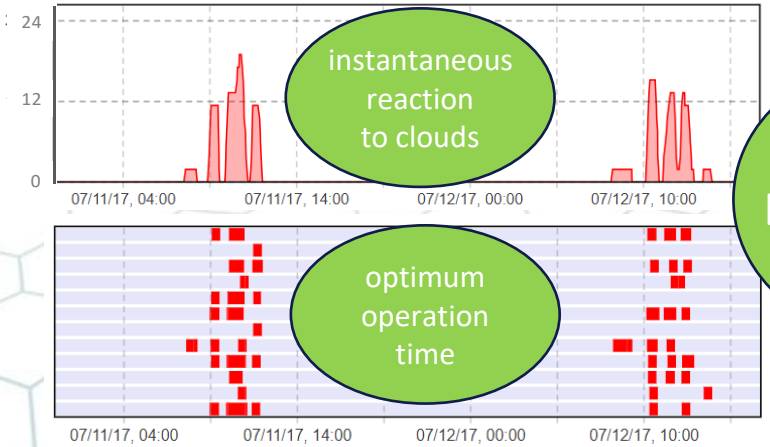


Σ Heat Pumps

Aggregated consumption of heat pumps in 12 private houses

Heat Pumps

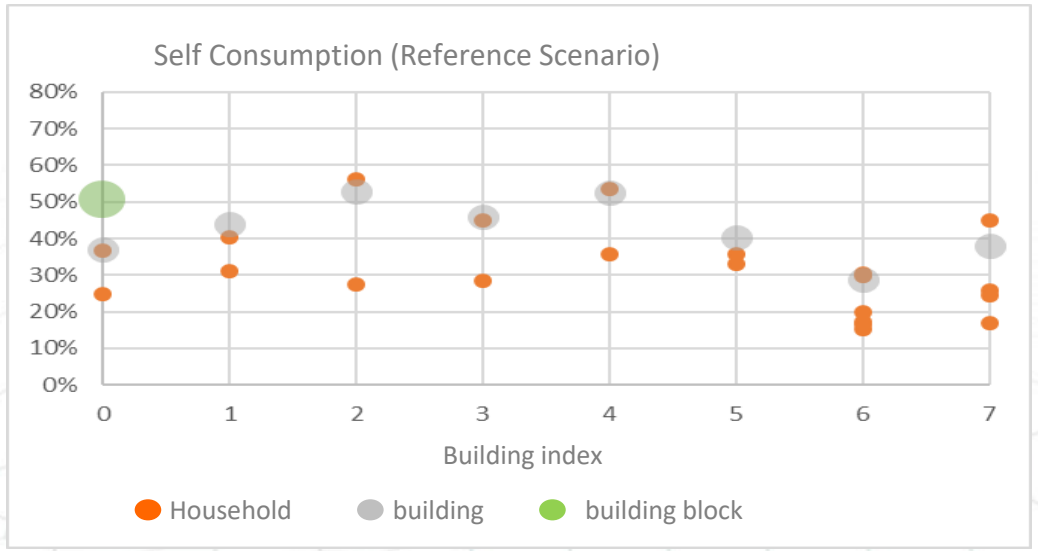
Switching decisions of heat pumps in 12 private houses
(in summer: warm water only)

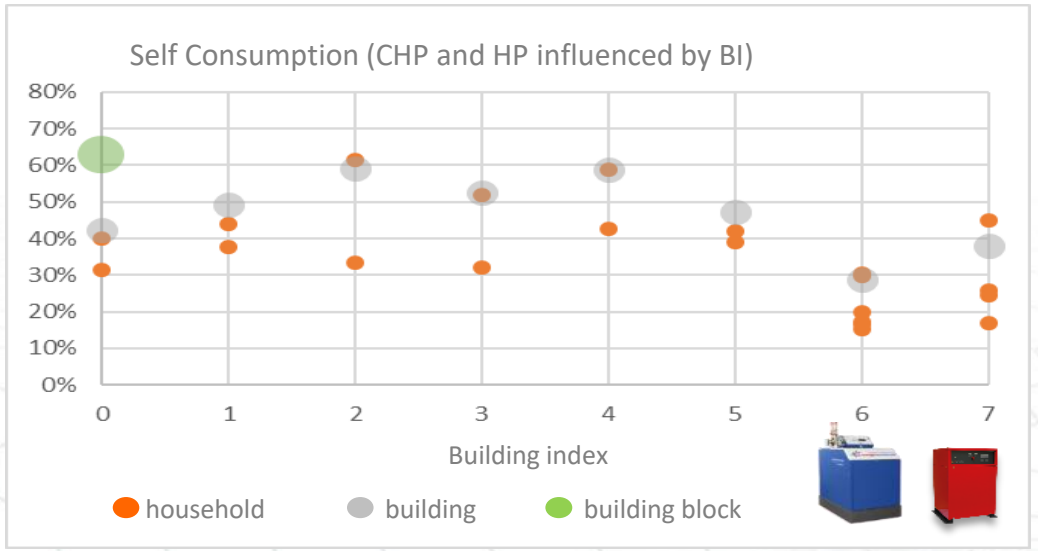


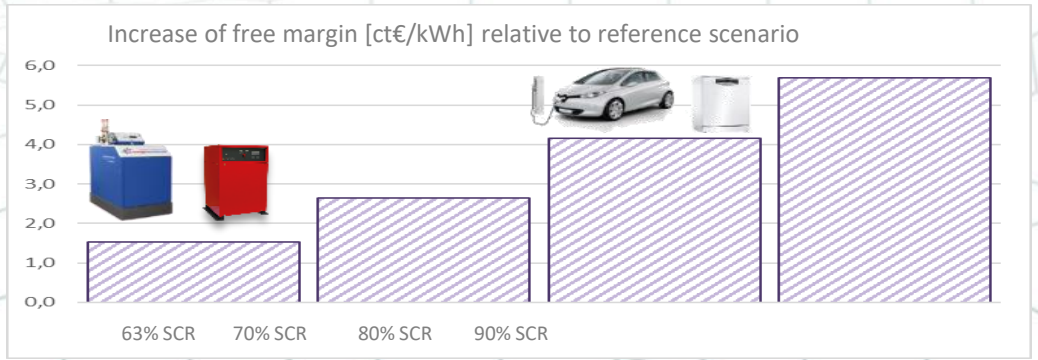
heat pumps: 100% PV energy

Reference project

Increased Self-Consumption-Rate: Financial impact





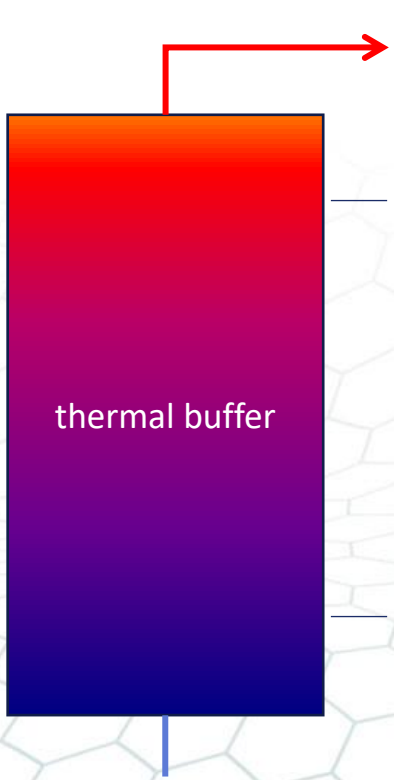


Smart operation just of heating increases SCR
50% → 63%

SoLAR
Smart Grid ohne Lastgangmessung Allensbach-Radolfzell

Background

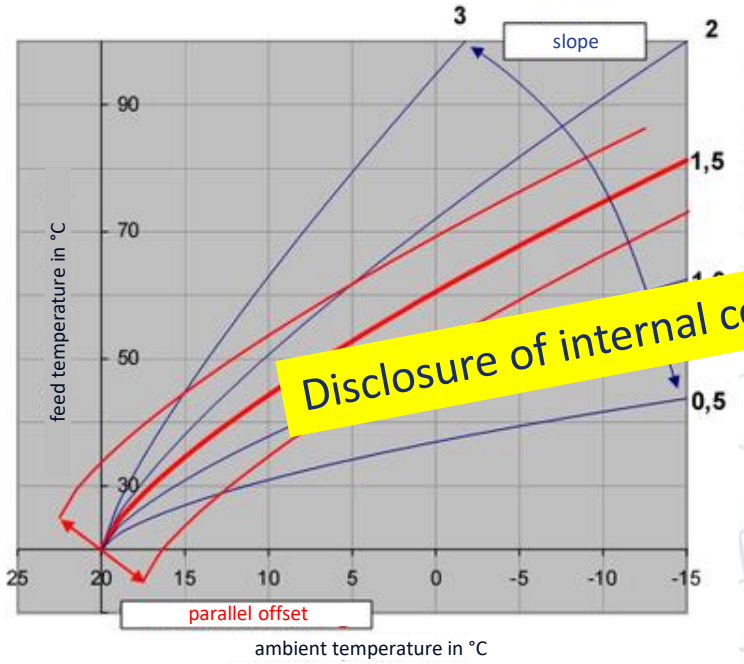
Smart HP controller for “virtual battery”



heat demand (heating control curve)

full

low



Source: Wikipedia

Disclosure of internal control data not needed!

power requirement

flexibility reserve

Controller Standard

on/off

power

power requirement

flexibility reserve

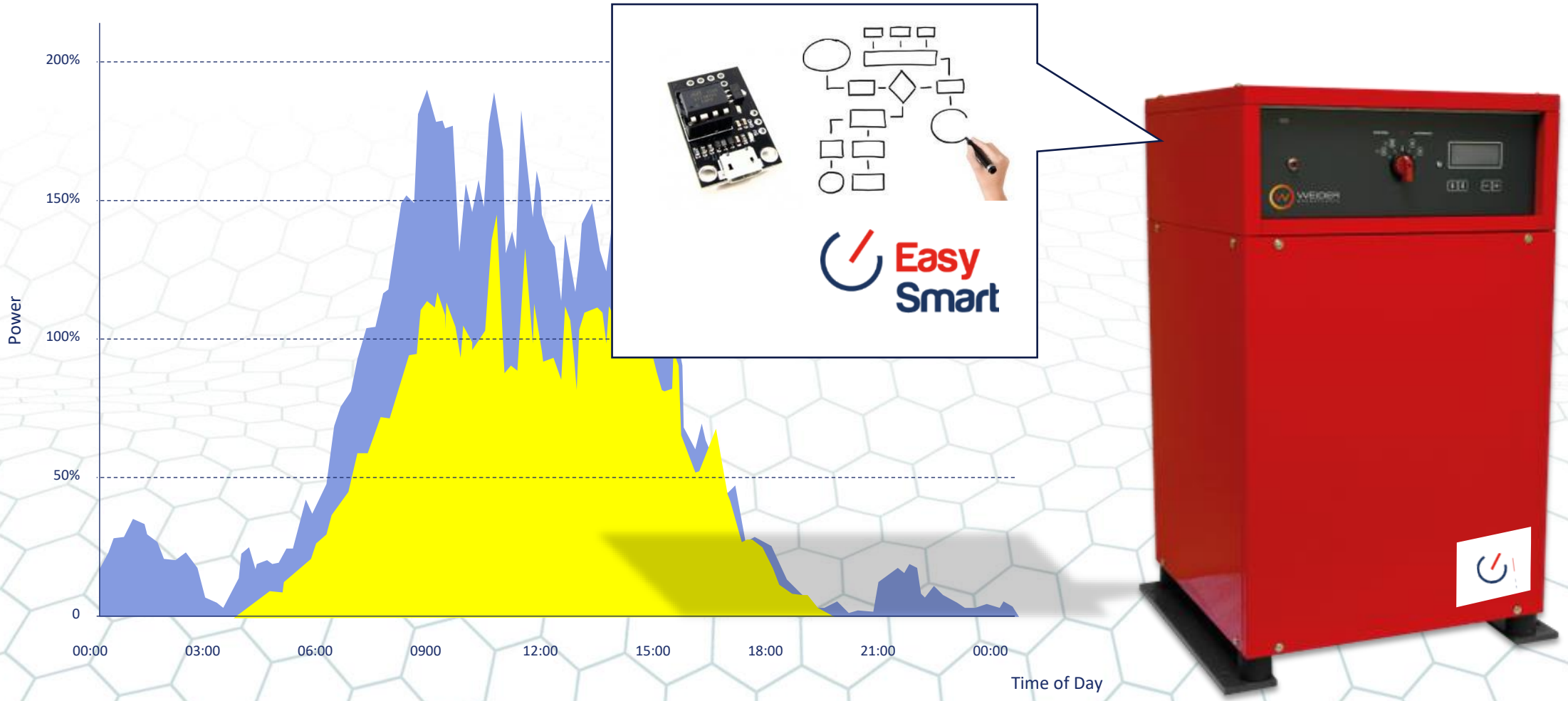
balance indicator

Controller Smart

on/off

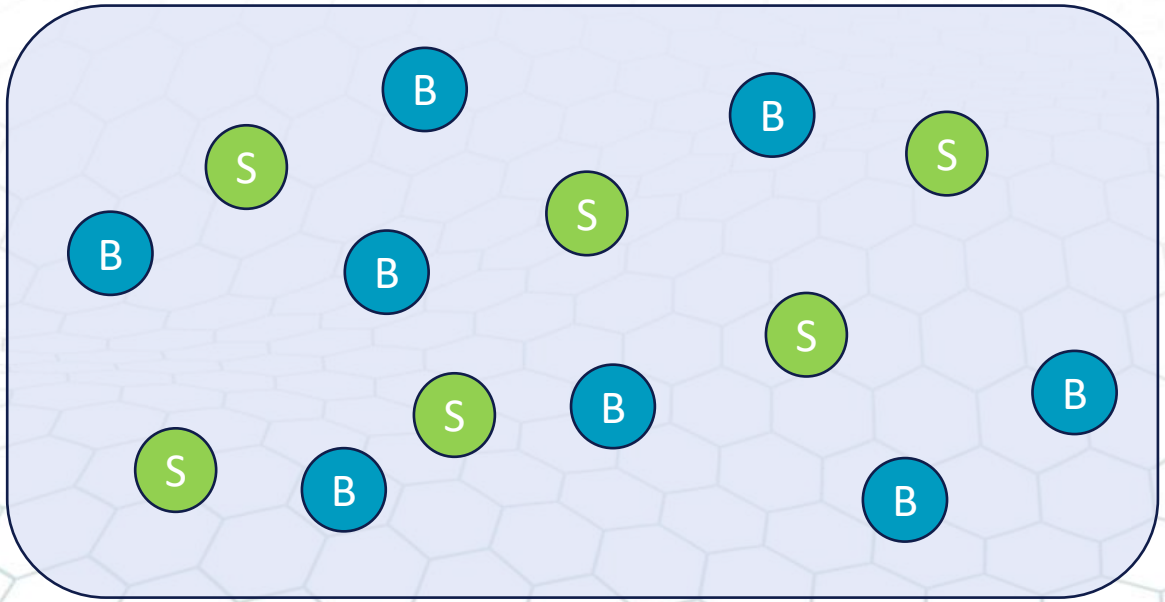
power

Firmware update to implement a “virtual battery”



Establish local balance price with one measurement

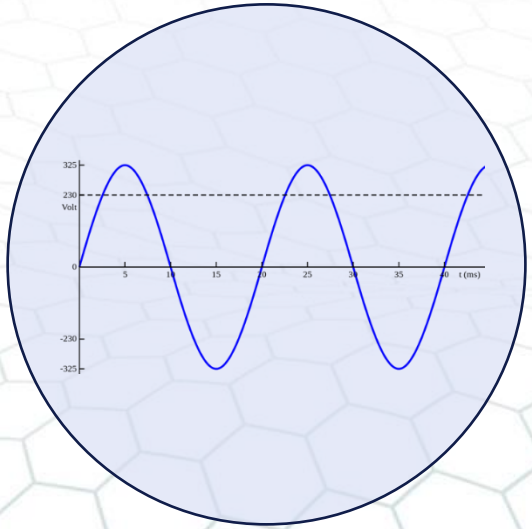
Sellers and Buyers in decentralized Local Energy Market (LEC)



Export energy:
P_n too high

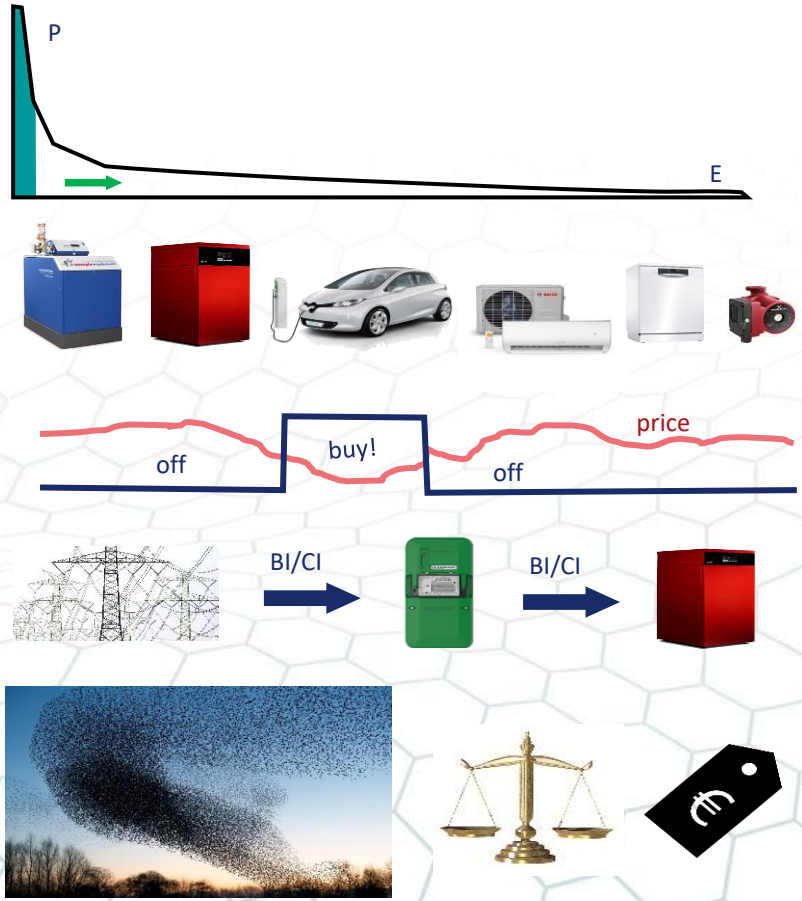
Import energy:
P_n too low

Frequency change caused by imbalance:
f up if P_n too high,
f down if P_n too low



Balance Indicator (BI) derived from power (coupled LEC) or frequency (isolated LEC)
Note: Price derivation and reaction protected by patents for Easy Smart Grid GmbH

Benefits of real time price signals



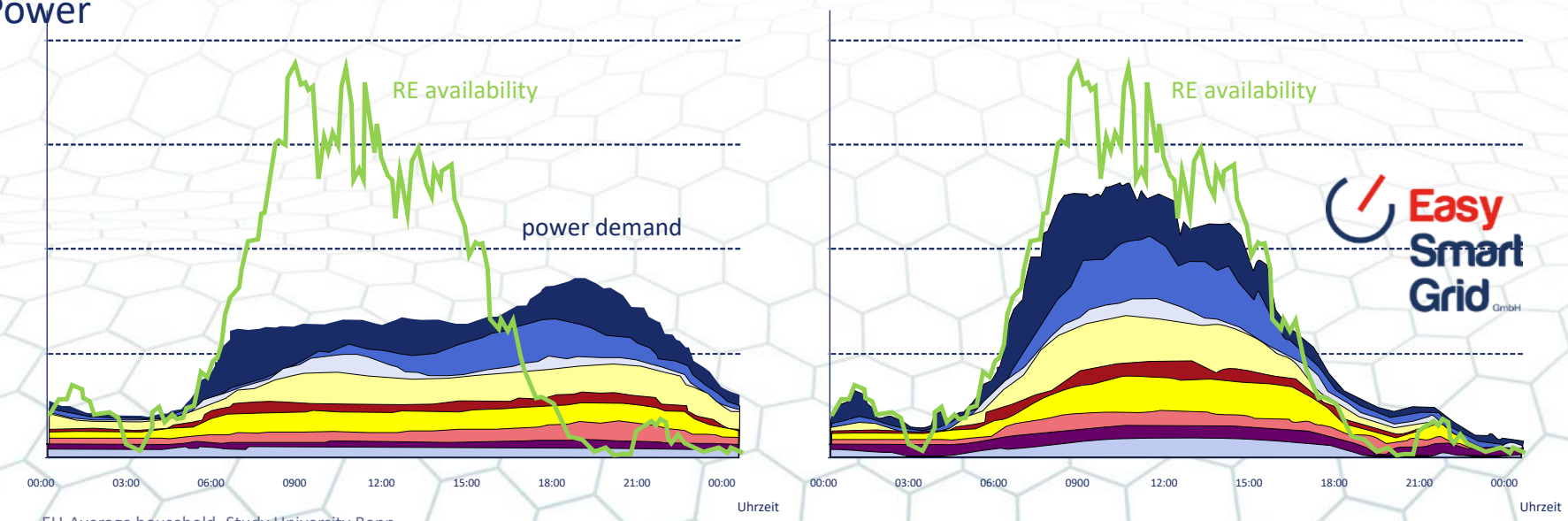
- ✓ All flexibility can be used as “virtual batteries”: any number, any power, any duration, any availability
- ✓ Growing low-cost “virtual battery” storage potential as heating and mobility sectors are de-carbonized
- ✓ Simple contracts without bidding or penalties
- ✓ Low bandwidth, unidirectional broadcast is simple to implement and ensures data privacy
- ✓ Increased resilience against failures and attacks
- ✓ Prices derived by fair and transparent mechanism

Use regular household flexibility

Appliances receive price signal

Shifted operation benefits owner and grid

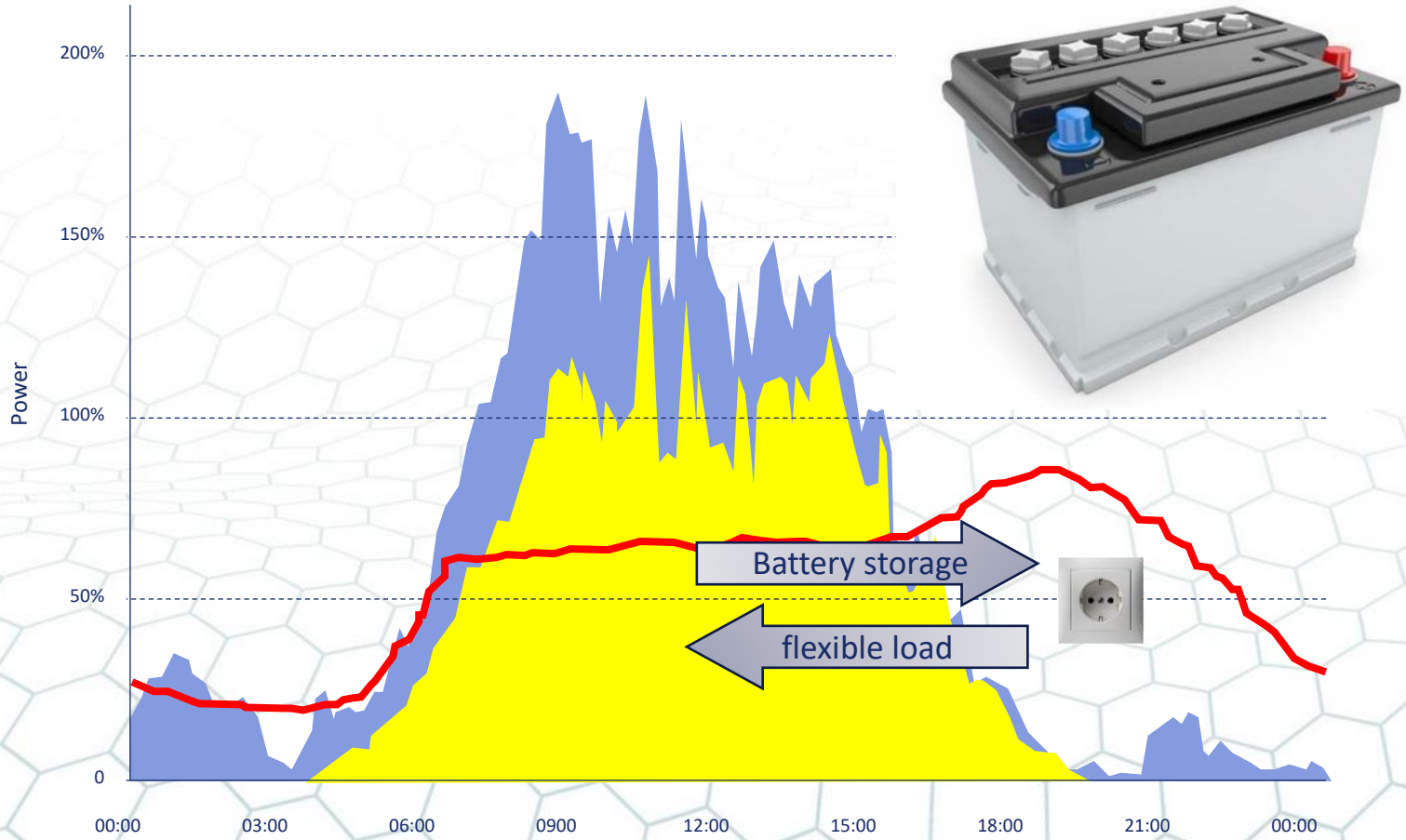
Power



- Water heater
- Aircon
- Baking and cooking
- Dryer
- Washing machine
- Circulation pump
- Dishwasher
- Fridge
- Freezer

EU-Average household, Study University Bonn
https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/smart-a_synergy_potential_of_smart_appliances.pdf

Using „virtual“ instead of „real“ batteries saves CAPEX



Leverage existing flexibilities for energy storage

- **Non-residential applications**
  business, commerial, industrial buildings
- **Cooling applications**
  buildings, cold storage, computer centres
- **Local/district heating/cooling**
  Heat pumps and CHP at interface to buildings and thermal storage
- **For all cases:** heating and cooling lead, others follow

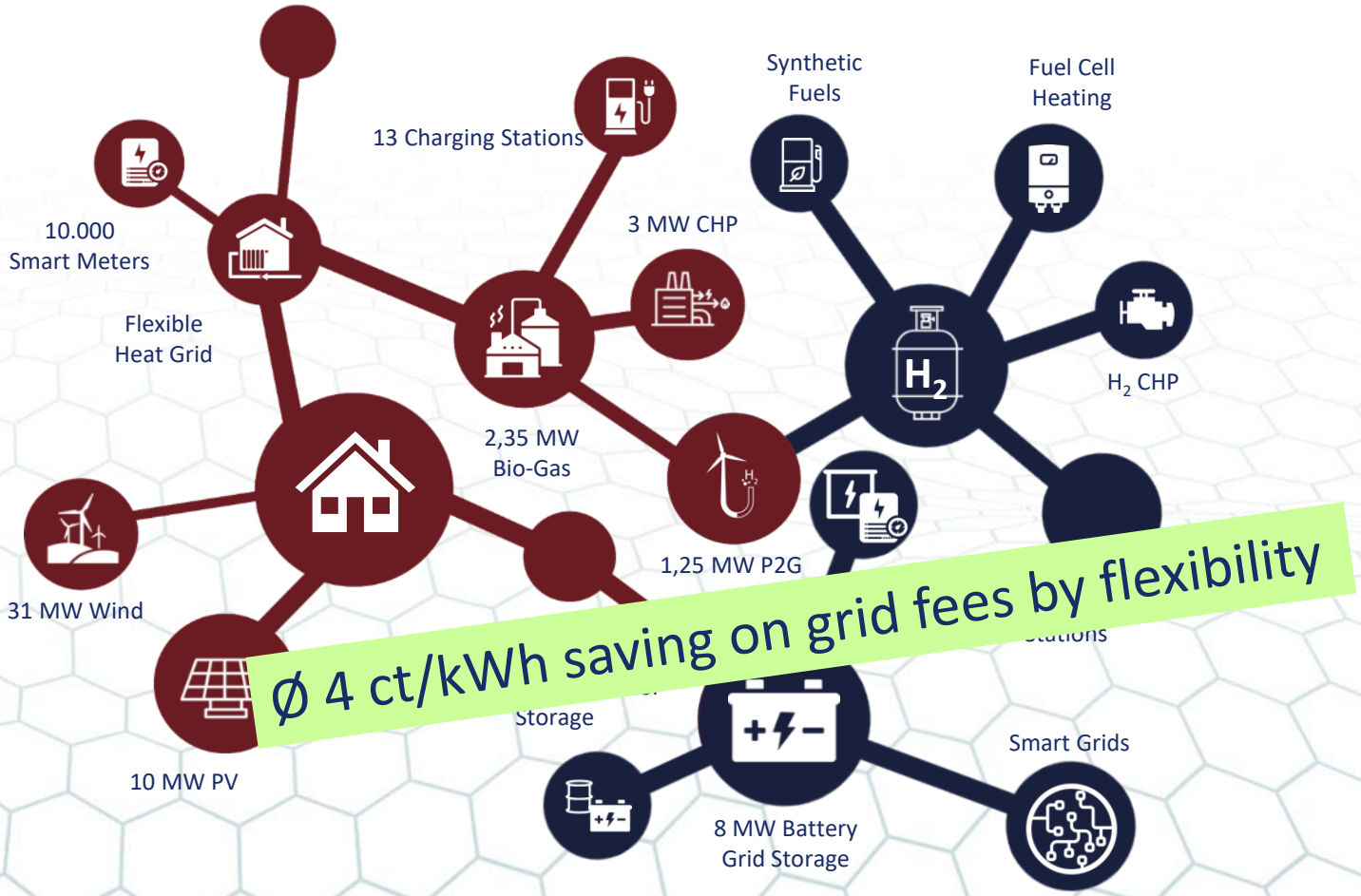
Evolution

Extend to DSO level

stadtwerk haßfurt

- 200% of yearly demand served by local RE
- Still 38% of energy demand supplied from HV grid

➔ HV grid load and fees avoided by better matching of supply and demand at DSO level



Thank you
for your attention!

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