Workshop DSM Potentials, Implementations and Experiences

PowerMatching City II,

Demonstration of multi-objective optimization in a living lab

René Kamphuis, TNO


Hoogkerk living lab environment (PMC-I)

- Established in the Integral-project
  - EU-FP 6: http://www.integral-eu.com
  - VPP Virtual Power Plant
    - 25 households with heating system + heat storage connected
      - 50 % Stirling µ-CHP
      - 50 % Hybrid Air-to-air heatpump + Gas fired boiler
    - Solar cells
    - Wind turbine
    - 2 EV's
    - Operated in 7 use case applications
  - Implementation via PowerMatcher-technology developed in the project
  - PC home gateways concentrate at the home level; further concentration architecture dependent on the use case

Technology used

Agent

Generic Protocol

Device

Device Agent

Price

Bid

Business Logic

Objective Agent

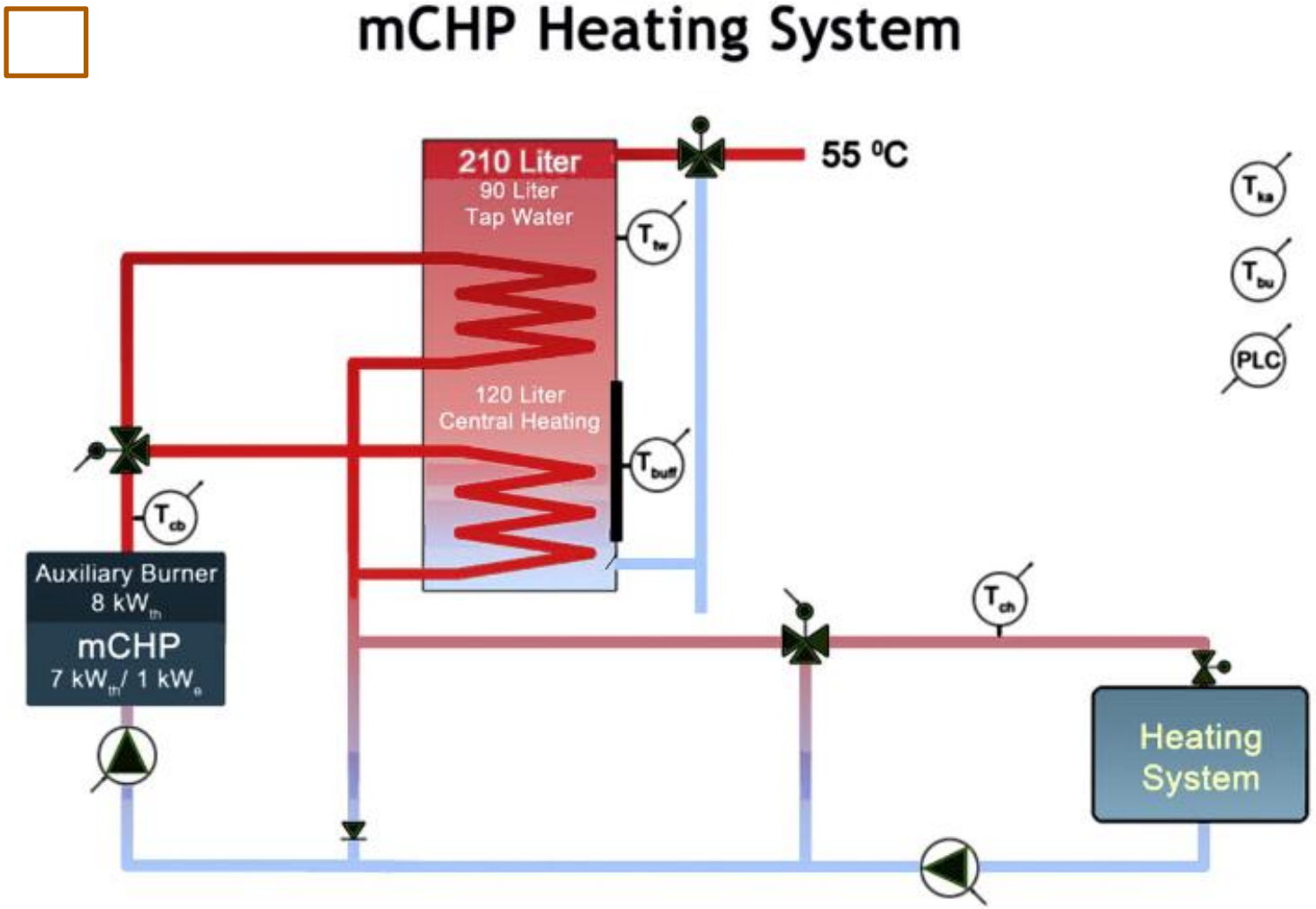
Auctioneer Agent

Concentrator Agent

Hoogkerk

PowerMatching City

Demand response potential is in heating buffer




TNO innovation for life

The Hoogkerk smart grids living lab: use cases phase I

- How to use the gas infrastructure to support the electricity system
  - Congestion and capacity management
  - Optimize energy usage on the home level
  - Reduce wind imbalance in real-time in the portfolio of a market responsible party
  - Balance in optimizing PhotoVoltaic integration
  - Aid in trade dispatch


TNO innovation for life

Functionality in PMC-II (2012-2015)

- PowerMatcherCity II (IPIN-project; Dutch SmartGrid program)
  - More heterogeneous cluster with more device types (scheduling dishwasher/washing machine)
  - Introduce a ‘Distribution-Agent’ in a residential area (congestion)
  - Coupling of agent transactions to wholesale processes
    - ‘Smart meter allocation’ of individual customers
  - Coupling of agent transactions to billing processes
  - Agents on mainstream ICT platform -> embedded systems + Cloud
  - Improved agent price models (marginal prices)
  - Capacity management of concerted EV charging in buildings
    - 2-11 EVs
    - According to emerging standards
    - As a time-dependent capacity proposition
    - Safe fast-charging
    - Billing and grid transaction communication


TNO innovation for life

Phase II

- New use cases: Multi-Objective optimization
  - Trade dispatch
  - Distribution system operation (congestion management)
  - Community proposition objectives

Setting

In-Home Optimization

Cost Effective use of Energy

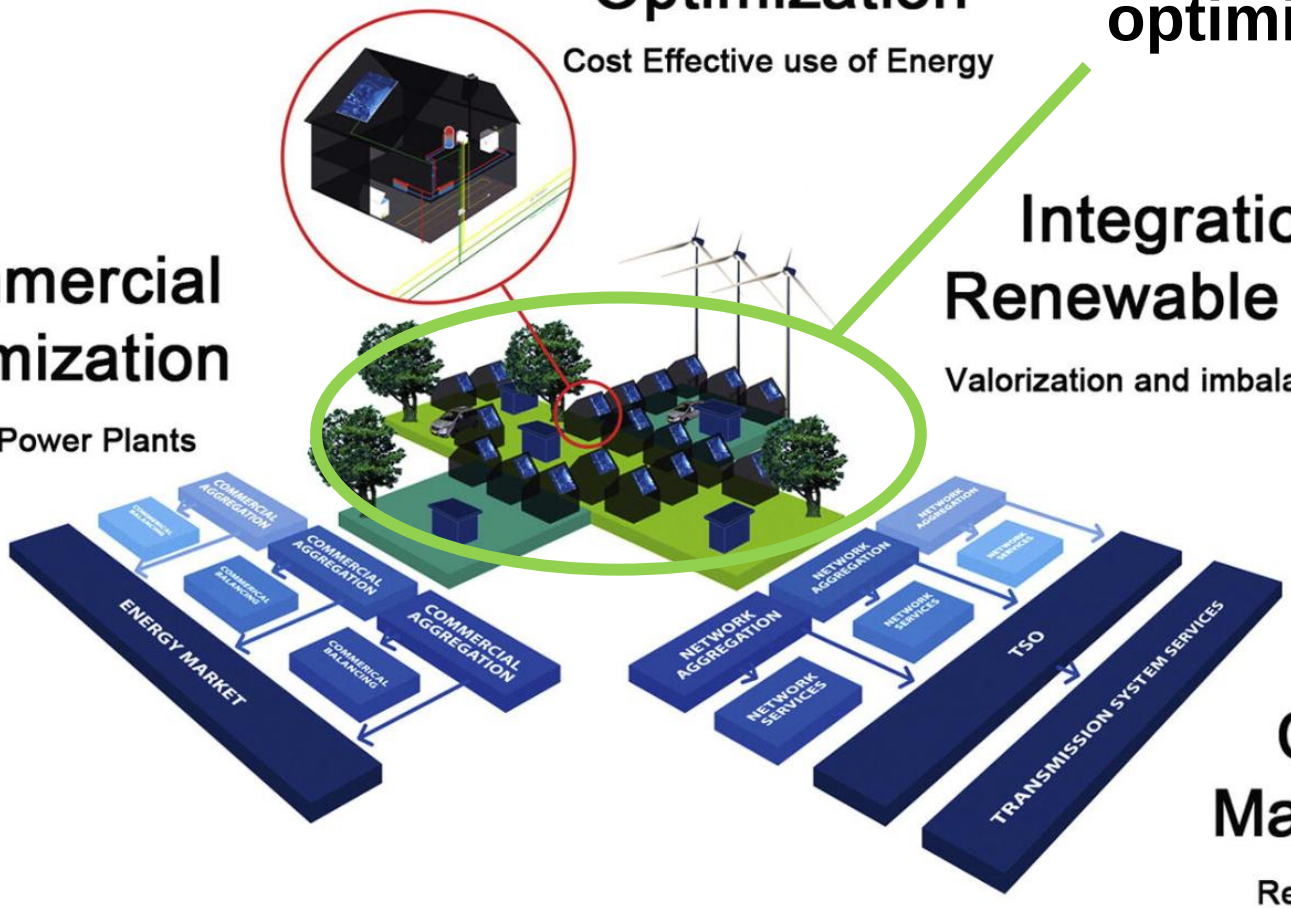
Community optimization

Commercial Optimization

Virtual Power Plants

Integration of Renewable Energy

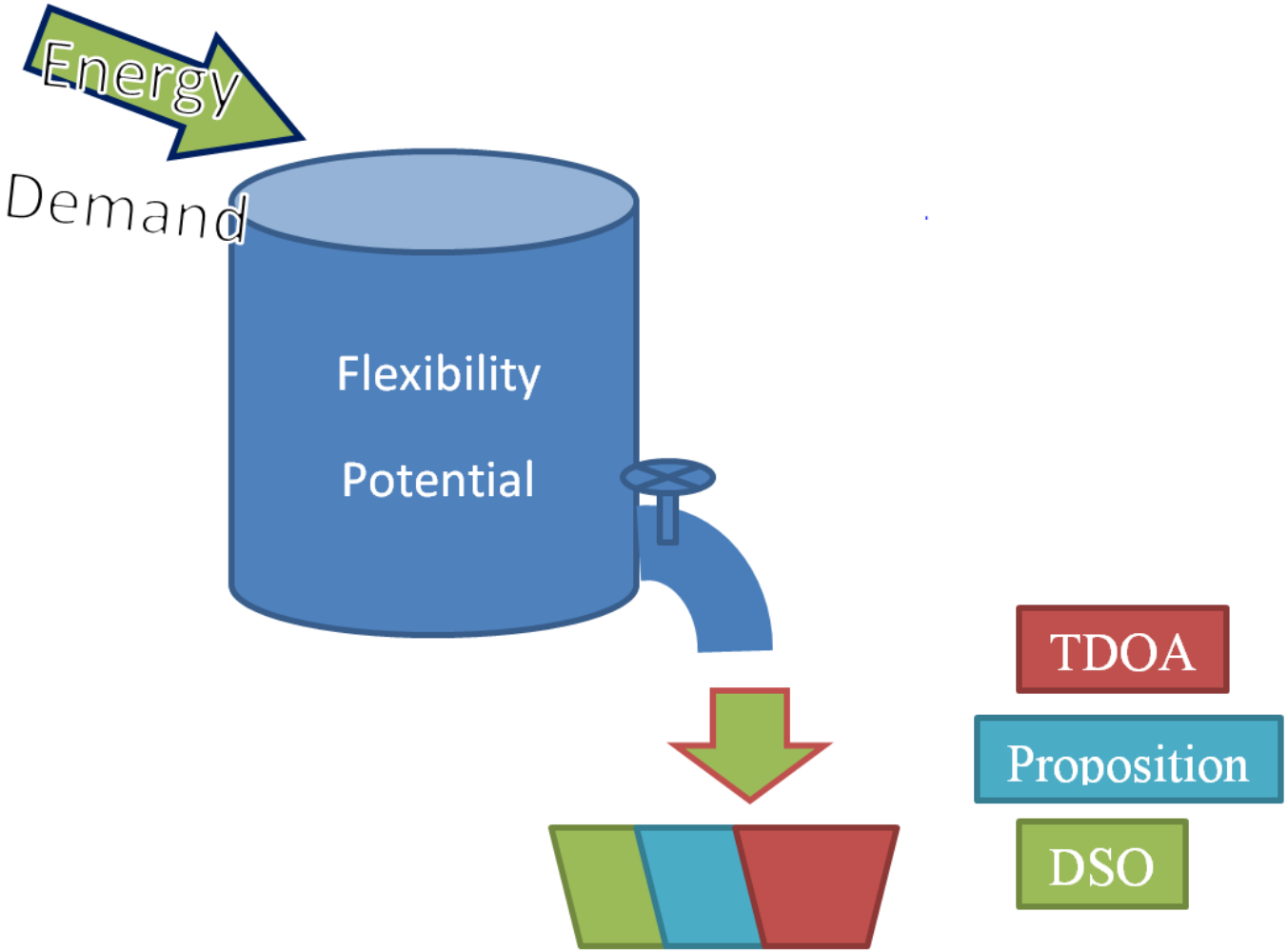
Valorization and imbalance Reduction



Capacity Management

Reduce Peak Loads

Demand response potential is shared



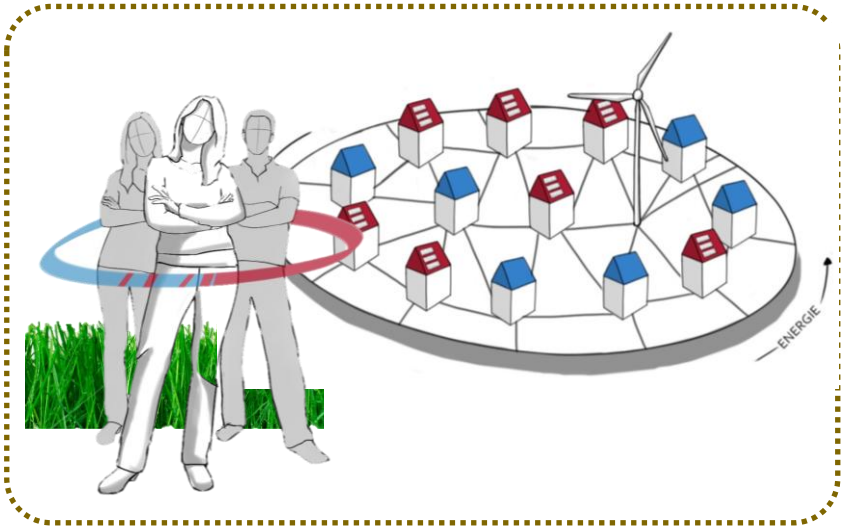
PMC-II communities

- User portal
  - Community formation and marketplace for communities; new role of retailer as mediator between communities
  - App on SmartPhone for energy management; energy dashboard
  - Usability assessment

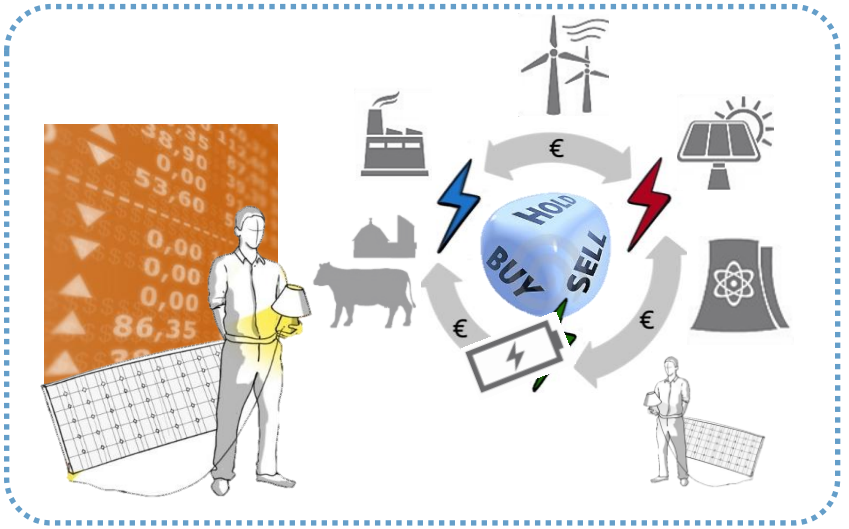
PowerMatching City

Propositions are based in driving forces of customers

Renewable



Smart cost saving

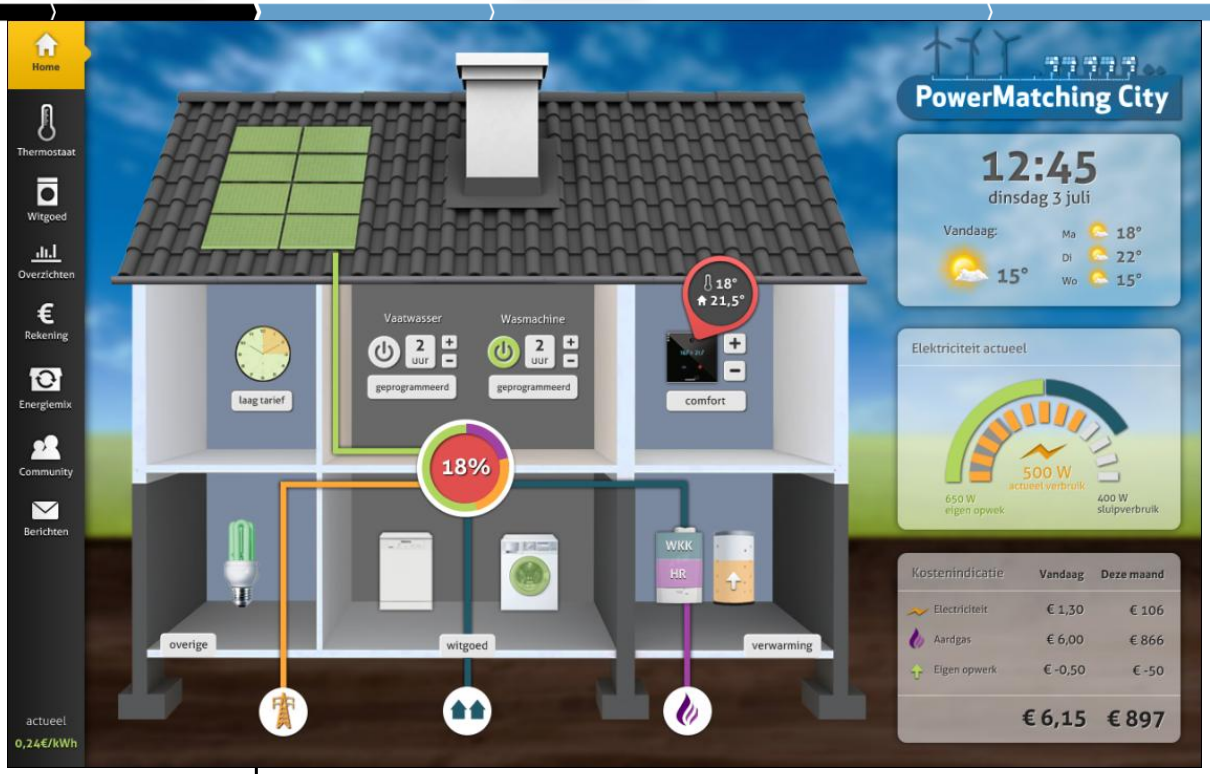


Scope: **PV, µ-CHP , heat pump, washing machine, dish washer**

- **Utilize renewables**
- **Independent**
- **Comfort**

- **Together Minimize cost**
- **Lowest price**
- **Retain comfort**

PowerMatching City

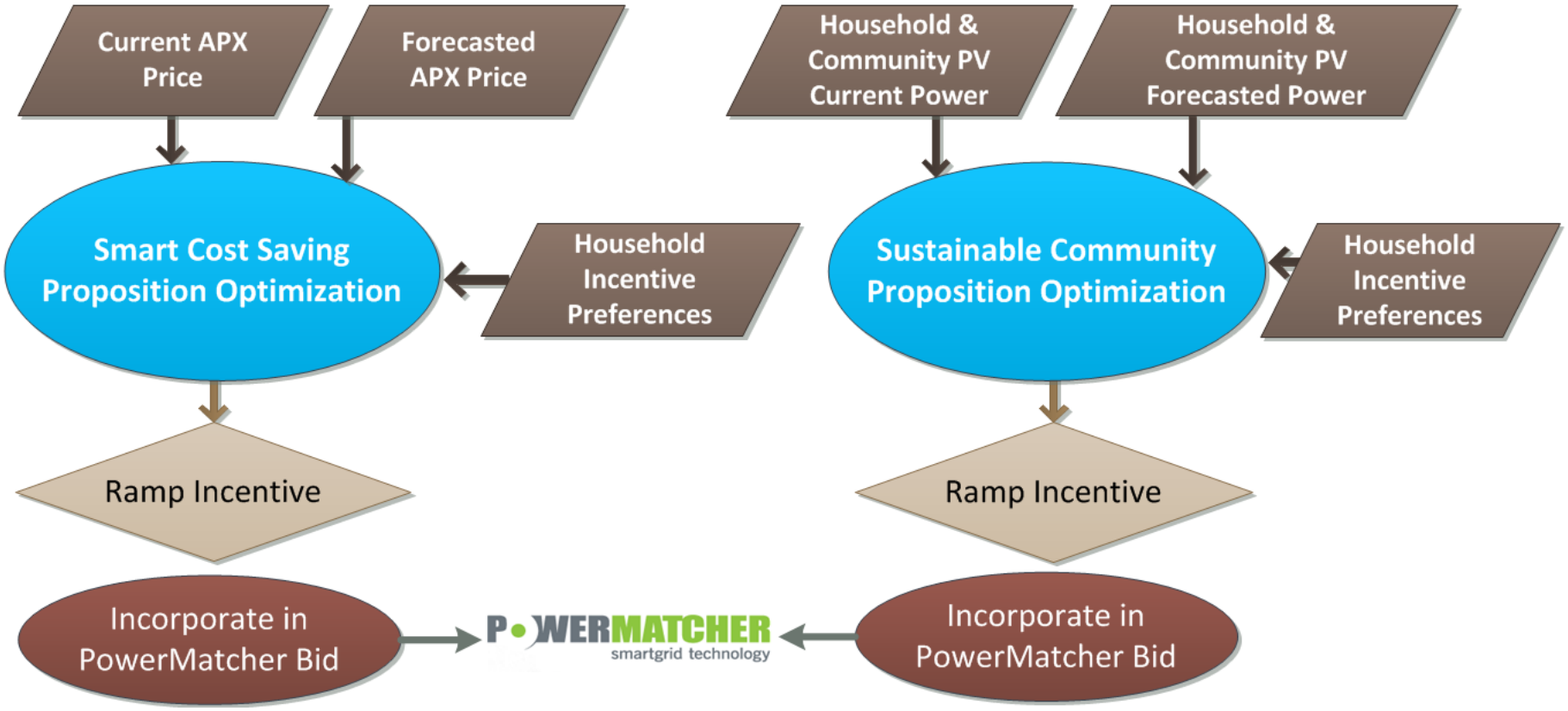


Energy dashboard information

- Variable price for energy (real-time, history)
- kWh vs price
- Feedback on cost-effective operation of devices
- Monthly cost-saving
- Usage at several tariff zones

- Home balance: kW, kWh (real-time , history)
- Community balance: kWh (in real-time , history)
- Monthly usage per energy carrier

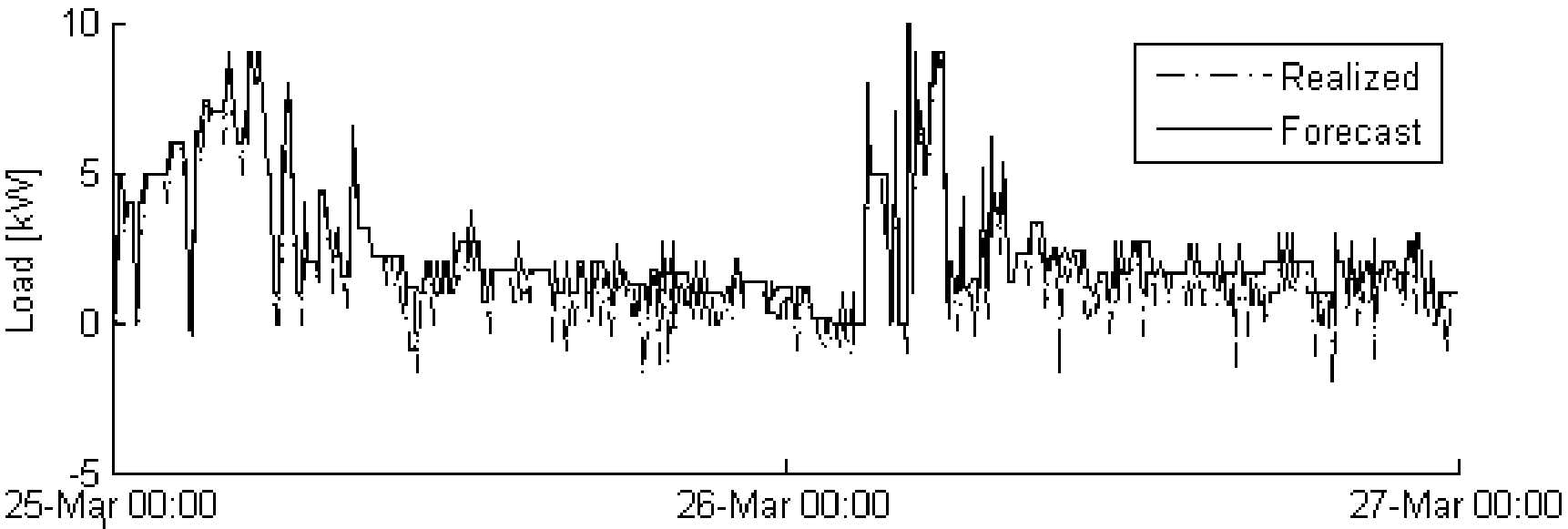
Incorporation multi-objective in PowerMatcher bids



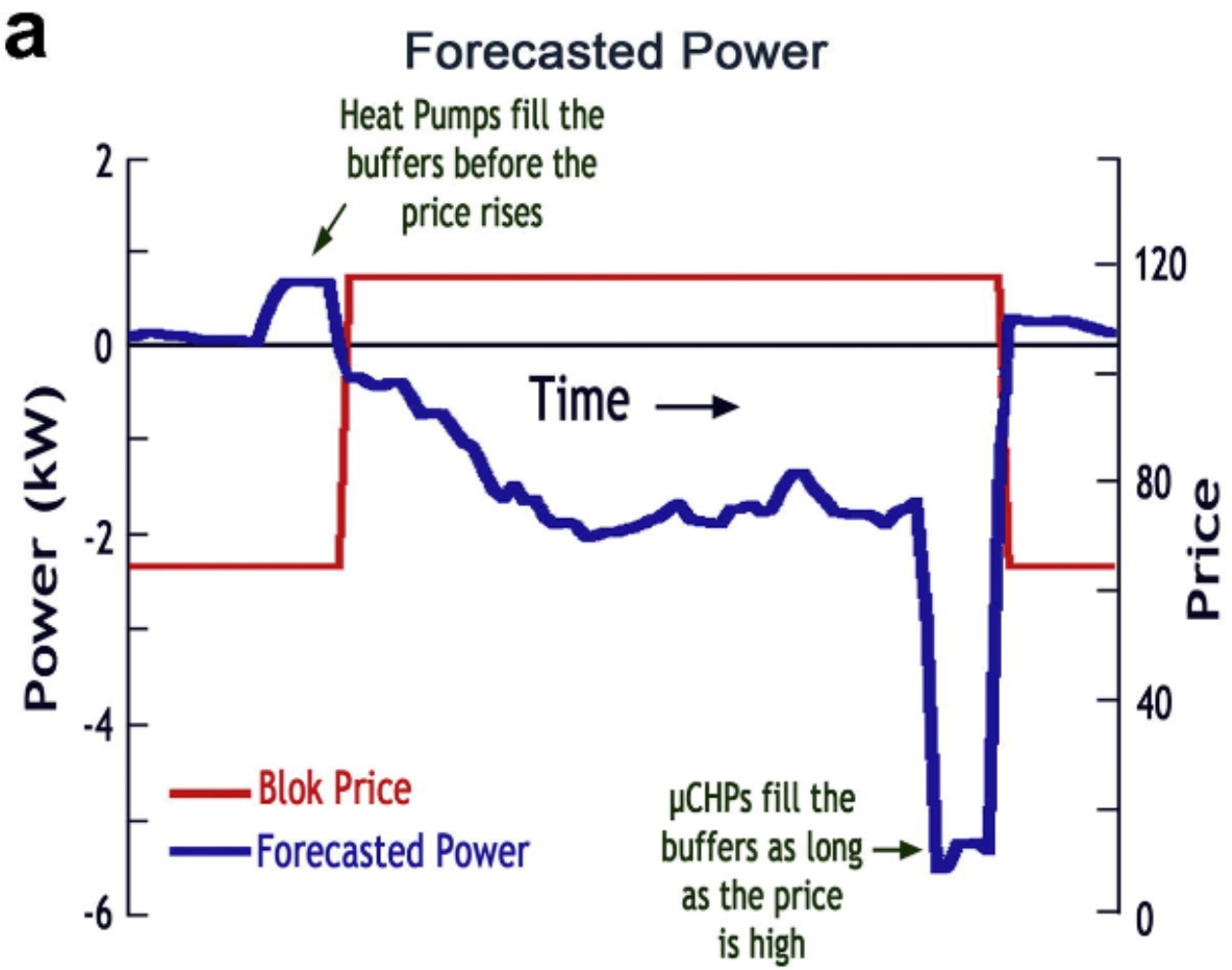

Link to forecasting

- Pre-empted or postponed Demand Response and generation
- Production forecasts are made for all types of devices aggregated
  - heating demand related -> dependent on the temperature
  - clustering with reference patterns
  - historic realisations
- Photo-Voltaic
  - Link to expected solar incidence and past realisations

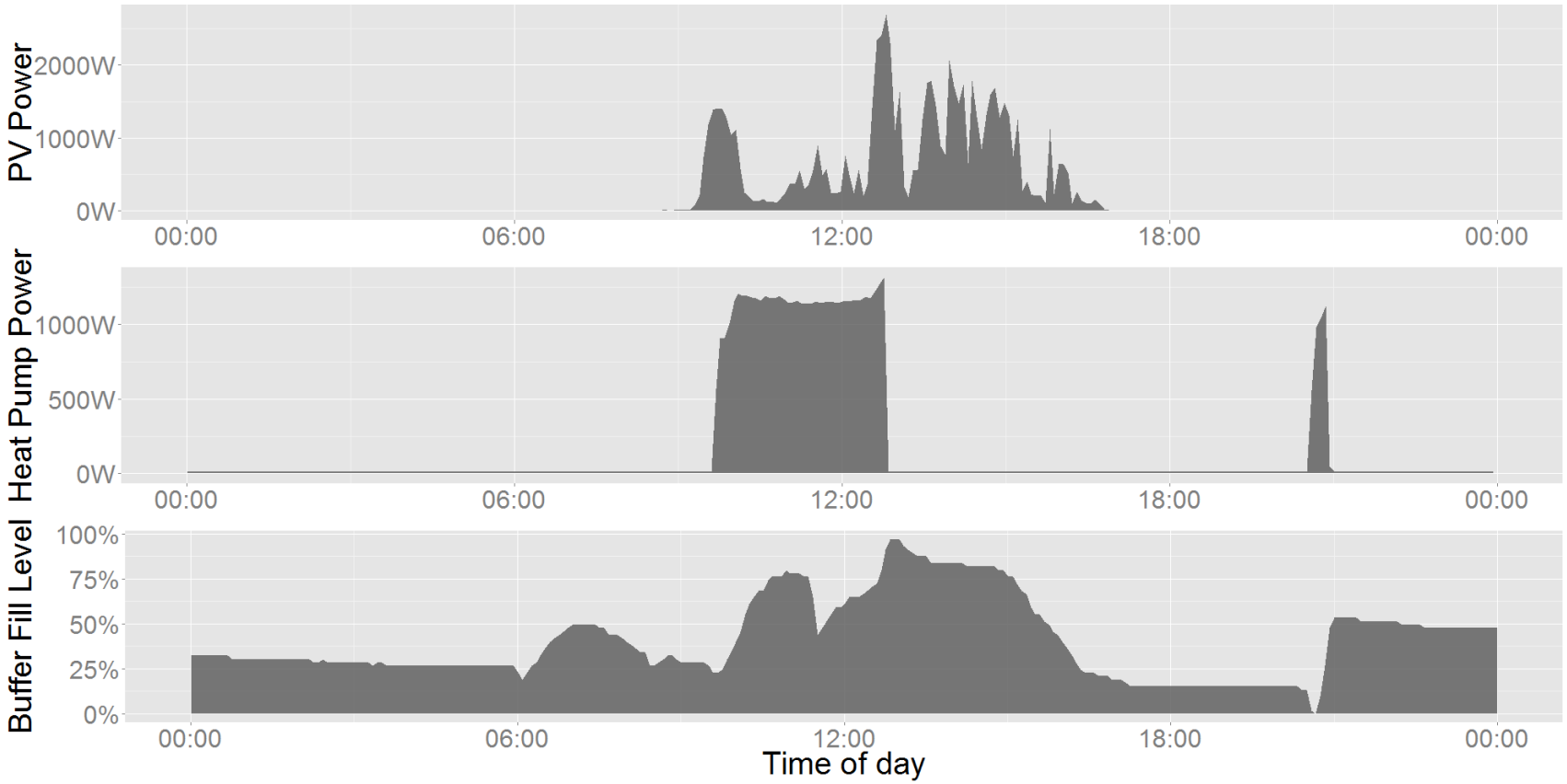
Bandwidth of flexibility in the cluster



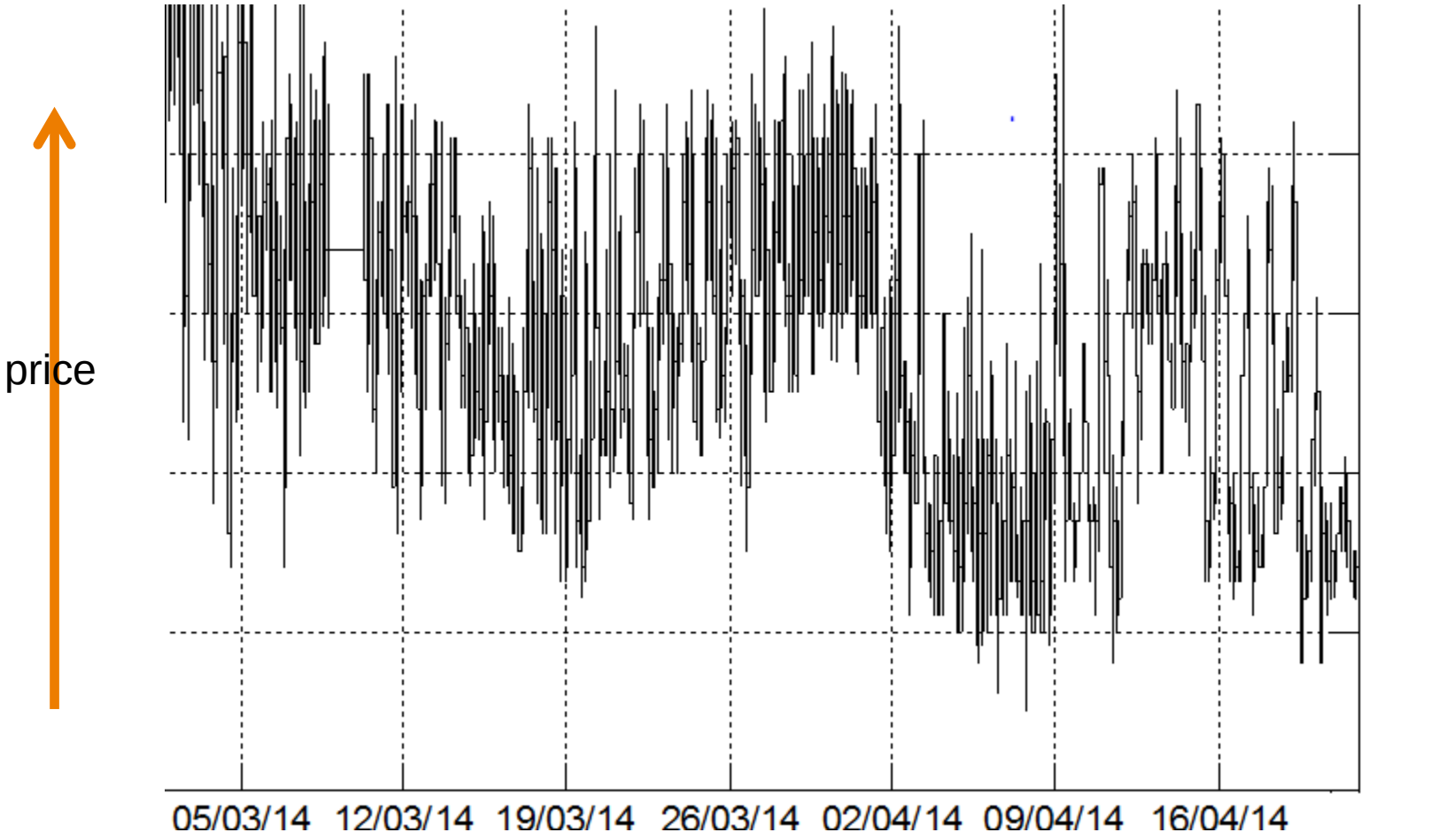
TDOA:Pre-emptive charging of heat buffers – Hybrid approach: Optimization on forecast and real-time adjustment



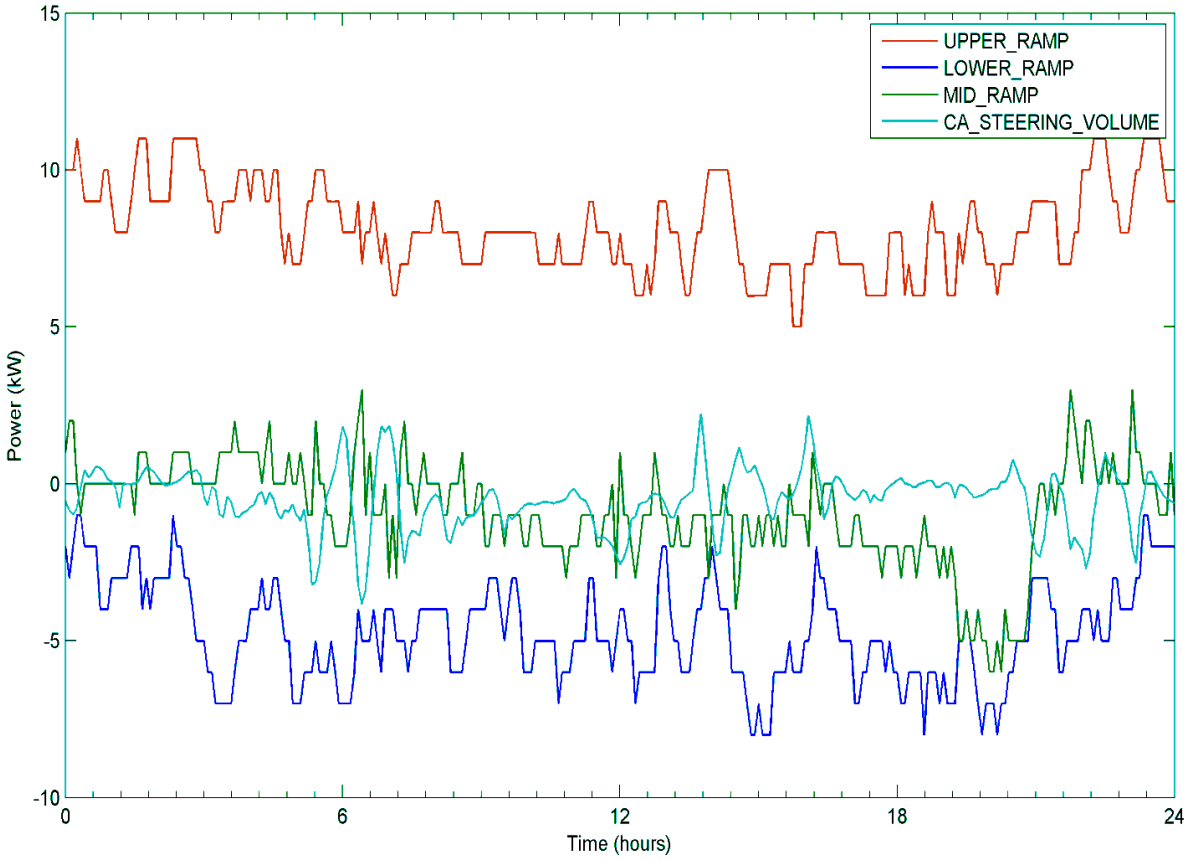
Concerted operation of PV and heat pumps in renewable proposition



Sustained balancing via internal PowerMatcher Price



Bandwidth of flexibility in the cluster




TNO innovation for life

Thank you rene.kamphuis@tno.nl