Bosch Thermotechnology

ExpertTalk
Energy Management

2021-02-16 | 10:00 AM CET

Agenda

Stefan Kluepfel
Energy Management Market Overview

Martin Weiss
How does energy management work?

Christian Heise und Jared Weinfurtner
Decentralized energy trading – an outlook

Bosch Thermotechnology ExpertTalk
Energy Management

Stefan Kluepfel

Business Analyst Systems Electrification, Energy Management and Electrical Storage Systems

Energy Management Market Overview

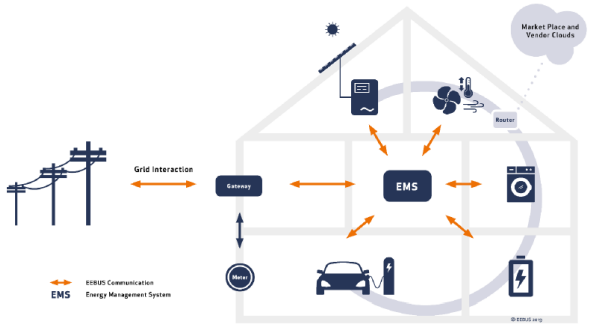
Energy Management – What's behind?

Energy management is the proactive, organized and systematic coordination of procurement, conversion, distribution and use of energy to meet the requirements, taking into account environmental and economic objectives
(VDI-Guideline VDI 4602)

Tasks

- Control of energy production
- Control of energy conversion (P2H,P2M,M2P,M2H)
- Control of energy distribution (and storage)

What does this mean in context of residential buildings?

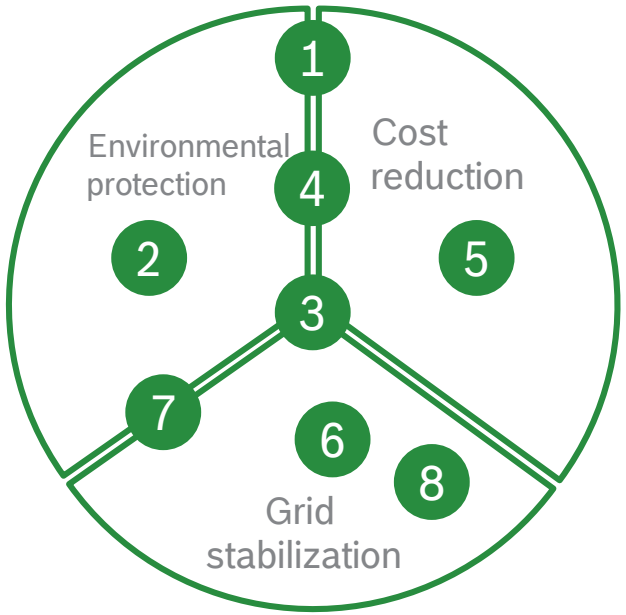


Goals

- Protection of environment
- Economic optimization
- Grid stability

Energy management = Optimizing operation of a sector coupled energy system to reach specific goals

Energy Management – Most important Use Cases



Number	Use Case	Country[1]
1	**Increase of Self consumption** *Increase use of self produced renewable energy by shifting operation time of flexibles loads (and sources)*	
2	**Minimization of curtailment losses** *Avoiding regulatory limitation of generation power by storing or consuming energy in potential limitation periods*	
3	**Tariff optimized consumption** *Cost reduction by shifting operation time of flexibles loads into low tariff periods*	
4	**Energy Monitoring** *Increasing awareness on energy use and system failures by visualization*	
5	**Peak shaving** *Reduction of connected load and base fees by avoiding peak loads by use of storages and limitation of flexible loads*	
6	**Overload protection** *Keeping power consumption below the building connected load to avoid power outages*	
7	**Power Limitation** *Remote dynamic limitation of power consumption by DSO to stabilize power grids in times of high fluctuations*	
8	**Control energy provision / balancing power** *Provision of positive and negative control energy*	

[1] *Only most important markets*

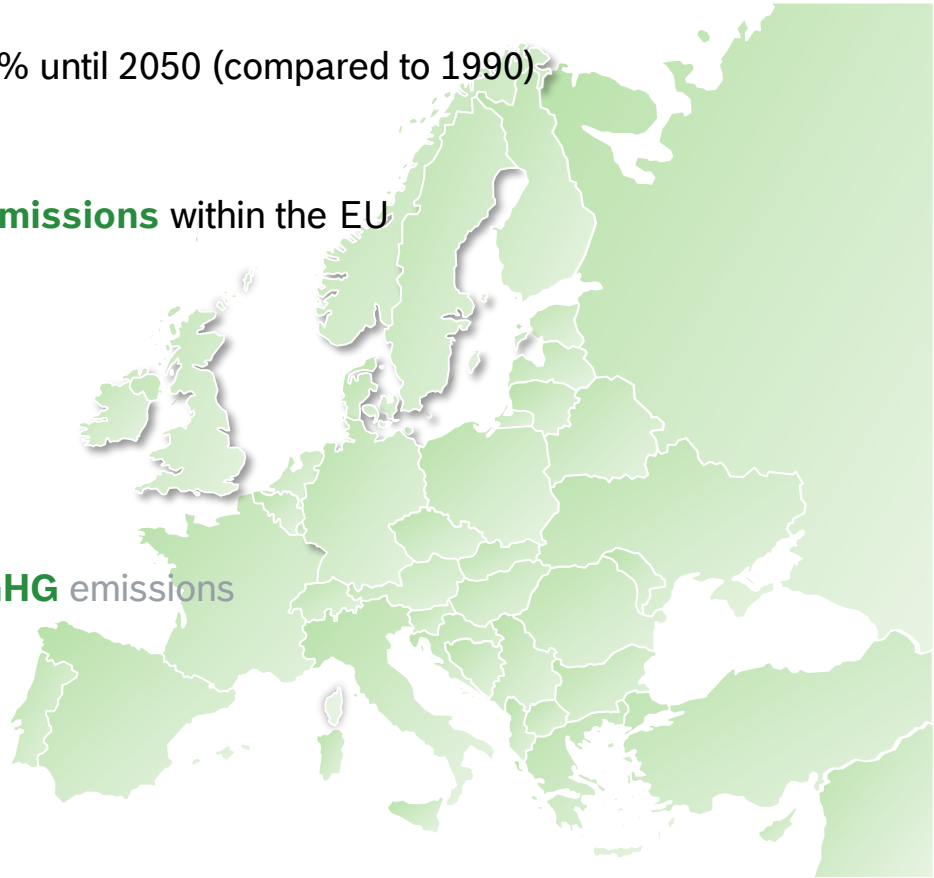
BOSCH

EU green deal: Boundary conditions for energy management

- **EU Green Deal**: Reduce EU net GHG* emissions to 55% until 2030 and 0% until 2050 (compared to 1990)

- **Buildings account for 40% of energy consumption and 35% of GHG emissions** within the EU
  - Incentivise energy-efficient buildings
  - Digitalisation and climate-proofing of buildings
  - Strict enforcement of legislation on energy performance of buildings

- **Production and use of energy** account for more than **75% of the EU's GHG** emissions
  - Increase energy efficiency and share of renewable energies
  - Fully integrated, interconnected and digitalised EU energy market



GHG: greenhouse gas emissions*

BOSCH

EU directive on energy performance of buildings (2010/31/EU)

Energy Performance of Buildings (EPBD) and Energy Efficiency Directive

Directive 2010/31/EU

= Low Energy Buildings

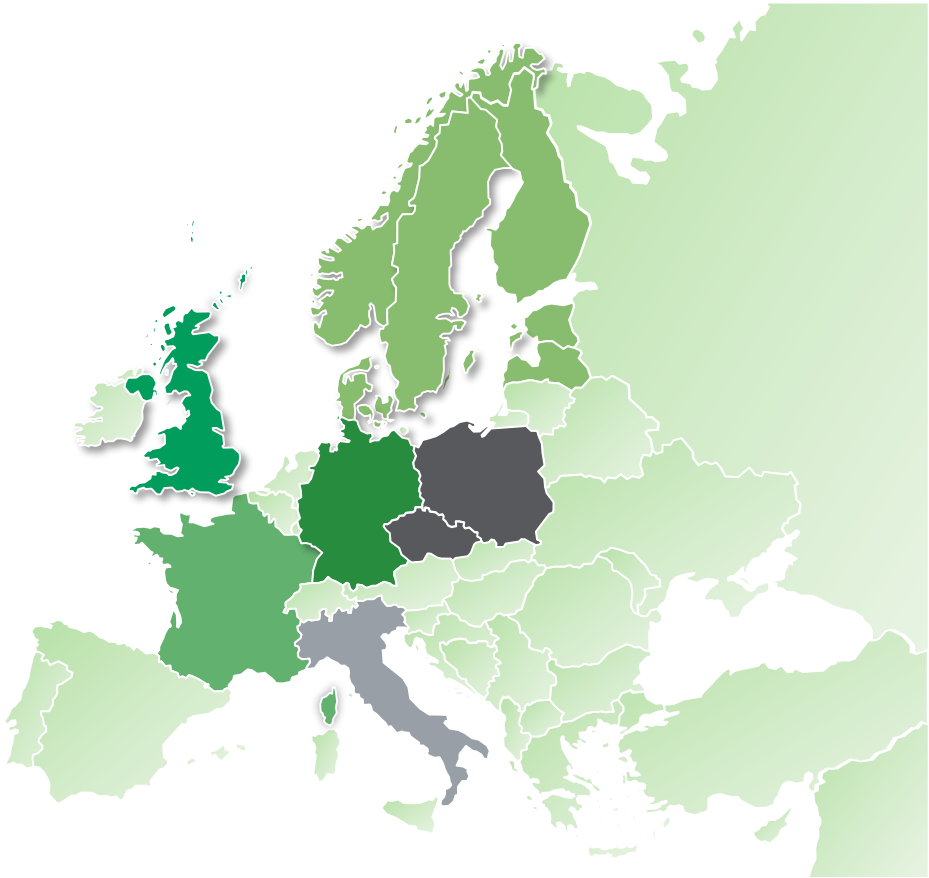
EU green deal

GEG (Buildings's energy directive)	**BEG** (Incentives on energy performance)	**EEG** (Renewable energy directive)
• **Reduction of energy demand** of building: PV-systems 30%, battery systems 45% • Insulation possible substitute for renewable energy • No oil boiler from 2026 w/o additional support from renewable energy	• **Promotion of energy efficient buildings: max.** 17,5% of 150k€ investment (26,5k€) • **Promotion of heat pumps** via one-time payments (up to **45% of investmen**)	• Promotion of residential, small scale **PV-systems** with **feed-in tariff** (2021: ~ 0,085 €/kWh) • Promoting **battery systems** for grid stabilization – depending on county ~ 200€/kWh

BOSCH

What does the energy management market look like within the EU?

Elec. Price [€/kWh]	0,17 – 0,20	0,18	0,17	0,30	0,13 – 0,18	0,23
Strong in	HP, EV, Smart Meter	EV, Smart Meter	HP	PV, BAT, HP	Growing HP market	PV, BAT, HP
HEMS use cases	Flexible tariffs, power limitation	Demand response, peak shaving	Network charges, PV self-consump.	PV self-consump., flexible tariffs	Network charges, PV self-consump.	PV self-consump., network charges
HEMS potential	Middle	Middle	Middle	High	Middle	Middle



*HEMS: Home Energy Management System

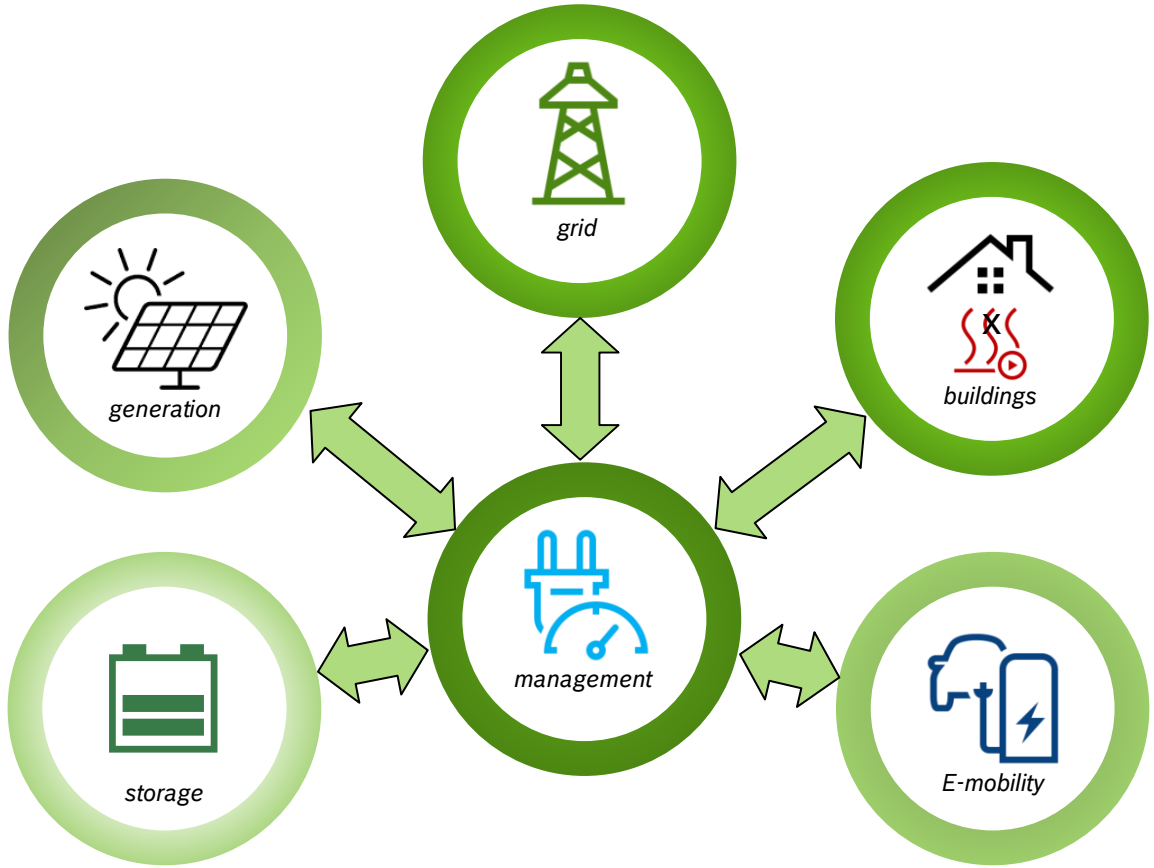
EV: Electric Vehicle

BOSCH

HEMS* market Germany

Tasks for HEMS:

1. Optimize consumption to generation
2. Maximize independence
3. Monitoring
4. Monitoring power grid connection point



HEMS: Home Energy Management System

BOSCH

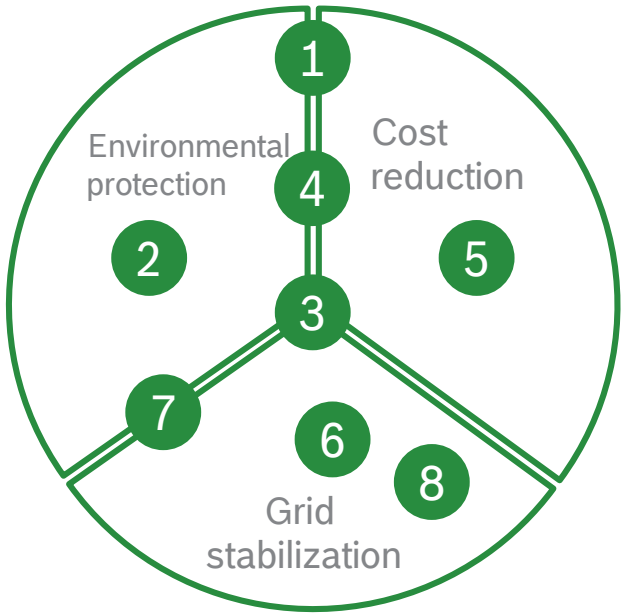
Bosch Thermotechnology ExpertTalk
Energy Management

Martin Weiss

Strategy Development and Product Owner Energy management

How does energy management work?

Energy Management – Most important Use Cases



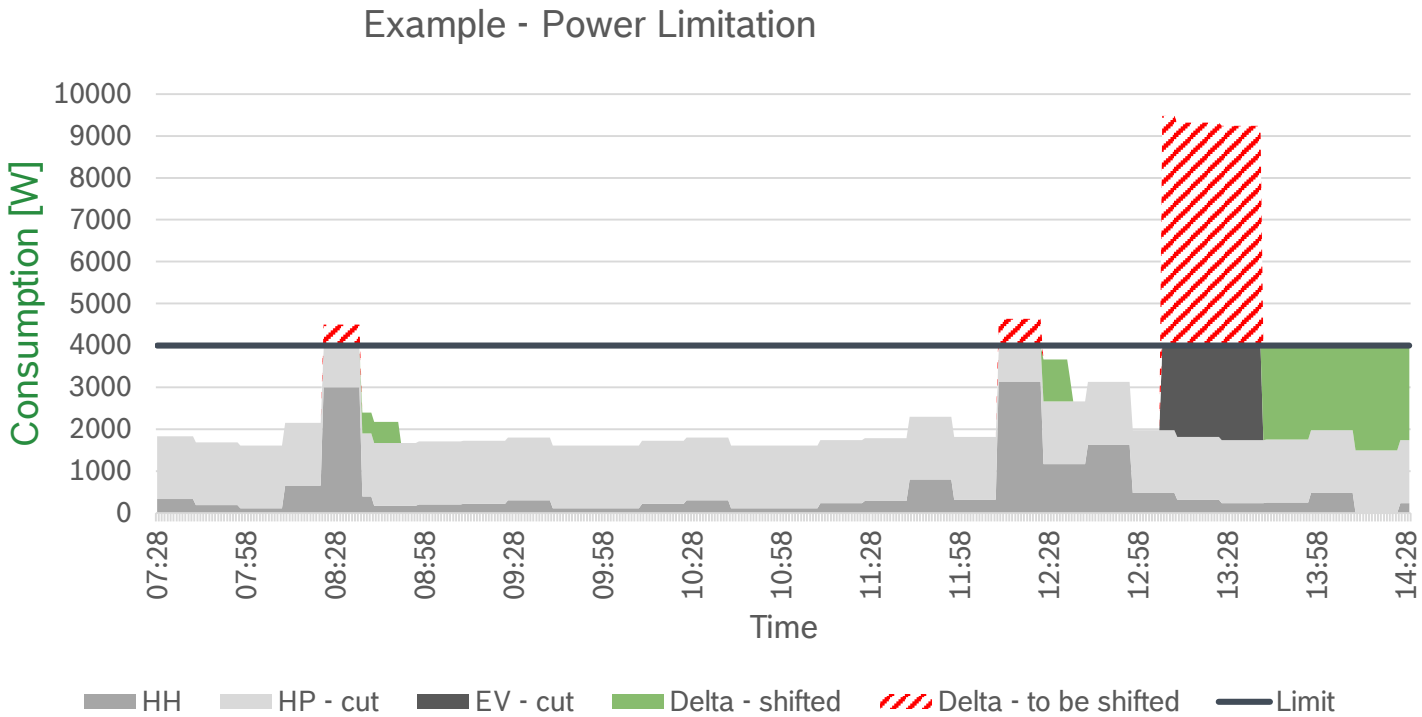
Number	Use Case	Country[1]
1	**Increase of Self consumption** *Increase use of self produced renewable energy by shifting operation time of flexibles loads (and sources)*	
2	**Minimization of curtailment losses** *Avoiding regulatory limitation of generation power by storing or consuming energy in potential limitation periods*	
3	**Tariff optimized consumption** *Cost reduction by shifting operation time of flexibles loads into low tariff periods*	
4	**Energy Monitoring** *Increasing awareness on energy use and system failures by visualization*	
5	**Peak shaving** *Reduction of connected load and base fees by avoiding peak loads by use of storages and limitation of flexible loads*	
6	**Overload protection** *Keeping power consumption below the building connected load to avoid power outages*	
7	**Power Limitation** *Remote dynamic limitation of power consumption by DSO to stabilize power grids in times of high fluctuations*	
8	**Control energy provision / balancing power** *Provision of positive and negative control energy*	

[1] *Only most important markets*

BOSCH

What’s happening in background? (1/3)

- **Overload protection / Peak shaving / Power Limitation**
  - **Goal:**
    Fulfilment **regulatory requirements** or reduction of **costs for higher power tariff**
  - **Energy Management Tasks:**
    - **Limit Power at PCC**
      (Point of common coupling) with static or dynamic limit
    - Reactive or proactive strategies possible

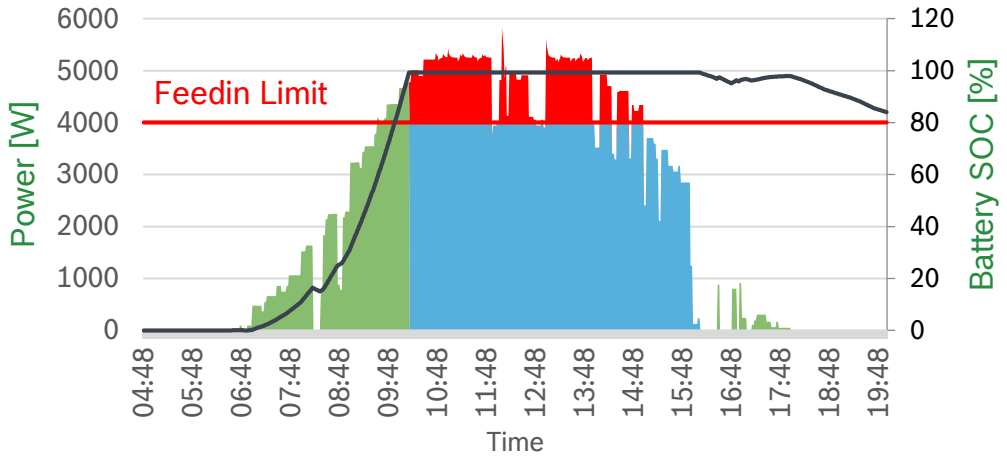


Example: Control of flexible loads with reactive strategy and a static power limit

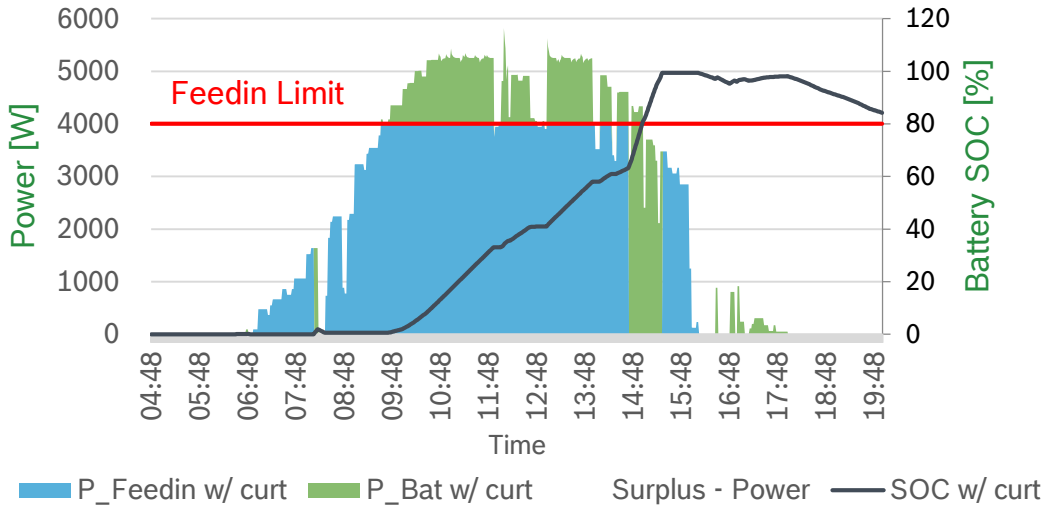
BOSCH

What's happening in background? (2/3)

Example without curtailment optimization



Example with curtailment optimization



Example: System behavior without and with curtailment optimization

Reduction of curtailment losses

- **Goal: Avoid curtailment losses** due to forced limitation of feedin
- **Energy Management Tasks:**
  - Optimized storage charging and flexible load schedules
  - **Prediction** of PV power, SOC and consumption required to be able to **schedule** loads and battery

BOSCH

What's happening in background? (3/3)

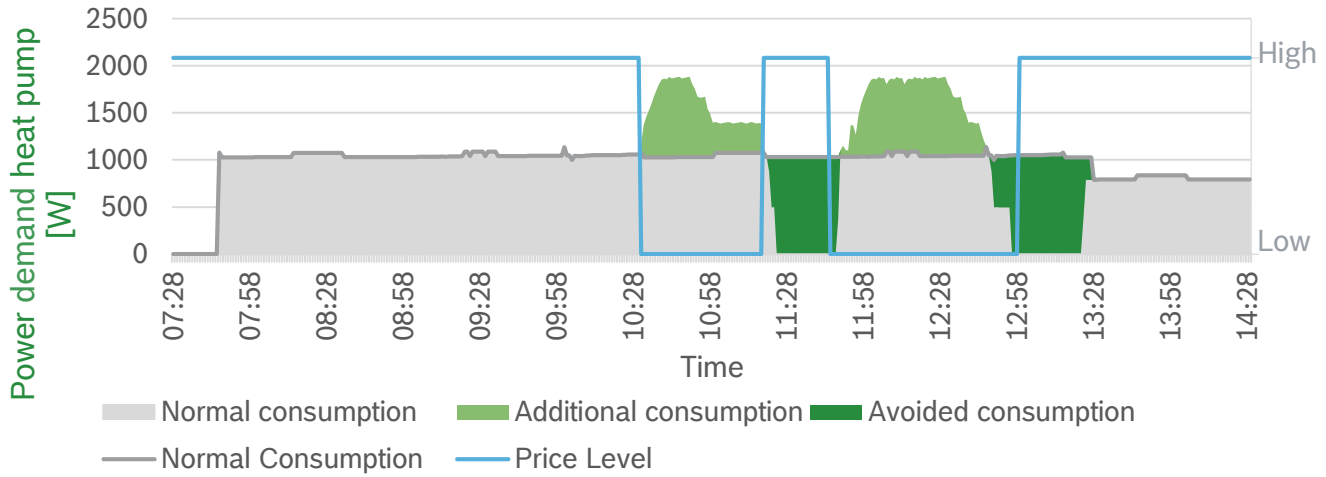
- **Increase of self consumption / Variable tariffs**
  - **Goal:**

    Reduce operating **costs** by use of **tariff spreads**

  - **Energy Management Tasks:**

    Shift power consumption from high to low tariff (or PV surplus) time frames
    - Scheduling (e.g. white goods, EV)
    - Storing energy in low tariff time (e.g. battery, heat pump, DHW)

Load shifting for cost optimization with variable tariffs



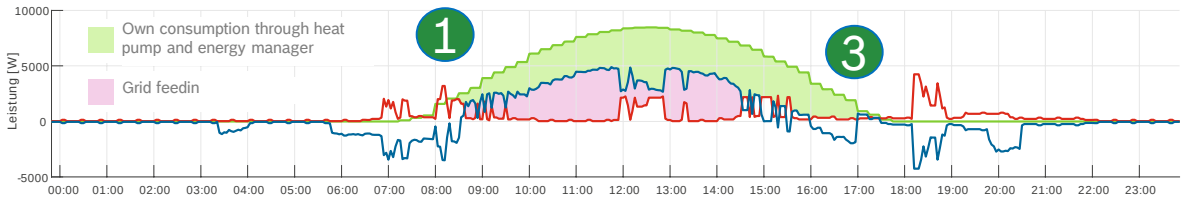
Example: Shifting heat pump consumption by overheating building

Depending on Use Case required functionality of an EM system differs significantly

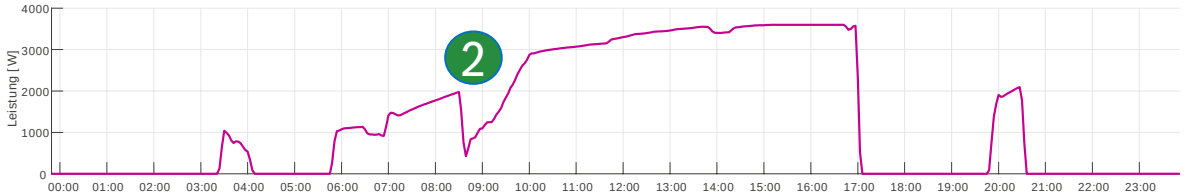
BOSCH

Load shifting with heat pumps

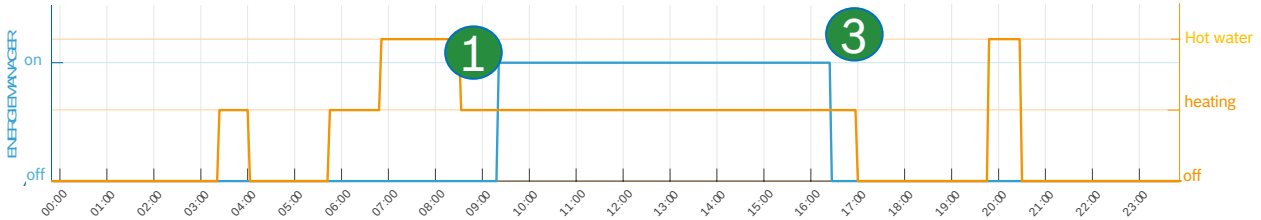
Power flow profiles, daily (PV-energy, domestic electricity, Grid connection point



Electricity consumption heat pump



Operating modes of the energy manager and the heat pump



1 PV surplus detected
→ HP set to overheating mode

2 HP increases power consumption
→ Heat is stored in buffer tank and building mass

3 Grid consumption at PCC
→ Overheating stopped
→ No operation for rest of the day

Control energy manager
Operating status energy manager

Electricity generation
Power at grid connection point
Household power consumption
Power consumption heat pump
Operating mode heat pump

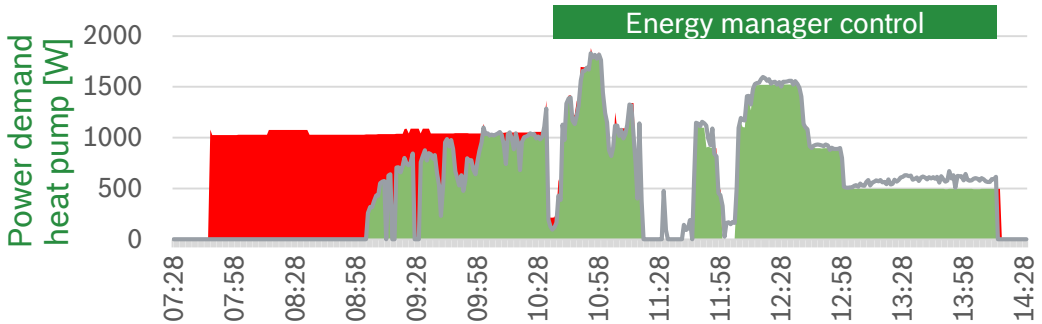
Energy consumption at night can be reduced by overheating building & storages over the day

BOSCH

Load shifting with heat pumps – Modulating control

PV Surplus
HP self consumption
HP grid consumption

Load shifting - Modulating control



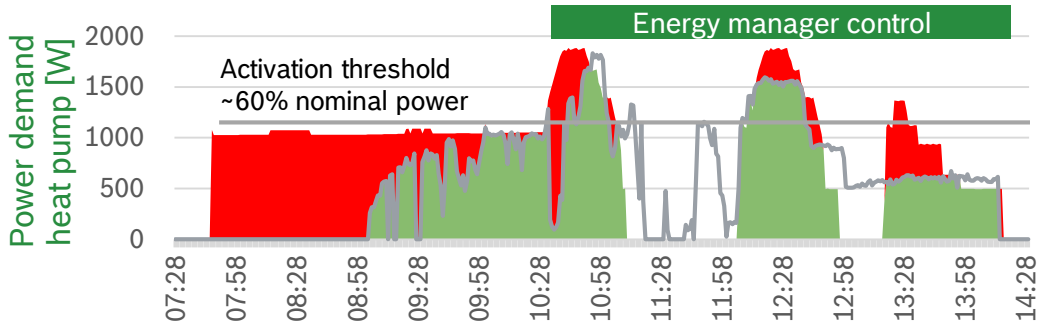
Energy Manager with Bosch Heat Pump

Heat pump power control according to current PV surplus

- Faster and more accurate
- Consumption limited to current surplus
  -> No grid consumption

- Example: Whole year simulation, EnEV building, 7 kWp PV:
  Increase in autarky: 520 kWh/a / 20 %
  Decrease in heating costs 97 EUR/a / -12 %

Load shifting - SG Ready



Energy Manager with control via SG-Ready

Heat pump is overheating after surplus reaches threshold

- Consumption rises to full power when SG Ready sent
  → Grid consumption unavoidable
- Slower reaction due to temperature driven control

- Example: Whole year simulation, EnEV building, 7 kWp PV:
  Increase in autarky: 216 kWh/a / 9 %
  Decrease in heating costs 42 EUR/a / -5 %

With modulating control of heat pump, cost savings by load shifting can be doubled

BOSCH

ENERGY MANAGEMENT CHALLENGES

- User acceptance
- Legislation
- Standardization
- Flexibility Forecast

Bosch Thermotechnology ExpertTalk
Energy Management

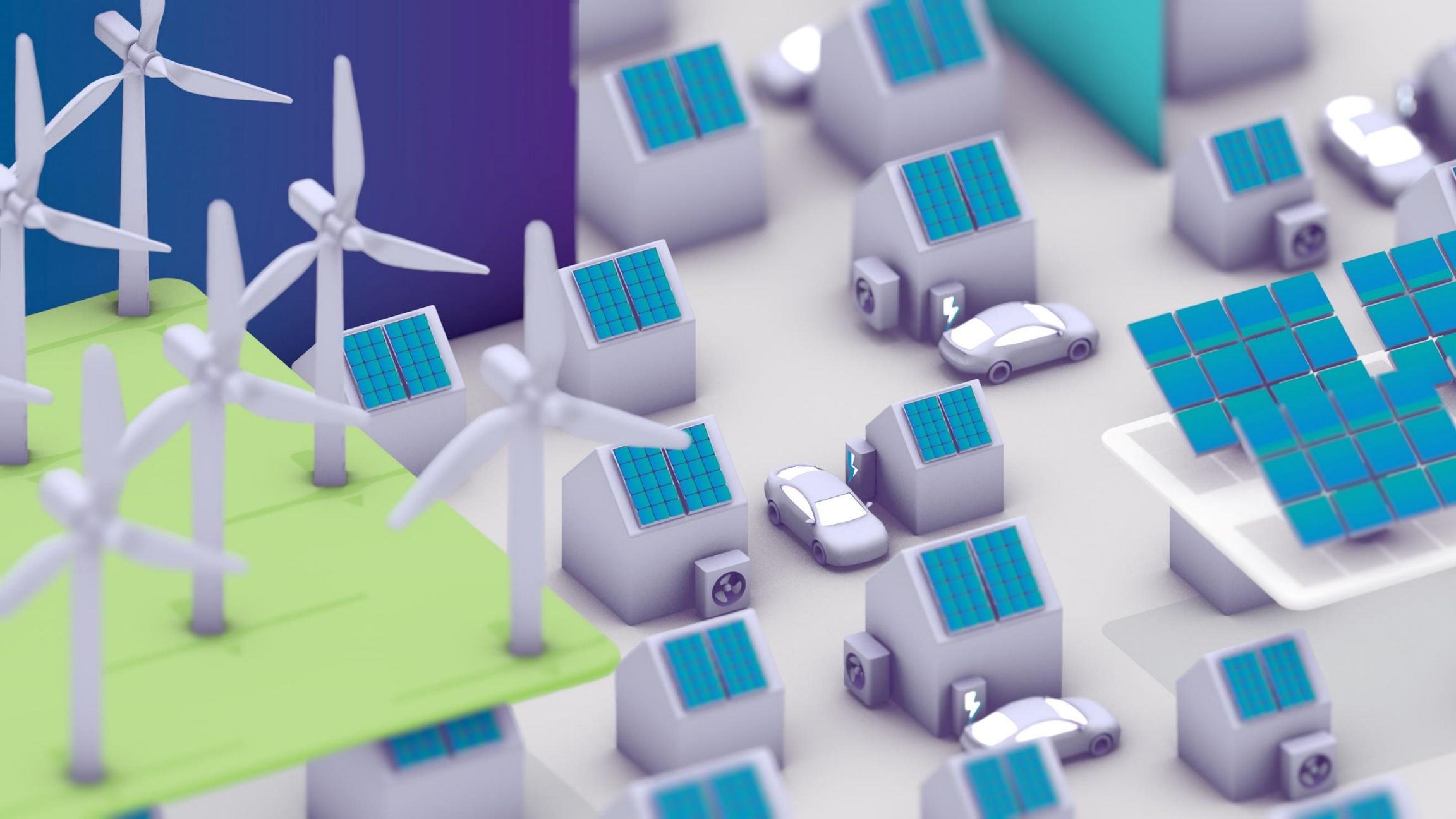
Christian Heise

Deputy Project Director “Economy of Things”

Jared Weinfurtner

Lead Architect – Decentralized Energy Trading

Decentralized energy trading – an outlook



Vision:

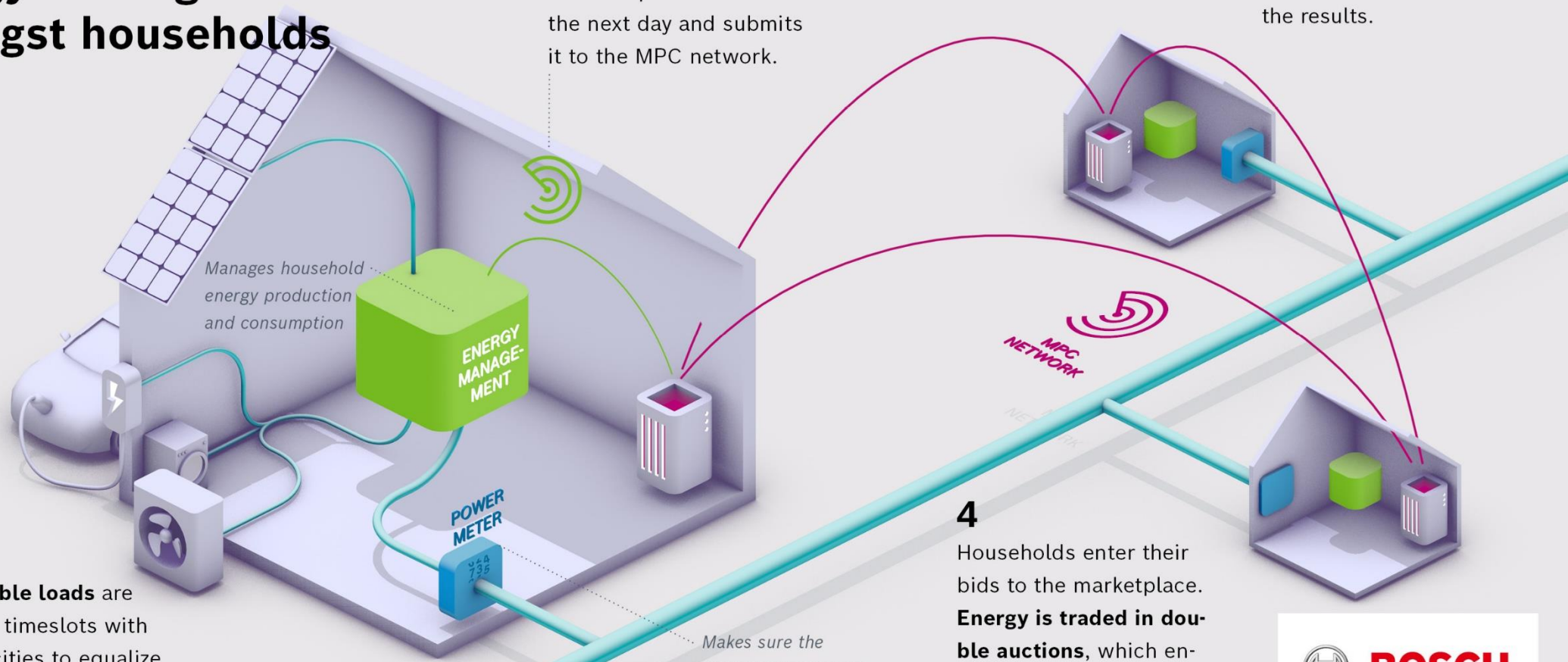
Privacy preserving energy trading amongst households

1

The **energy management predicts** energy consumption and production for the next day and submits it to the MPC network.

2

The **MPC network calculates** overall consumption/production for the community and publishes the results.



3

Controllable loads are shifted to timeslots with overcapacities to equalize the community's supply and demand.

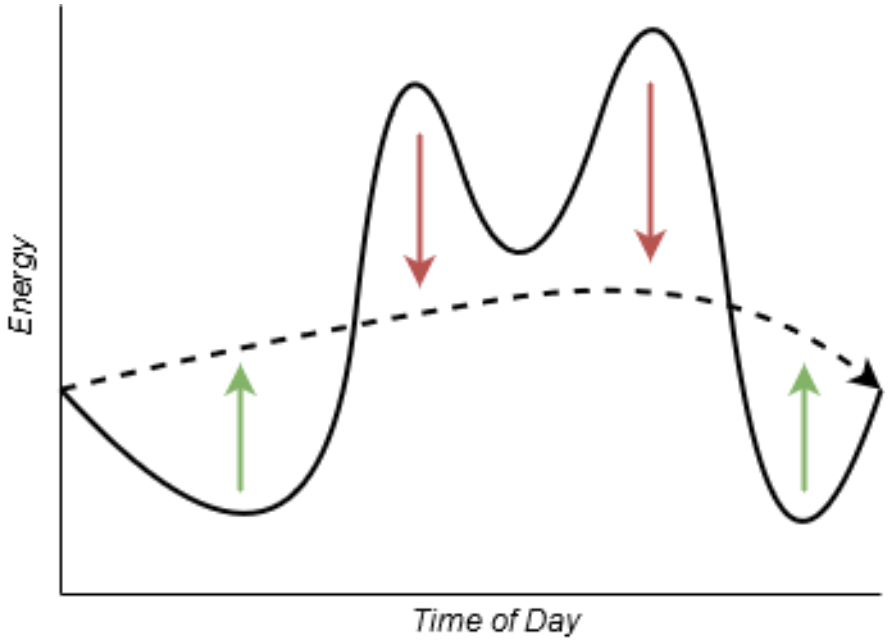
4

Households enter their bids to the marketplace. **Energy is traded in double auctions**, which ensures fair prices for both producers and consumers.

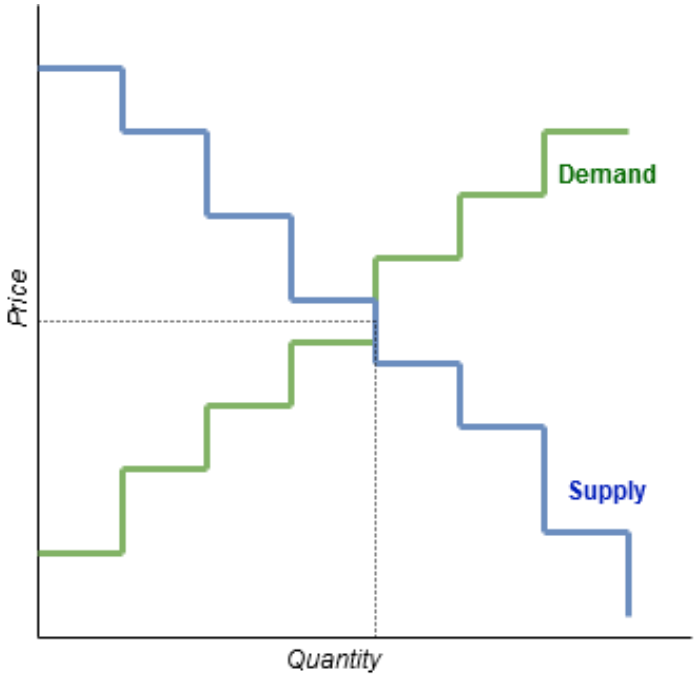
BOSCH
Invented for life

Our approach: Involve everyone and conserve data privacy

AGGREGATE PEAK-LOAD SHIFTING



DAY-AHEAD DOUBLE-AUCTION



Three technical layer with totally different involvement of players

Compete
when it comes to excellent products

- Smart Things → Connected Products and Agents
- Connectivity → Gateway
- EoT Service Suite → Service Suite Lifecycle Management
  - API Management
  - Smart Contract Safety
  - EoT Libraries

Cooperate
to run trusted decentralized platform

EoT Transaction Process

- **Discovery**
  - ▶ Search
  - ▶ Find
- **Meeting of the Minds**
  - ▶ Auction
  - ▶ Negotiation
- **Settlement**
  - ▶ Contract Execution
  - ▶ Arbitration
- **Post-Settlement**
  - ▶ Reputation
  - ▶ Indiv. Learning
  - ▶ EoT Learning

Self-Sovereign Identity

Collaborate
to evolve the system

- Governance body → Create a fair governance model
- DLT and MPC → All aspects of Distributed Ledger Technology and Multi-Party Computation
- Infrastructure → Any cloud of your choice / Data center

LEARN MORE

“CAN ENERGY MANAGEMENT AND TRADING BE IMPLEMENTED DECENTRALLY ACROSS HOUSEHOLDS?“
HTTPS://WWW.BOSCH.COM/RESEARCH/UPDATES/ECONOMY-OF-THINGS/USE-CASES-PROTOTYPES/#ENERGY-MARKETPLACES

ECONOMY OF THINGS RESEARCH UPDATES
HTTPS://WWW.BOSCH.COM/RESEARCH/UPDATES/ECONOMY-OF-THINGS/

BOSCH

Bosch Thermotechnology

ExpertTalk
Energy Management

2021-02-16 | 10:00 AM CET