Simple and efficient implementation of LEMs

4th International GSM Symposium
(Grid Service Markets)
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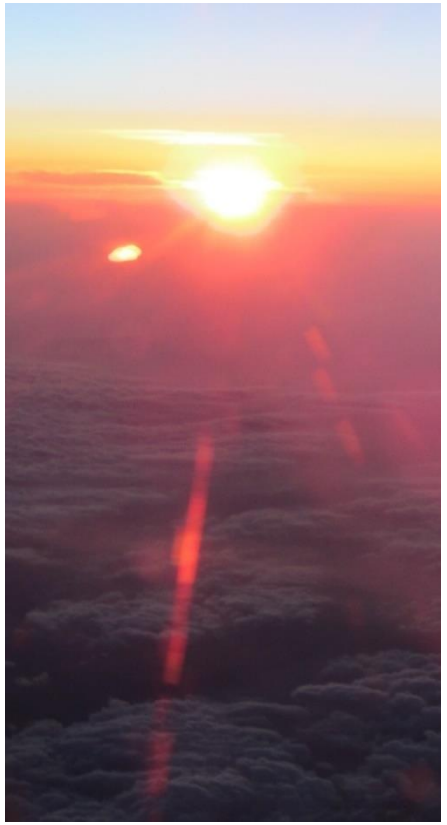


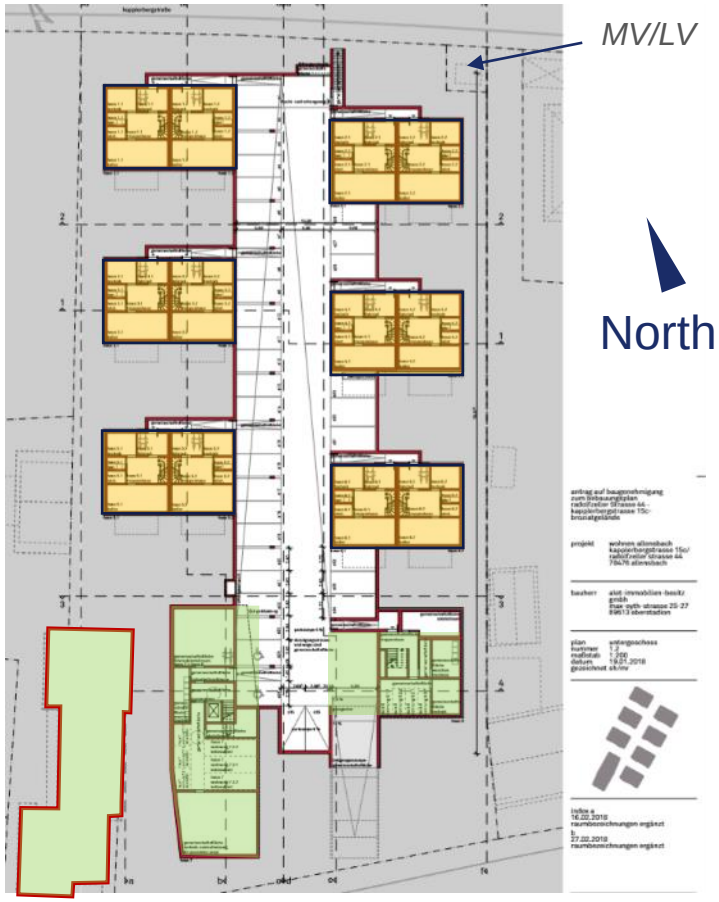
Agenda

1. Introduction of Demo LEM
2. Some Theory (Economics, Physics)
3. Benefits of Real Time LEMs
4. Multiple Opportunities for GSM

1. Introduction of Demo LEM
Climate Action in Allensbach/Germany

- Community decided on climate goals and measures
  - Extension of local PV generation
  - De-carbonisation of heating and mobility
- LEM (local energy market) best option to coordinate
  - Low price when abundant PV
  - Flexible loads save money by shifting operation
- ESG: Build LEM platform on grid physics
- Real demo simulated and built, operation starting

1. Introduction of Demo LEM
Site Outline Allensbach/D



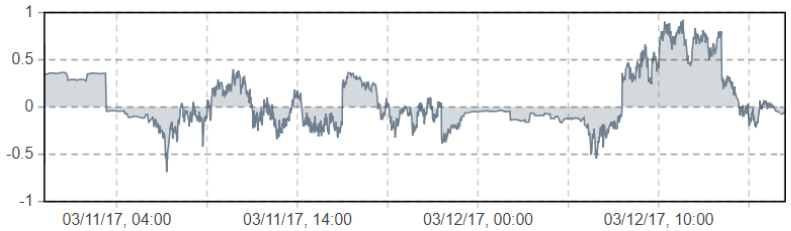
- 9 houses with 24 apartments
- 14 PV plants (~70 kWp)
- 12 heat pumps, 1 CHP
- up to 24 EV chargers
- batteries possible (KfW 40+ standard)
- flexible appliances (washing machines, dish-washers, dryers, fridges, freezers)
- Local price signal derived at transformer

=> co-ordinate up to 100 participants

https://solarlago.de/solar-allensbach/solar-goes-live/

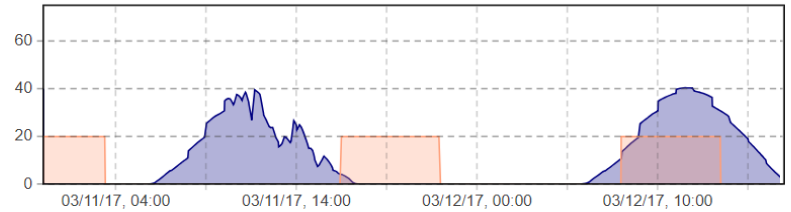
1. Introduction of Demo LEM
Two simulated spring days

household appliances



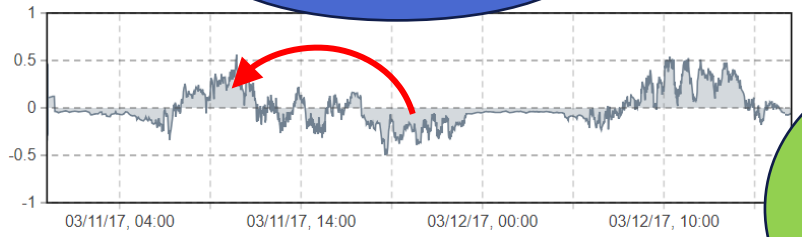
Balance Indicator

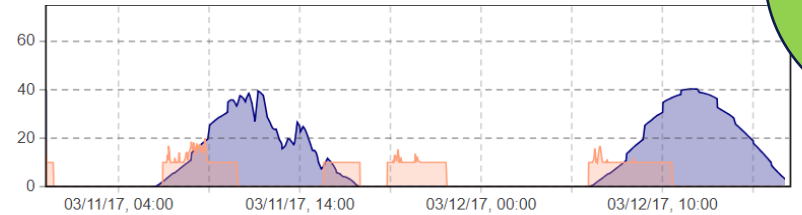
Calculated from power at grid connection
+1 = maximum feed-in
-1 = maximum supply



Generators

Electricity generation by PV plants and CHP

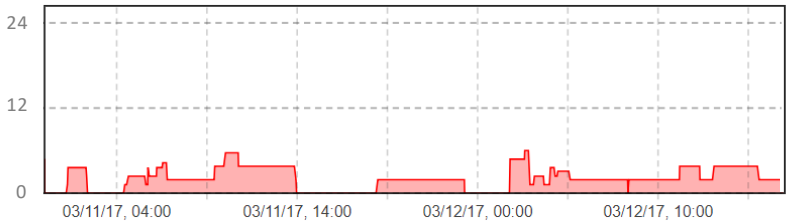




50% more self consumption

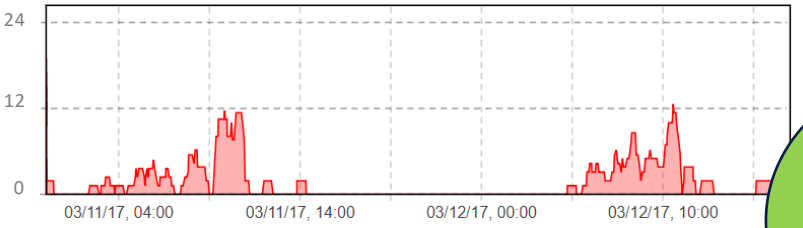
Control by heat demand

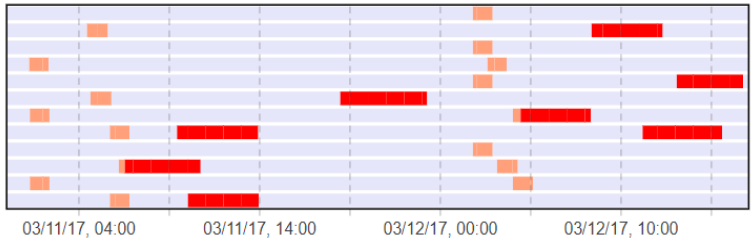
Control by Easy Smart Grid



Σ Heat Pumps

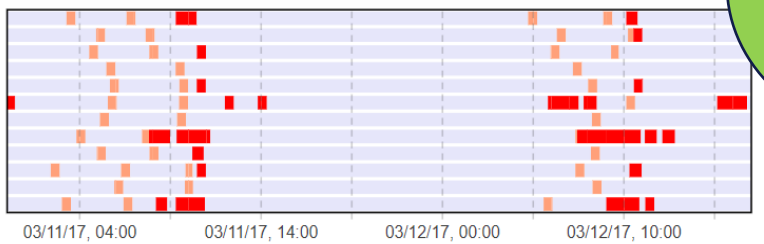
Total power consumption of 12 heat pumps in semi-detached houses





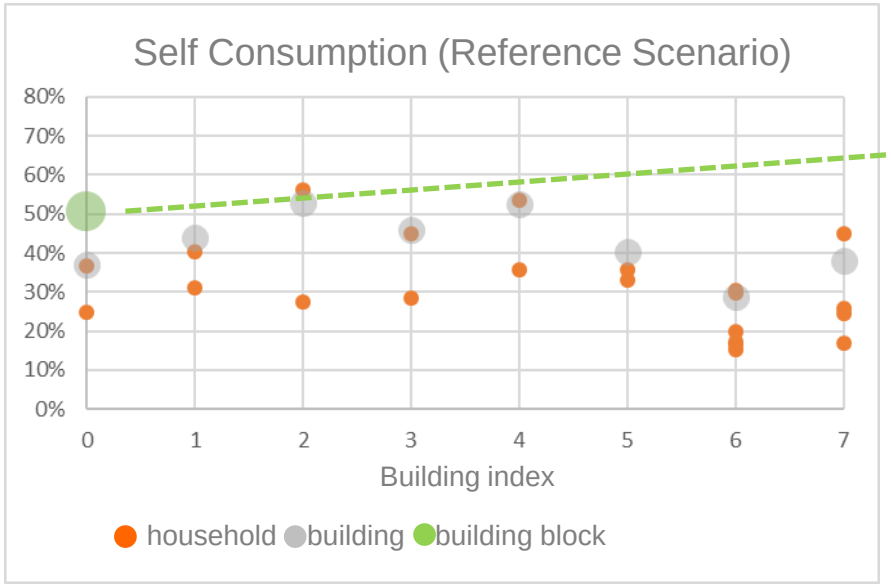
Heat Pumps

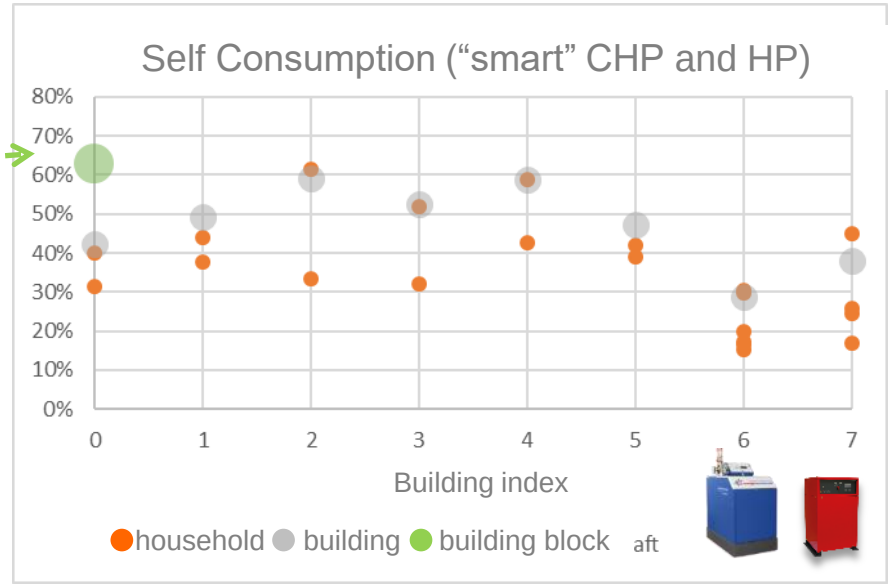
Switching of 12 heat pumps in semi-detached houses
hot water heating



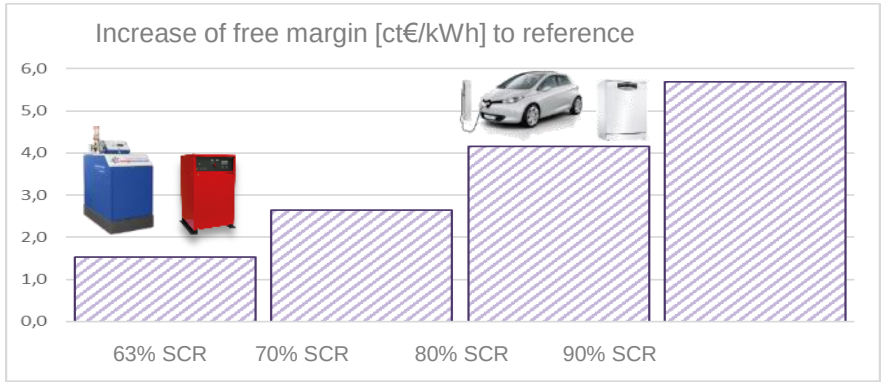
heat pumps optimum operation

1. Introduction of Demo LEM
Increased Self Consumption Rate and Margin





SCR increase at LEM level **50% ➔ 66%** (CHP and HP)



target using all flexibilities 4 to 6 ct/kWh free margin

Virtual Demonstrator

Result of Simulation

2. Some Theory
ESG exploits Physics to build better Markets

- Easy Smart Grid Approach (patented)
  - What is „good“ for the grid is „financially attractive“ for customers (expressed by „Balance Indicator“)
  - Customers react to price signals and also support grid
- Benefits
  - TSOs have simple access to flexibility
  - DSOs benefit from grid relief by decentral balancing and possibly also by dynamic grid fees
  - System friendly LECs/LEMs can be implemented simply and efficiently

2. Some Theory
ESG exploits physics to build simpler LEM

1. Walrasian Auctioneer (as for other markets, e.g. shares)

- Determines market balance by „tatonnement process“ (TP)

2. Kirchhoff‘s Law (for electricity markets only)

- Integrates all transactions in one node (**one** measurement only)

3. Maxwell Equations (for electricity markets only)

- Information travels with c * speed of light (this means real time!)

4. Successive Approximation implements TP

- Determine next market price P_{n+1} by adding balancing error to P_n

Real market price deter-mined in real time!

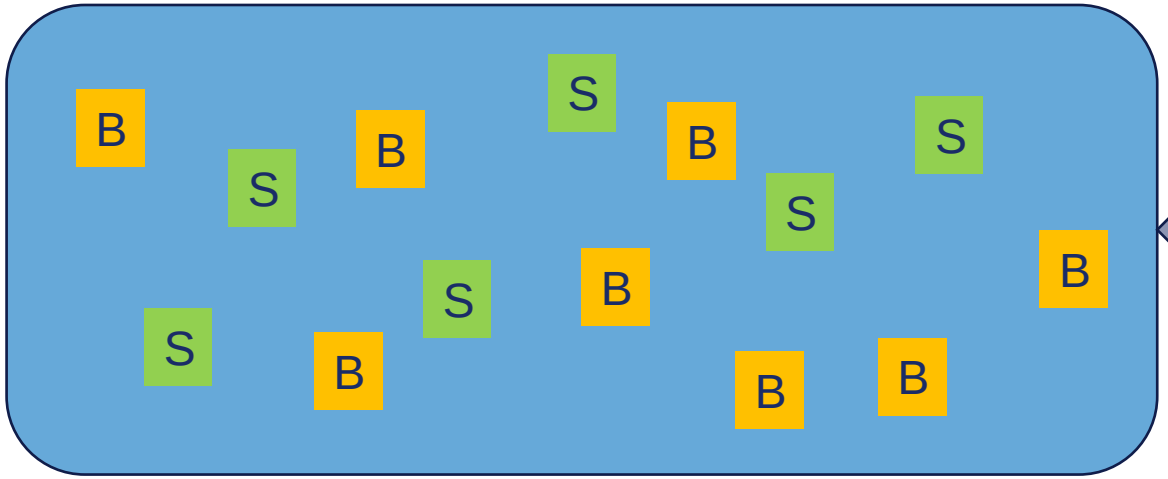
2. Some Theory
Single measurement allows to balance LEM

Local energy market with sellers S, buyers B and market price P.
One measurement to update price P in real time

- energy export (case: connected LEM) or
- grid frequency (case: isolated LEM)

Frequency going up:
P_n is too high

Frequency going down:
P_n is too low



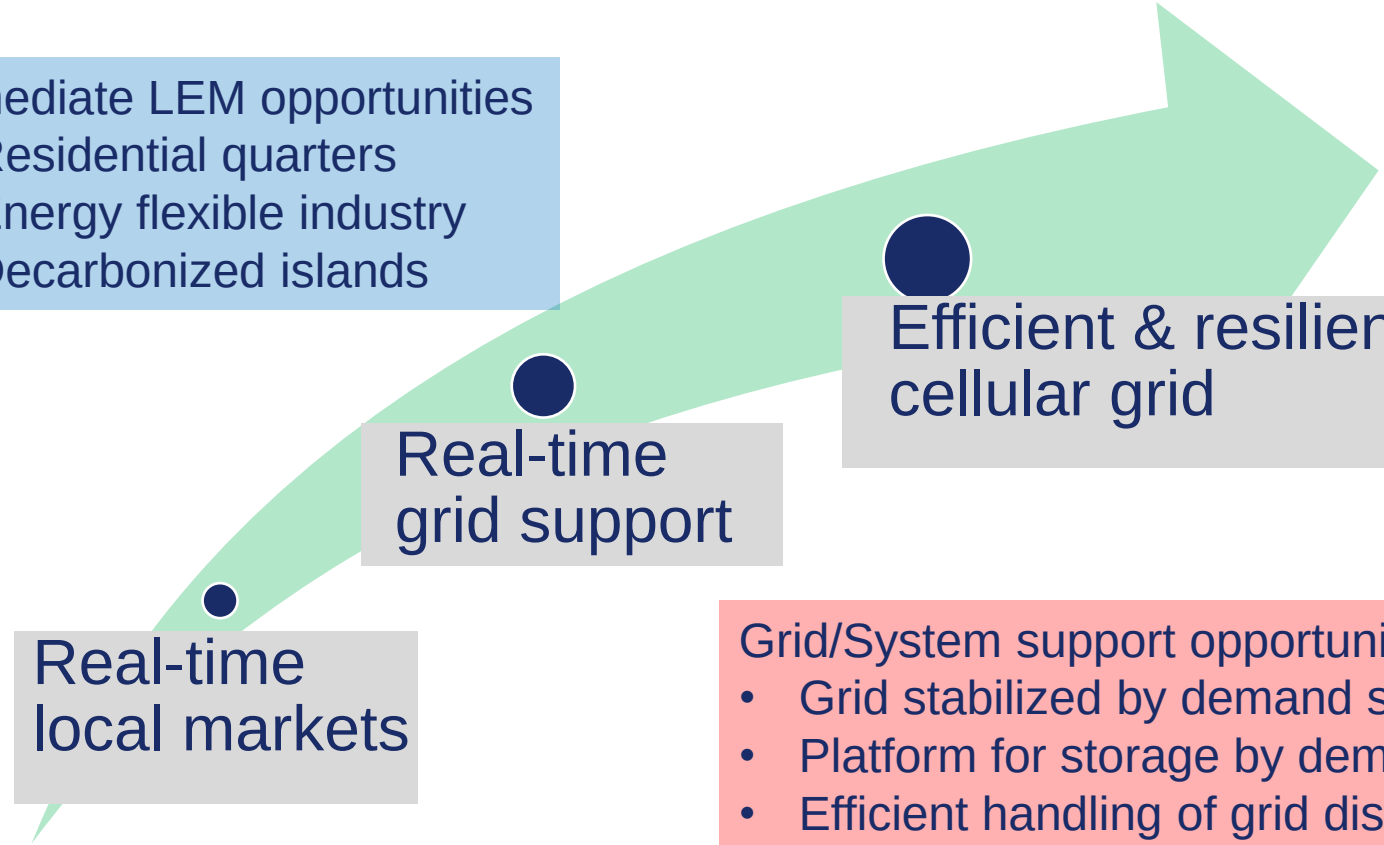
Energy export:
P_n is too high

Energy import:
P_n is too low

3. Benefits of Real Time LEM
Efficient Integration of Customer Flexibility

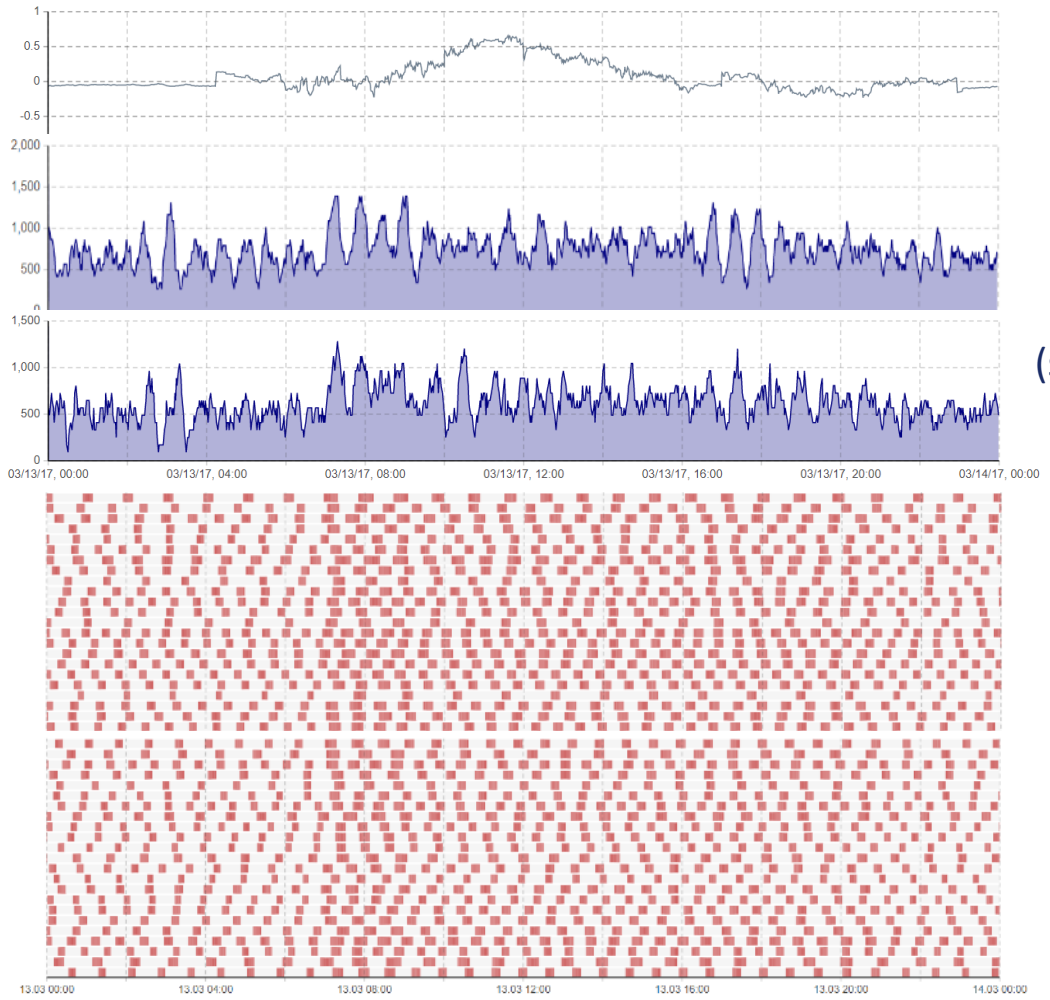
- ✓ Provide access to attractive flexibility potential
  - ✓ Huge addressed potential (de-carbonisation of heating and mobility)
  - ✓ Ultra-low storage cost (~1/100 of “real” battery)
  - ✓ Simple contracts – low barrier (no bidding, no pre-qualification)
  - ✓ Simple agents act for customer (customer sets limits e.g. finishing time)
  - ✓ No data privacy issues (price takers need not disclose anything)
  - ✓ Fair and transparent customer reward (efficient market)
- ✓ Very high performance with simple and low cost ICT
  - ✓ “Real” real-time operation (reactions within seconds)
  - ✓ High resilience (physics cannot fail nor be hacked)
  - ✓ Additional IoT only for non-critical functions (meter reading, price forecasts)
  - ✓ Basis for various infrastructure services (congestion relief, control power)
  - ✓ Seamless integration with grid operation and exception handling

4. Multiple Opportunities for GSM Applications and Migration



Grid/System support opportunities
- Grid stabilized by demand side integration
- Platform for storage by demand side integration
- Efficient handling of grid disturbances (customer appliances productively support system)

4. Multiple Opportunities for GSM
Example: Customers provide Stability & Storage



22 Fridges / Freezers reduce short term volatility (simulated result)

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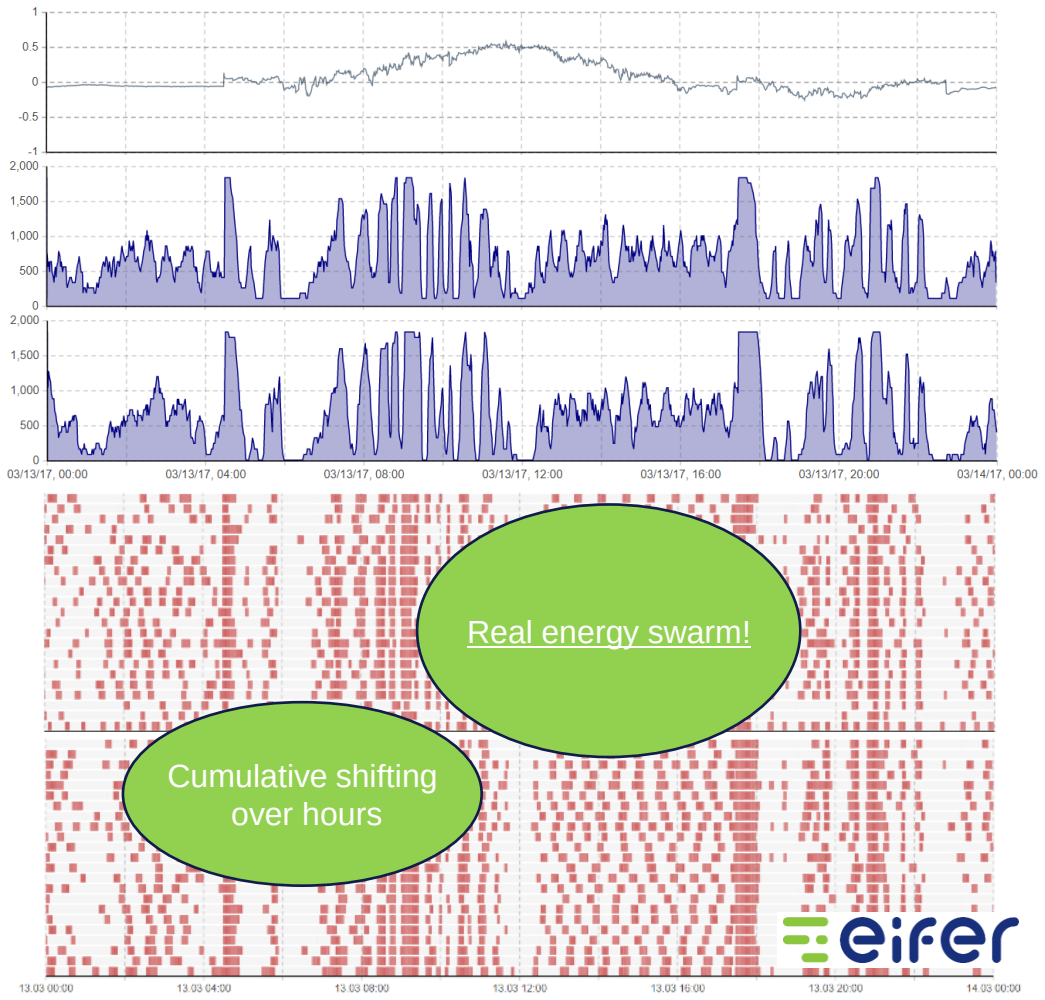
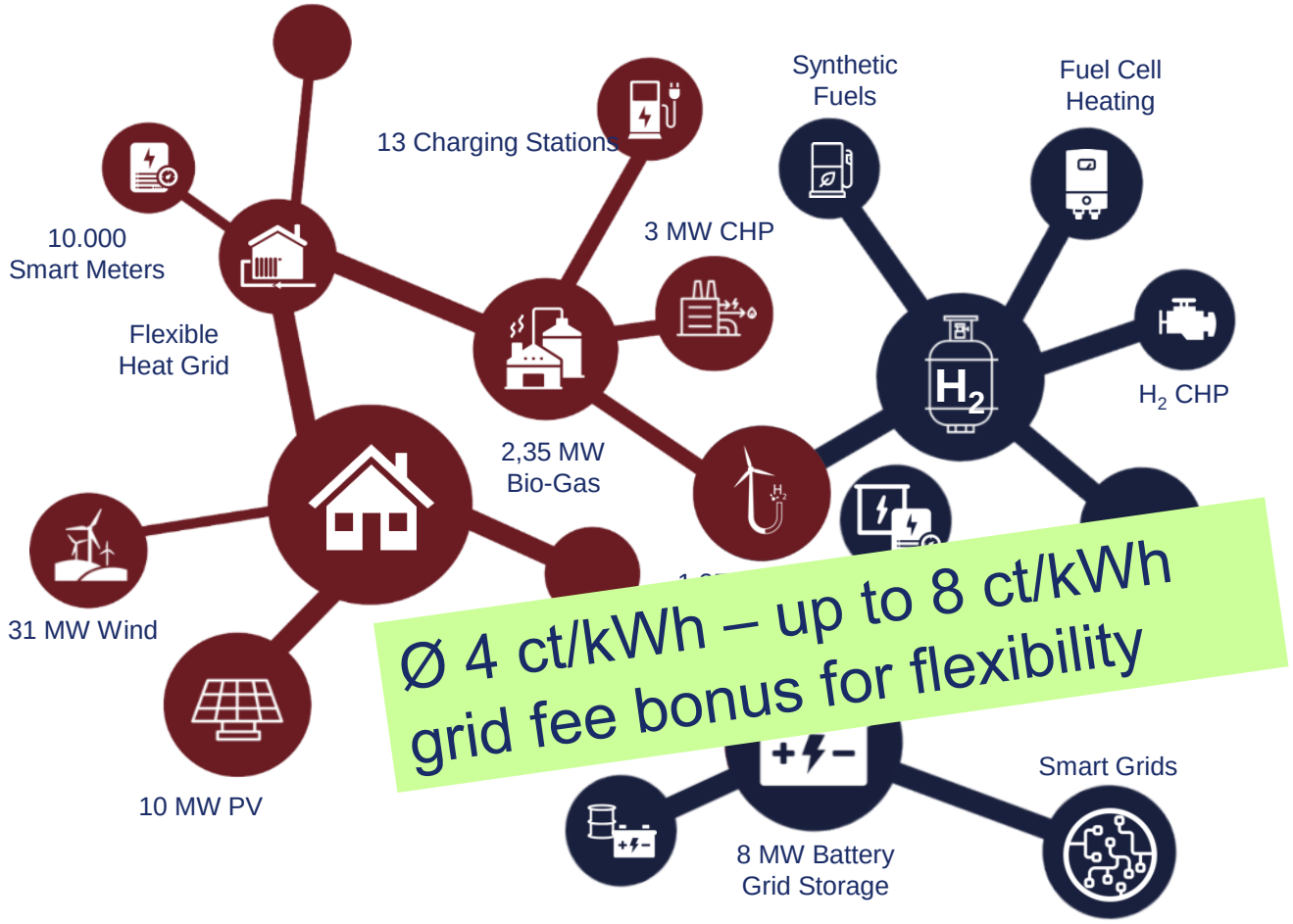


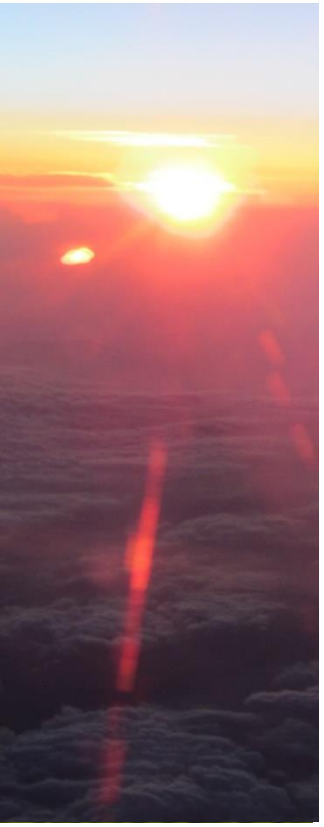
4. Multiple Opportunities for GSM
Example: Energy Management at DSO Level

stadtwerk haßfurt

- 200% of yearly demand served by local RE generation
- Still 38% of energy demand supplied by HV connection

➔ Lower HV grid load/fees by matching supply and demand at DSO level





Thank you
for your interest
and our exchange!

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