

PATHFINDER project



ETH zürich



HOCHSCHULE
LUZERN



UNIVERSITÉ
DE GENÈVE

EPFL

Purpose

- Renewable Management and Real-Time Control Platform
- Development and experimental validation of new control algorithms and hardware components in multi-energy systems
- Seamless transition from pure simulation (digital twin) to partial experiments embedded in simulations (hardware-in-the-loop) and eventually to full experiment
- Provides interface to existing research platforms: ESI at PSI, ehub (NEST, move) at Empa
- Minimize risks of directly going to a real live demonstrator



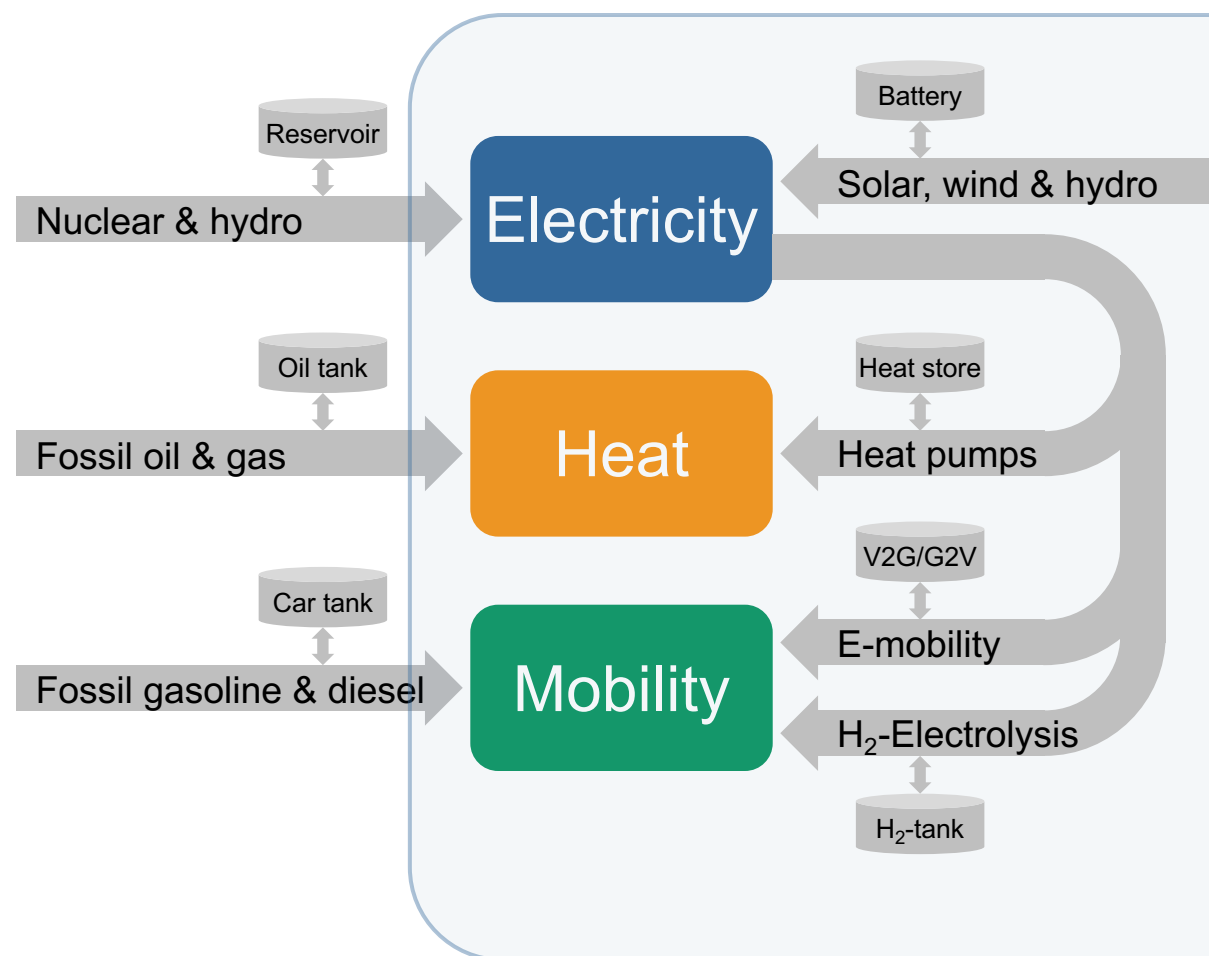
<https://remap.ch>



Motivation: the future is more complicated than the past

Old world

- Dispatchable power generation
- Energy services are decoupled
- Simple storage at user level



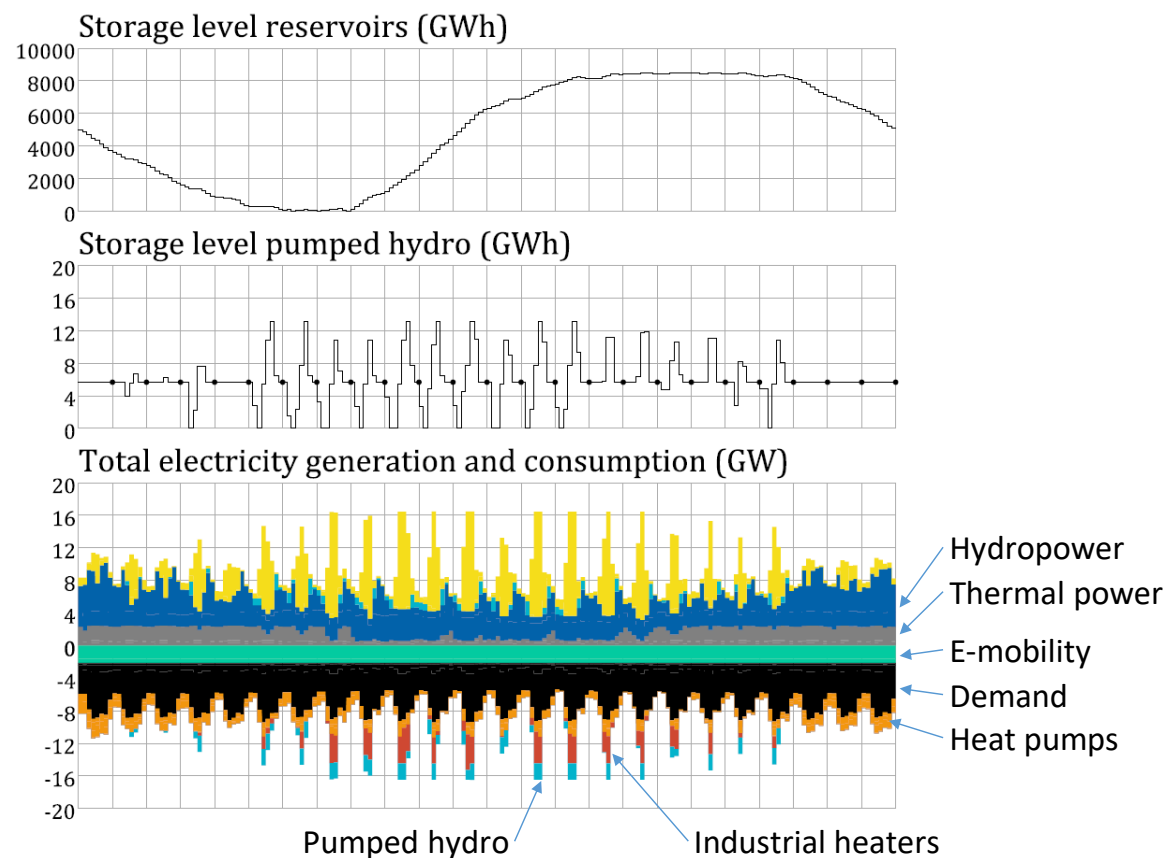
New world

- Fluctuating power generation
- Energy services are tightly coupled
- New storage devices allow for flexibility

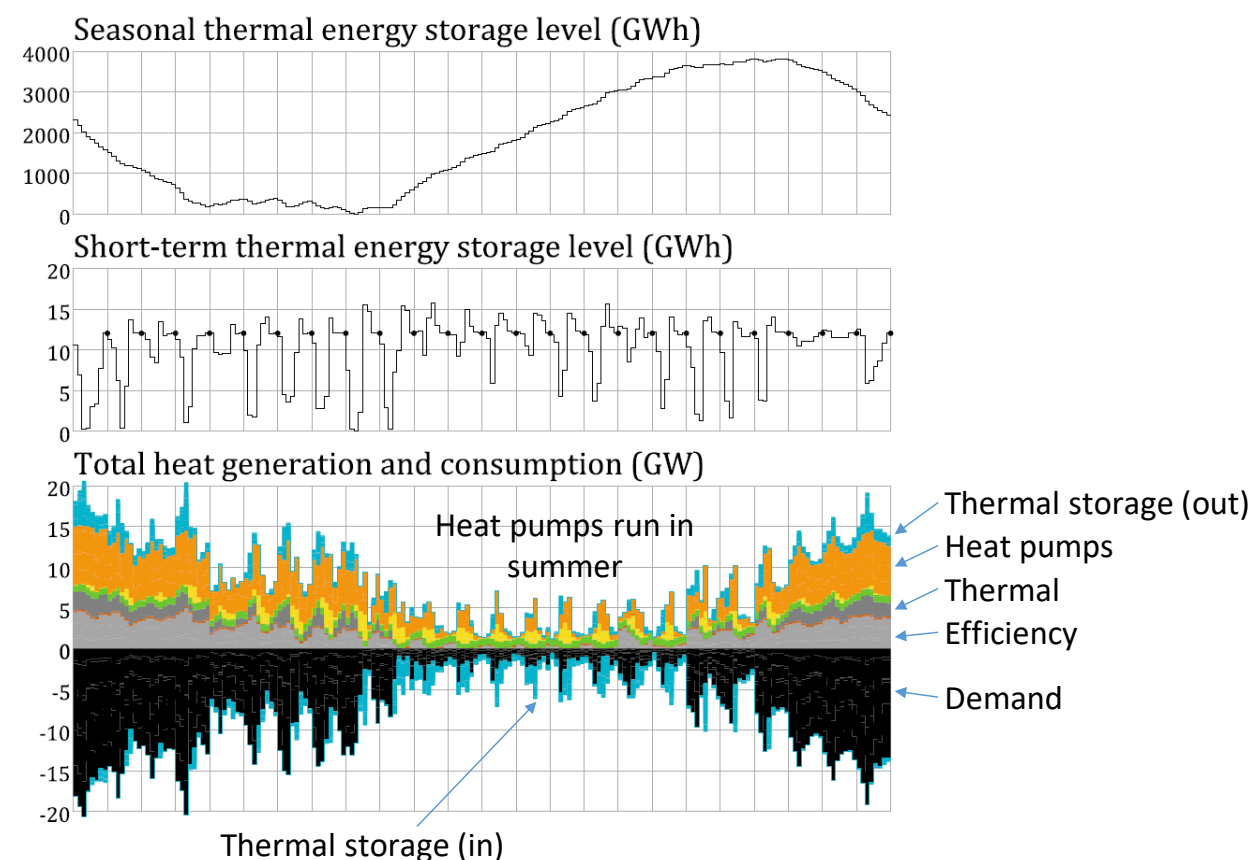


Lots of fluctuations, requires storage, flexibility, ...

Electricity

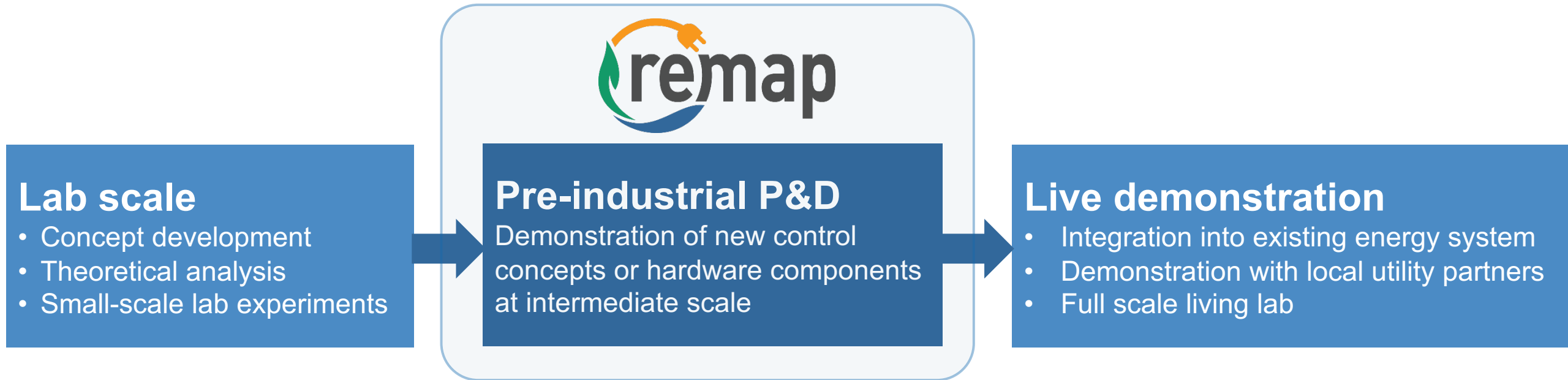


Heat

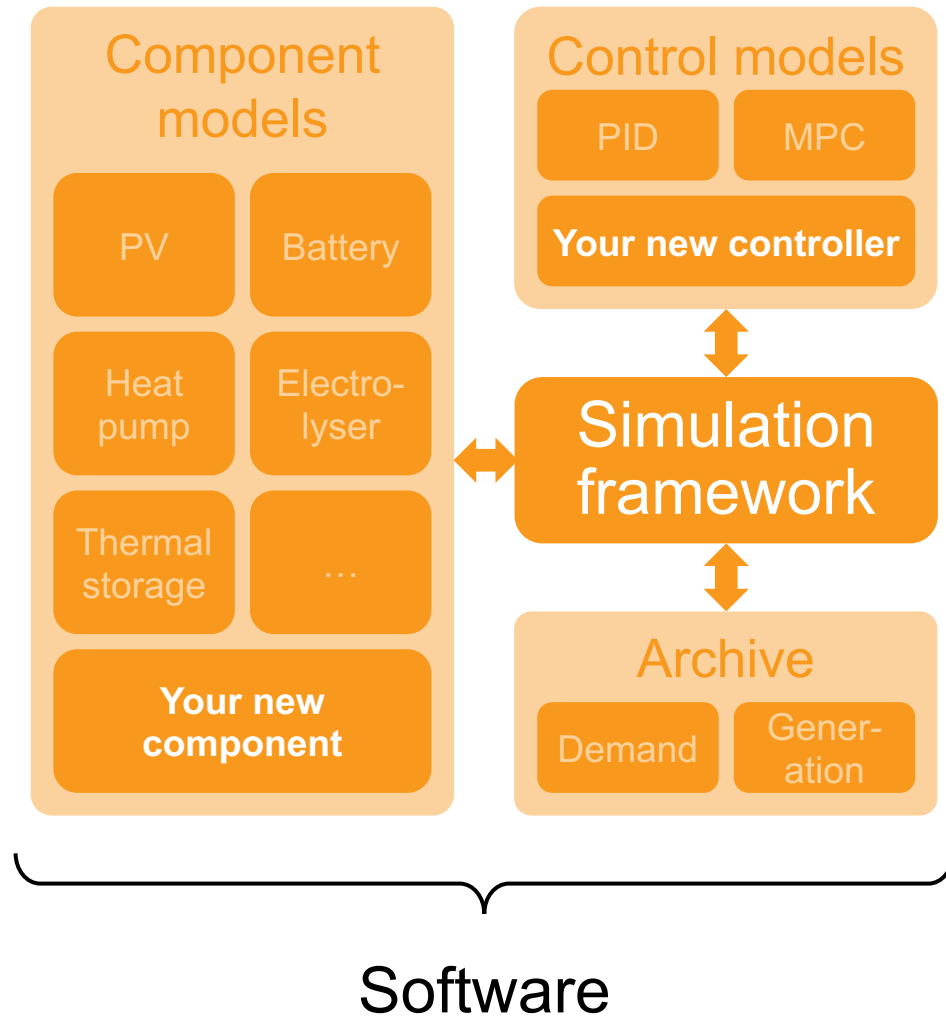


-6 Mt_{CO2}/a, calculated with Swiss Energyscope within the JASM project

Scope



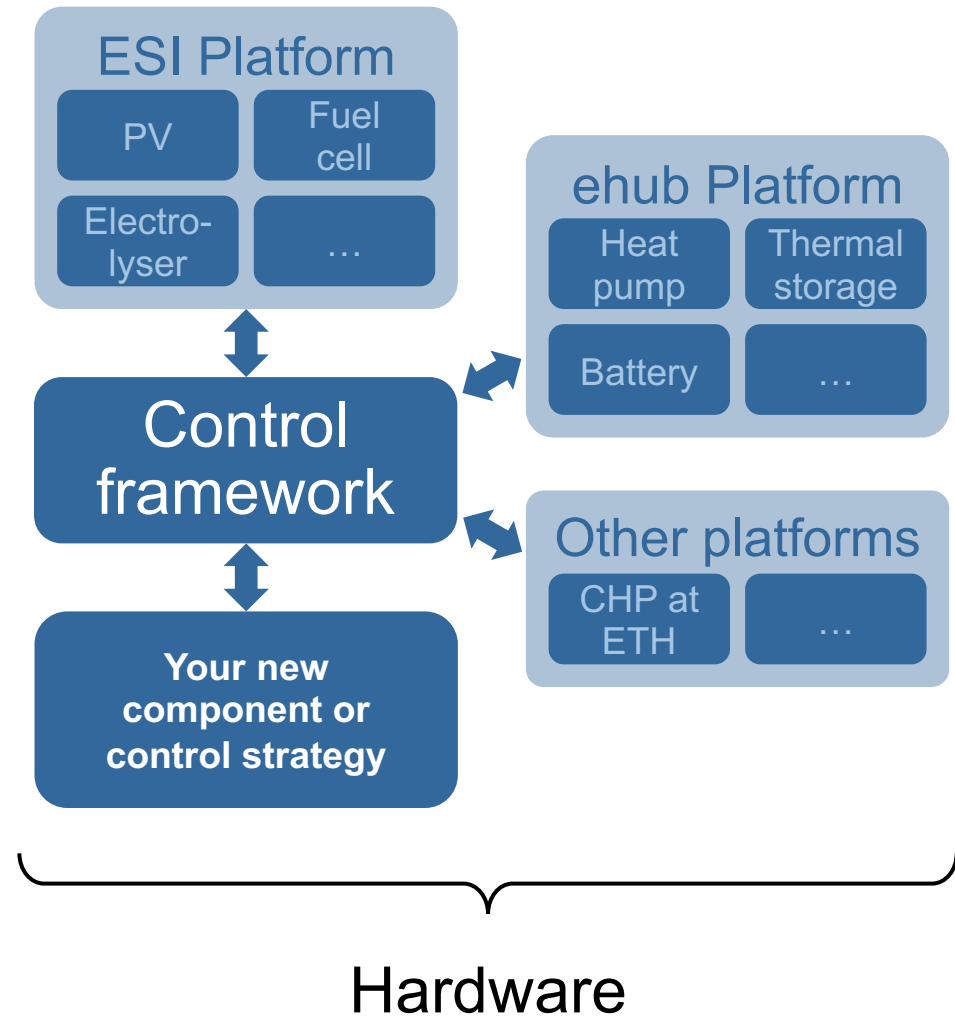
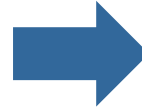
The ReMaP Platform



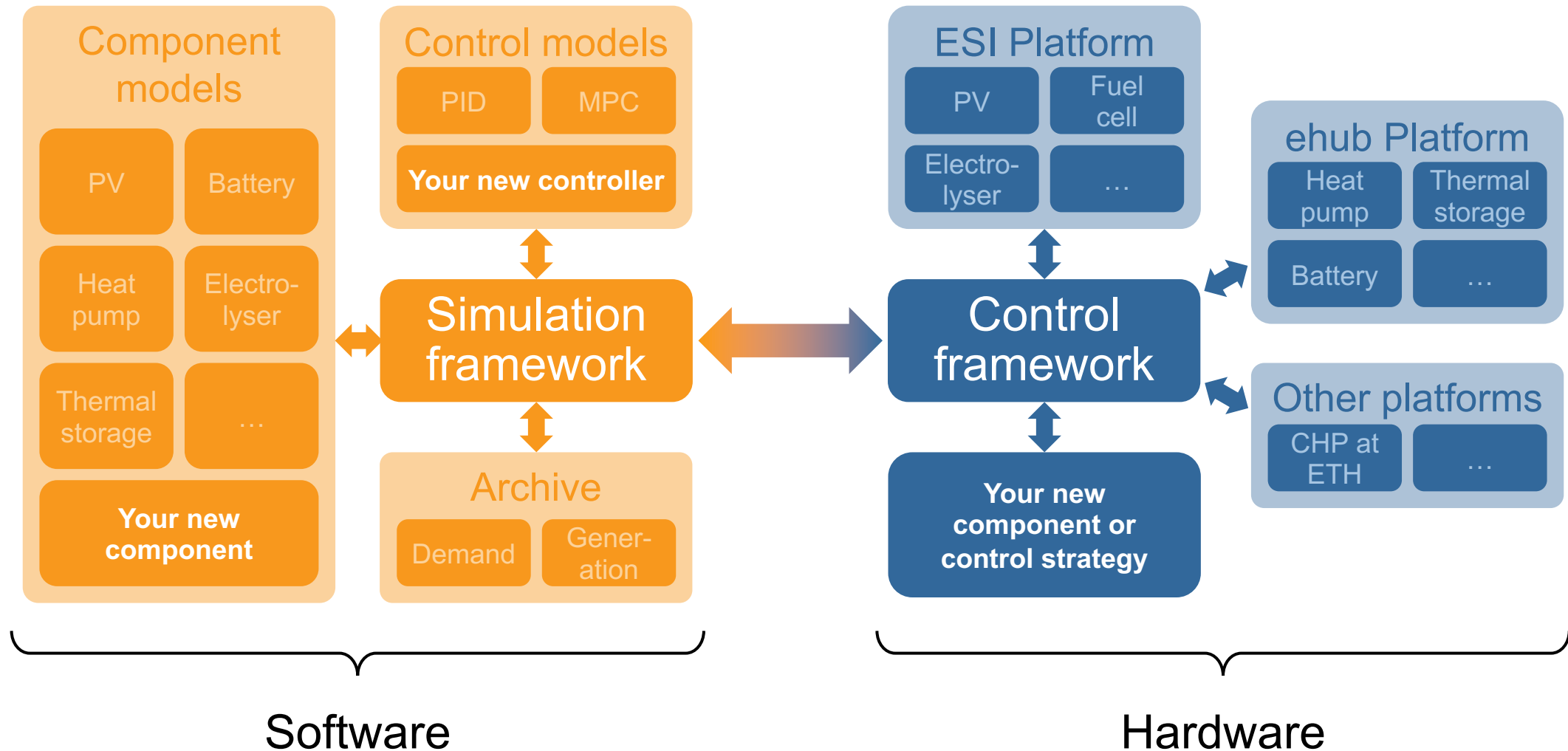
Highly modular
software tool based
on Python (ETH-FEN)

The ReMaP Platform

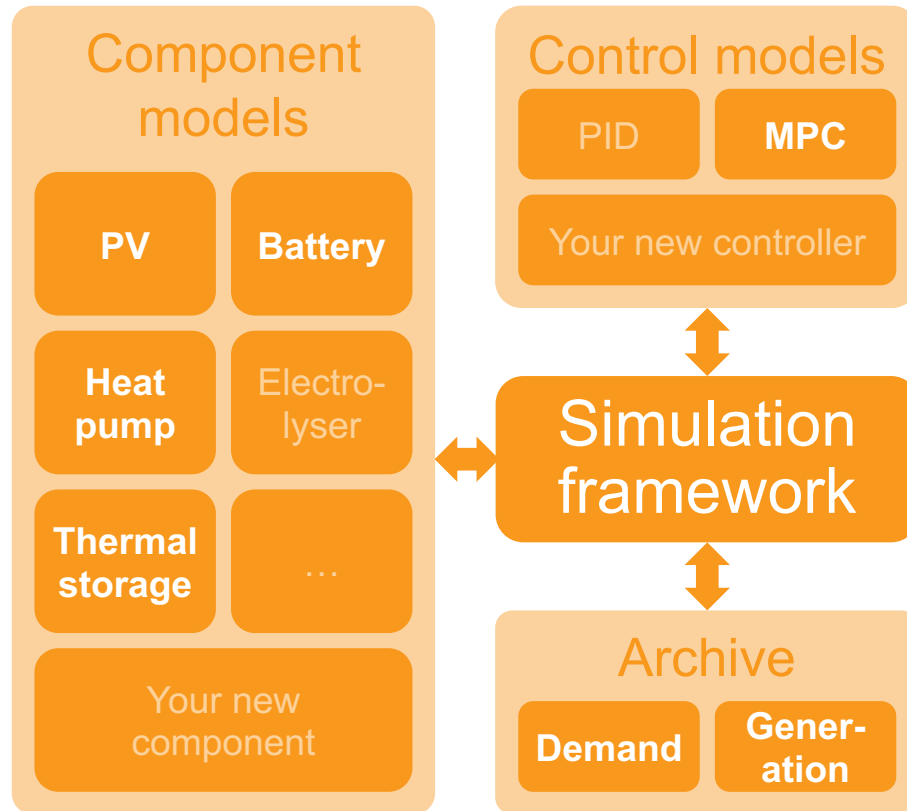
Software based on
Venios platform
(SGS-SCS)



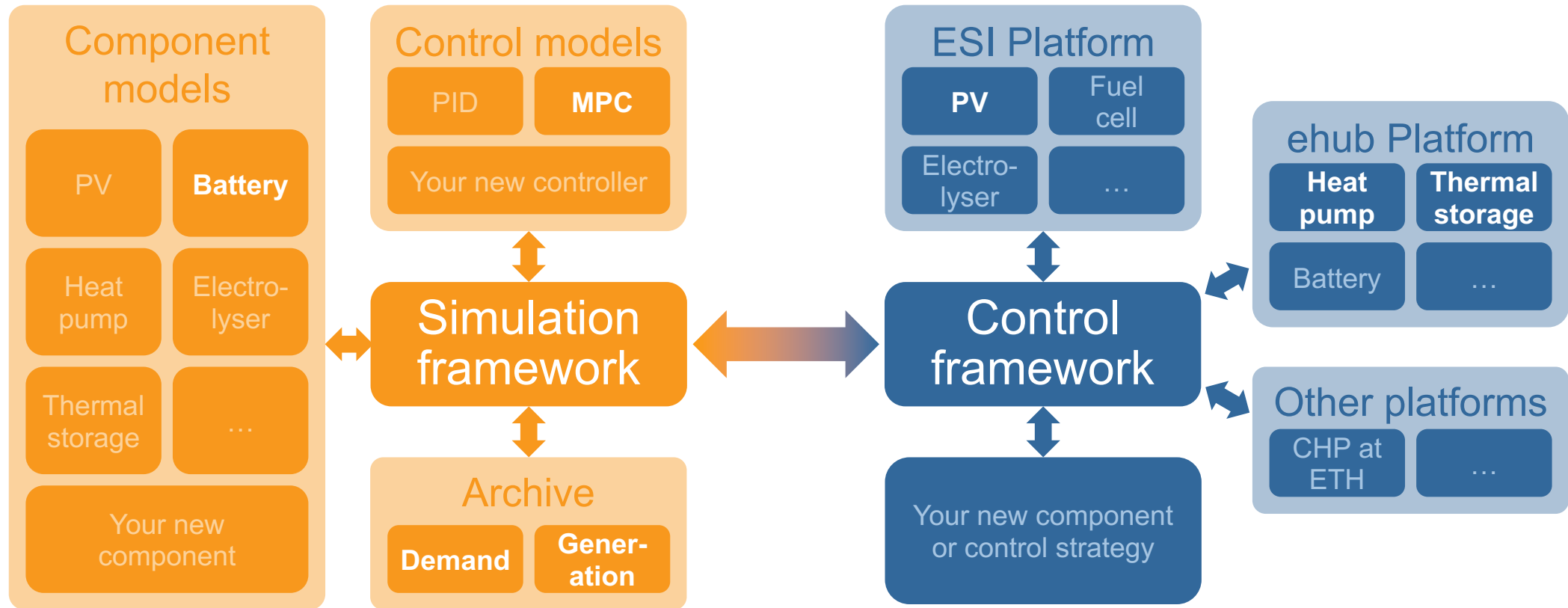
The ReMaP Platform



Build digital twin in Simulation framework



Replace components by hardware and run via Control framework

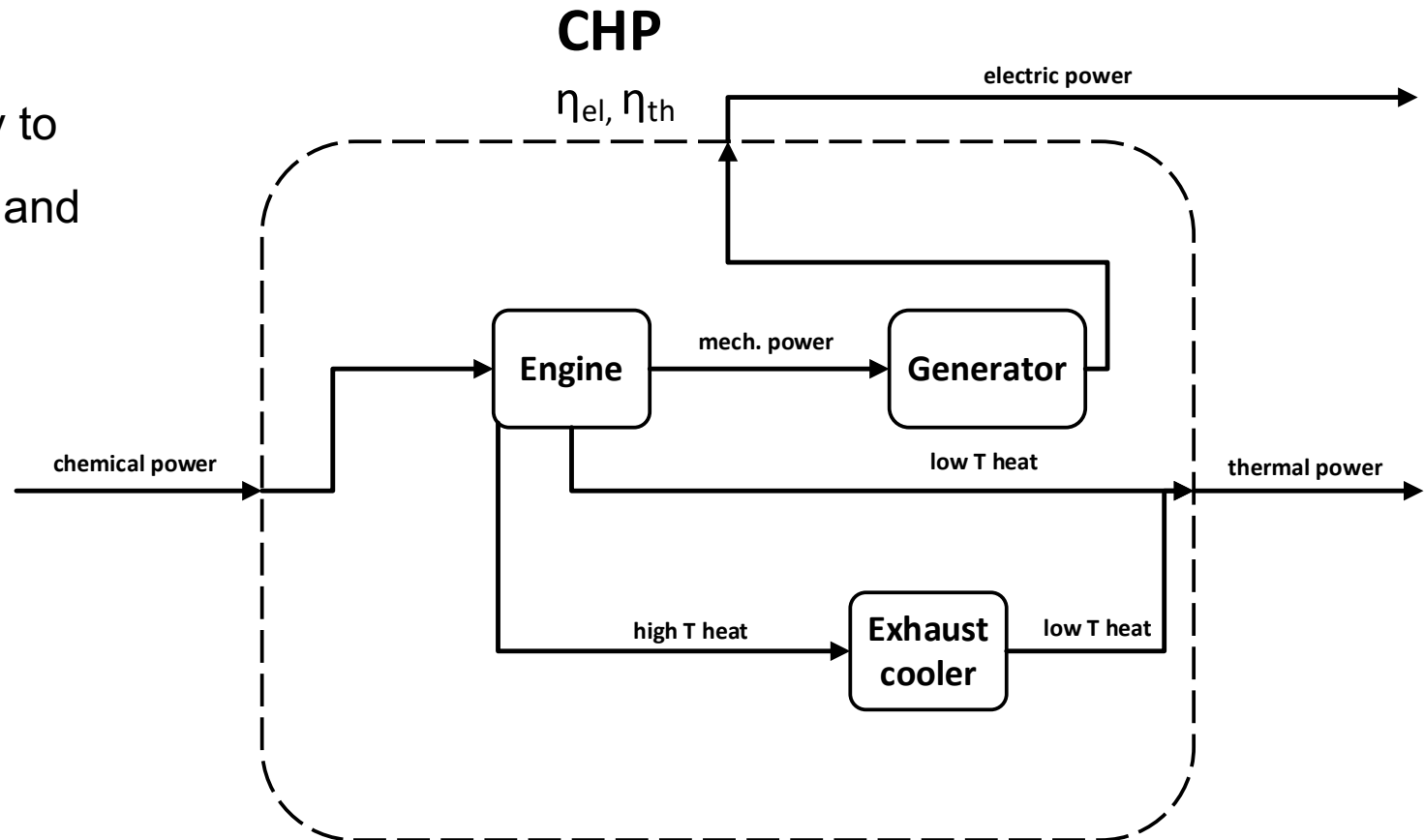


Combine heat and power (CHP) plant

Case #1

Project objectives:

- Develop and validate control strategy to improve flexibility and decouple heat and electricity production

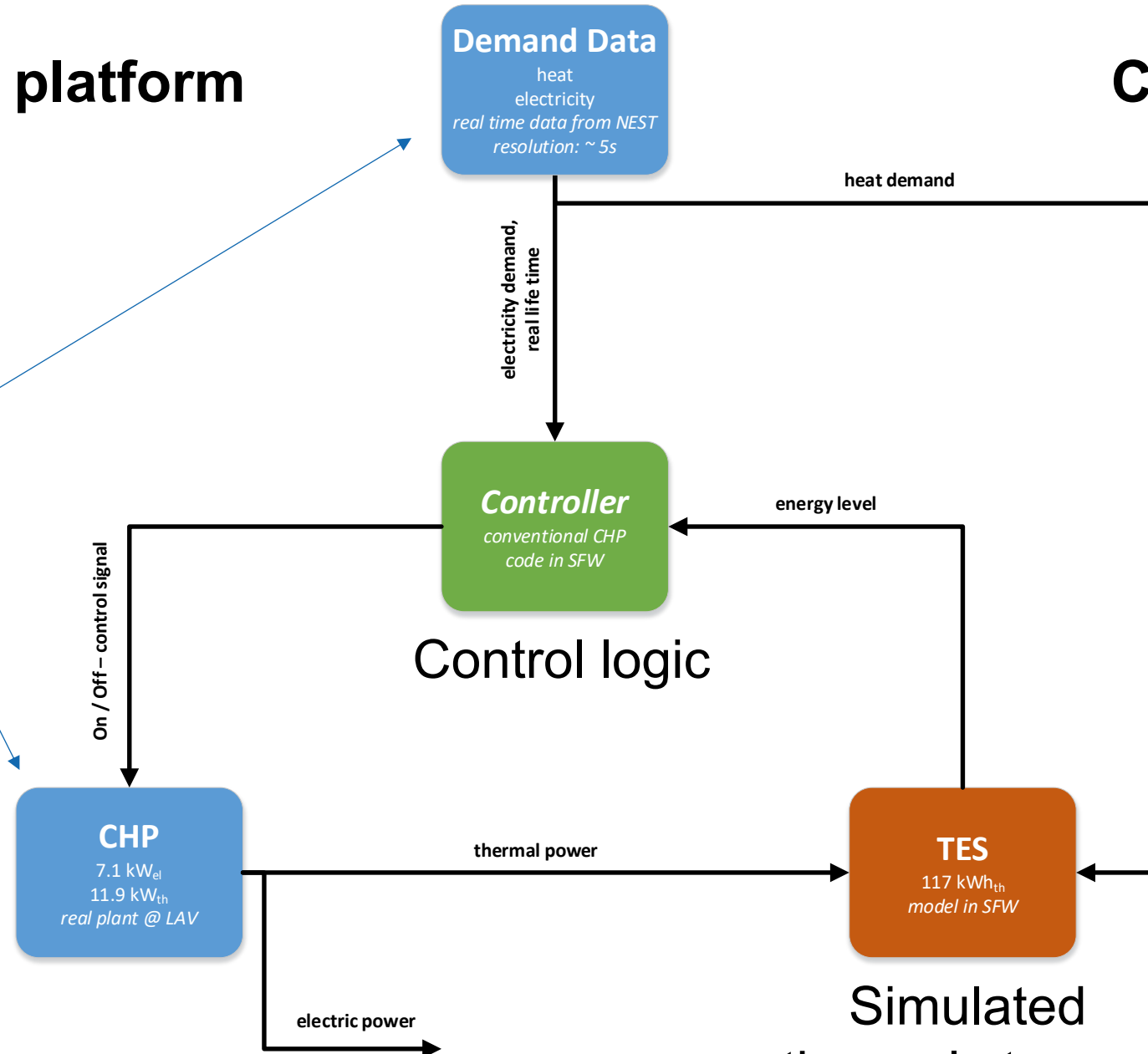


Philippe Buchecker, Christian Schürch (ETH)

Setup using ReMaP platform

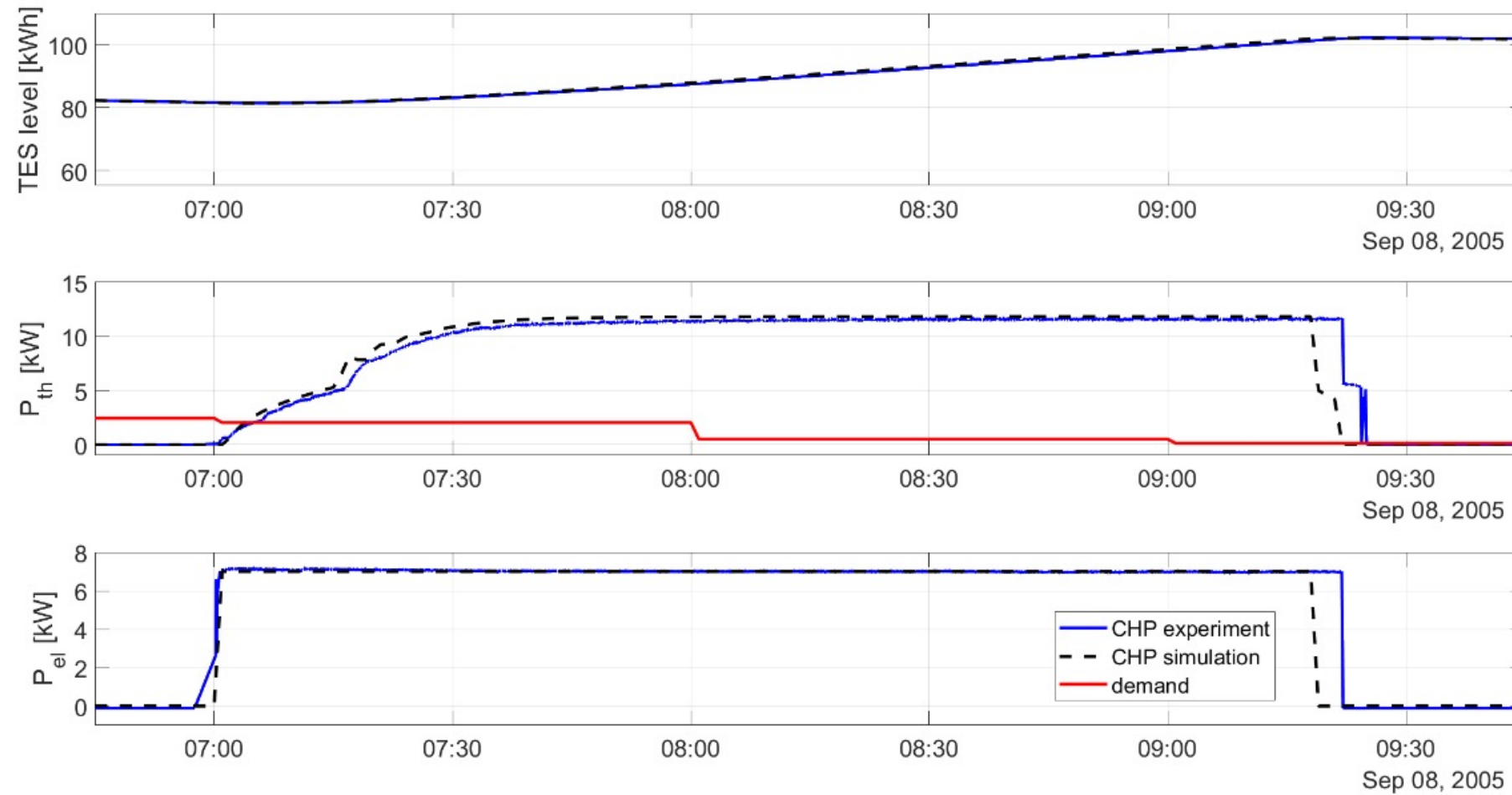
Case #1

Real hardware components



Some results

Case #1

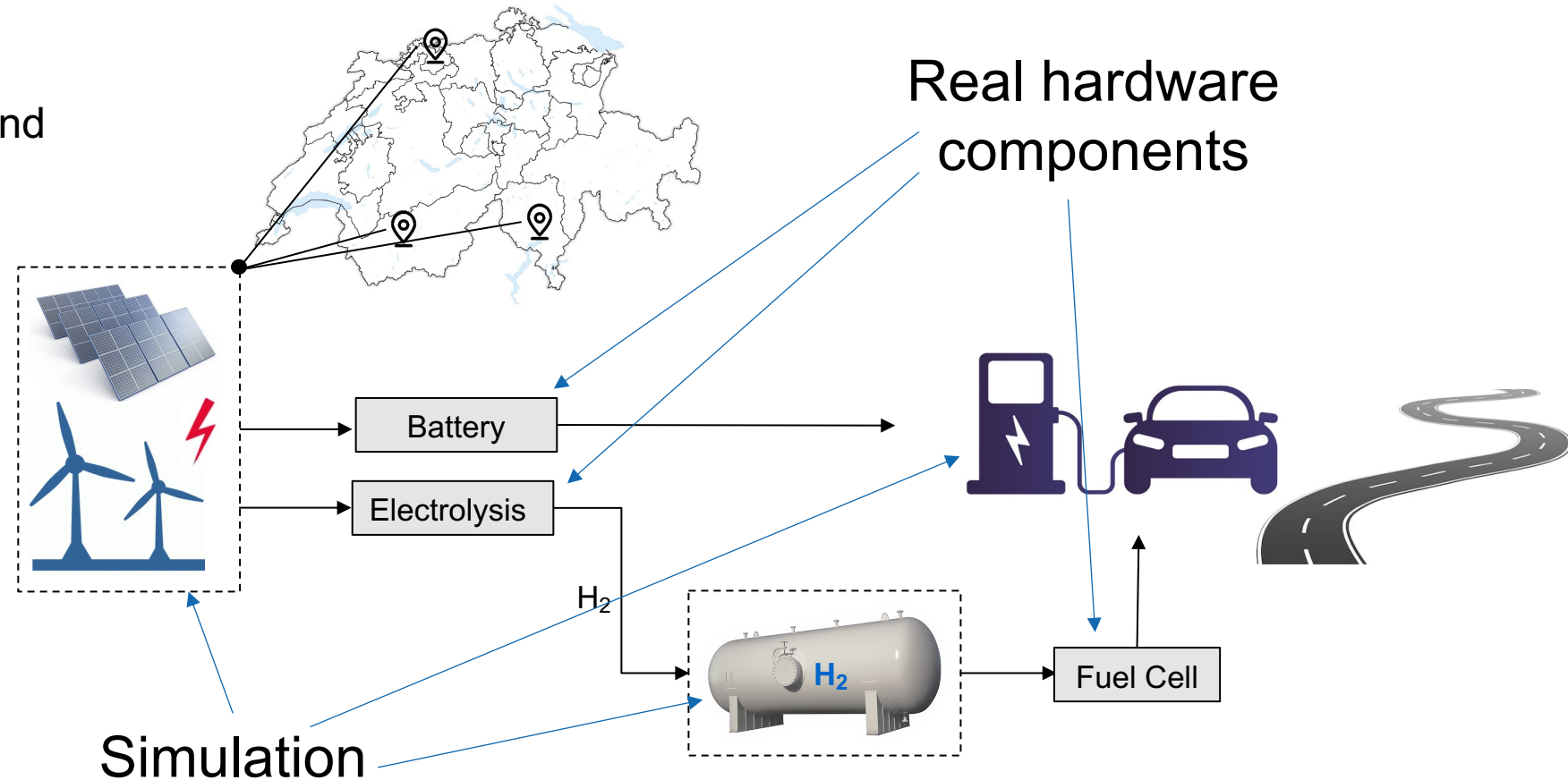


H2 as electricity peak supply

Case #2

Project objectives:

- Validate control strategy and interplay of components

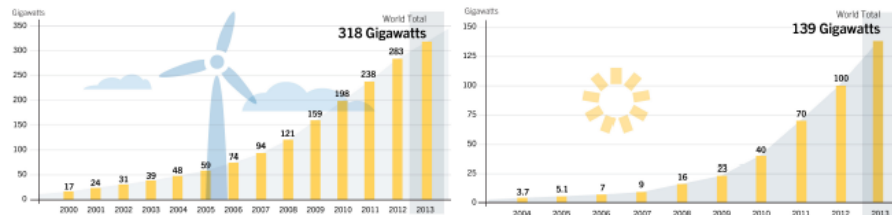


Markus Obrist, Tilman Schildhauer (PSI)

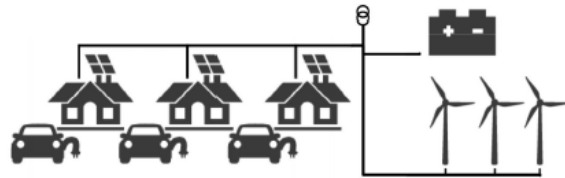
Real-time State Estimation and Feedback Optimization of Electrical Distribution Grids

Case #3

- Integration of renewables



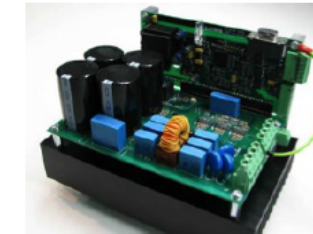
- Distributed generation & prosumers



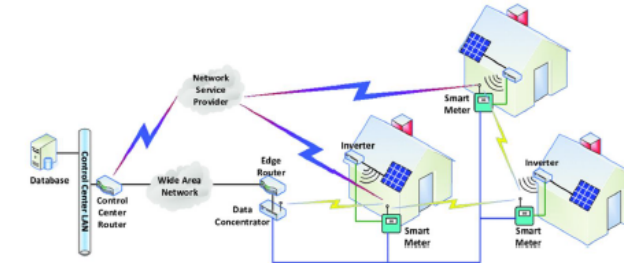
Challenges:

- Decentralized, two-way power flows
- Unpredictable generation
- Fast time-varying conditions

- New generation technology



- Sensors & communication network



Opportunities:

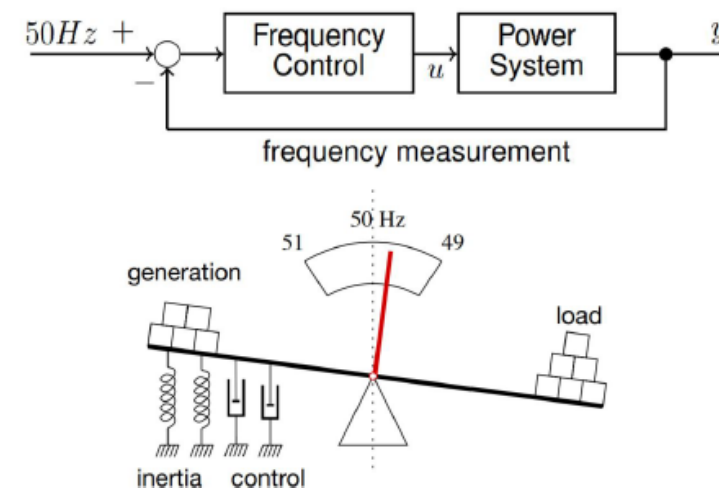
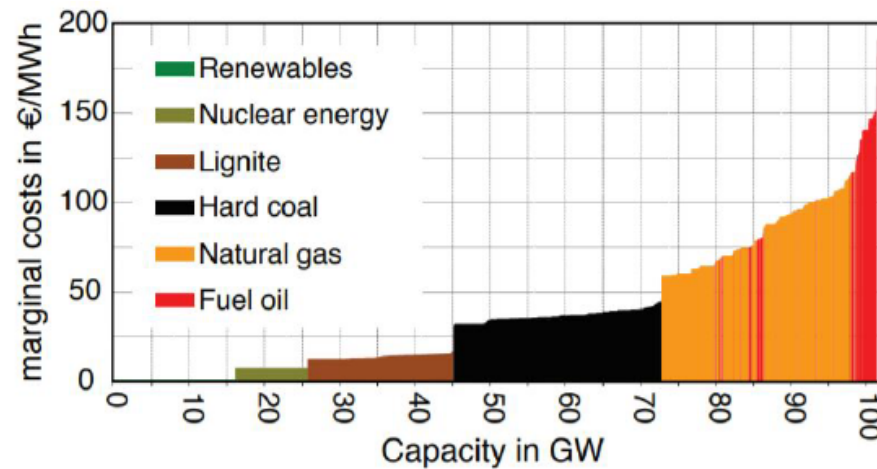
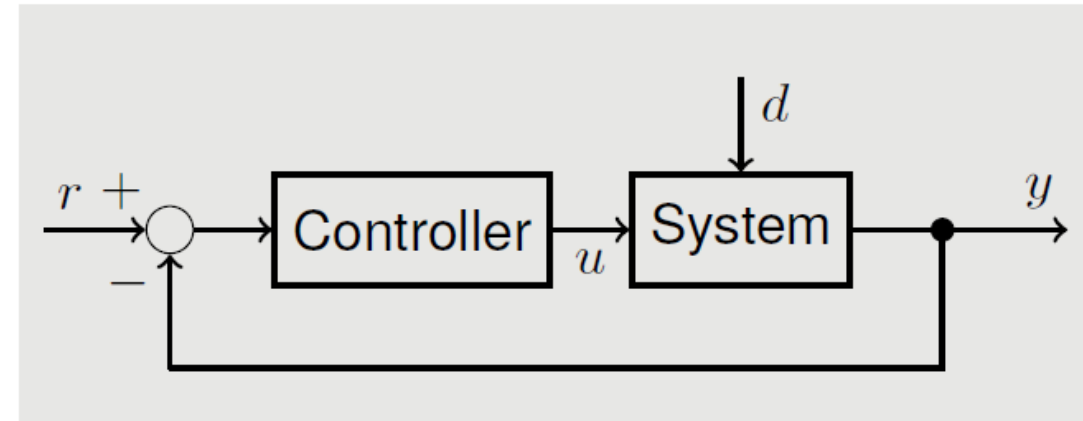
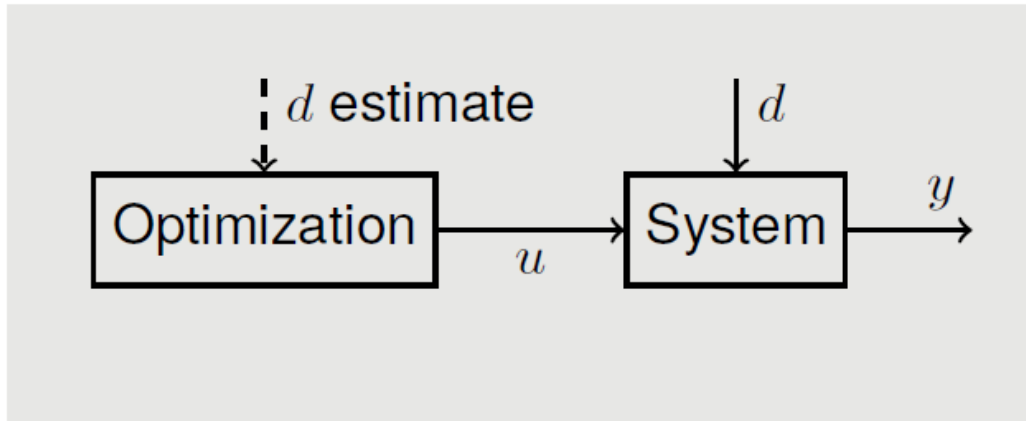
End-to-end real-time monitoring,
control and optimization

Feedforward planning

vs.

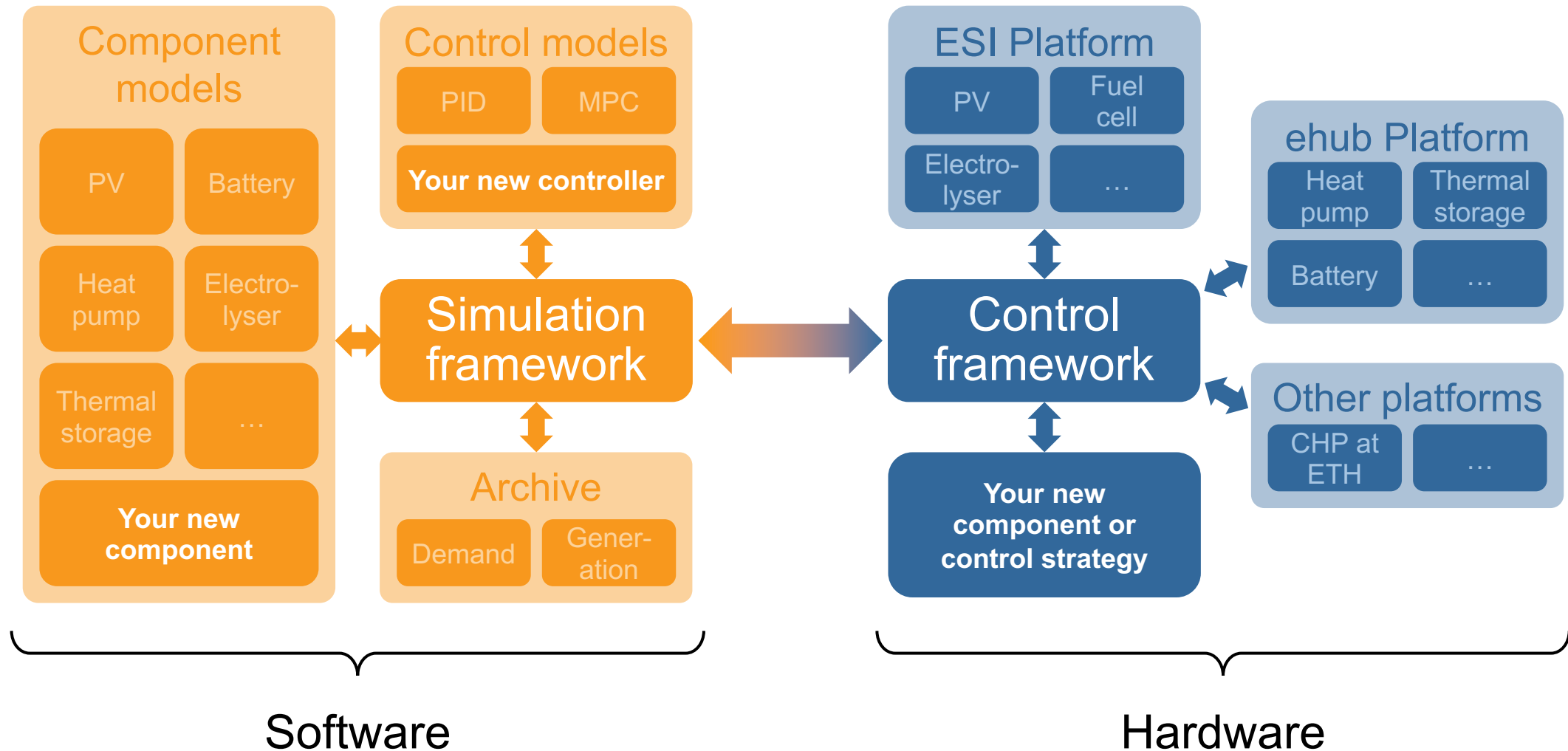
Feedback control

Case #3

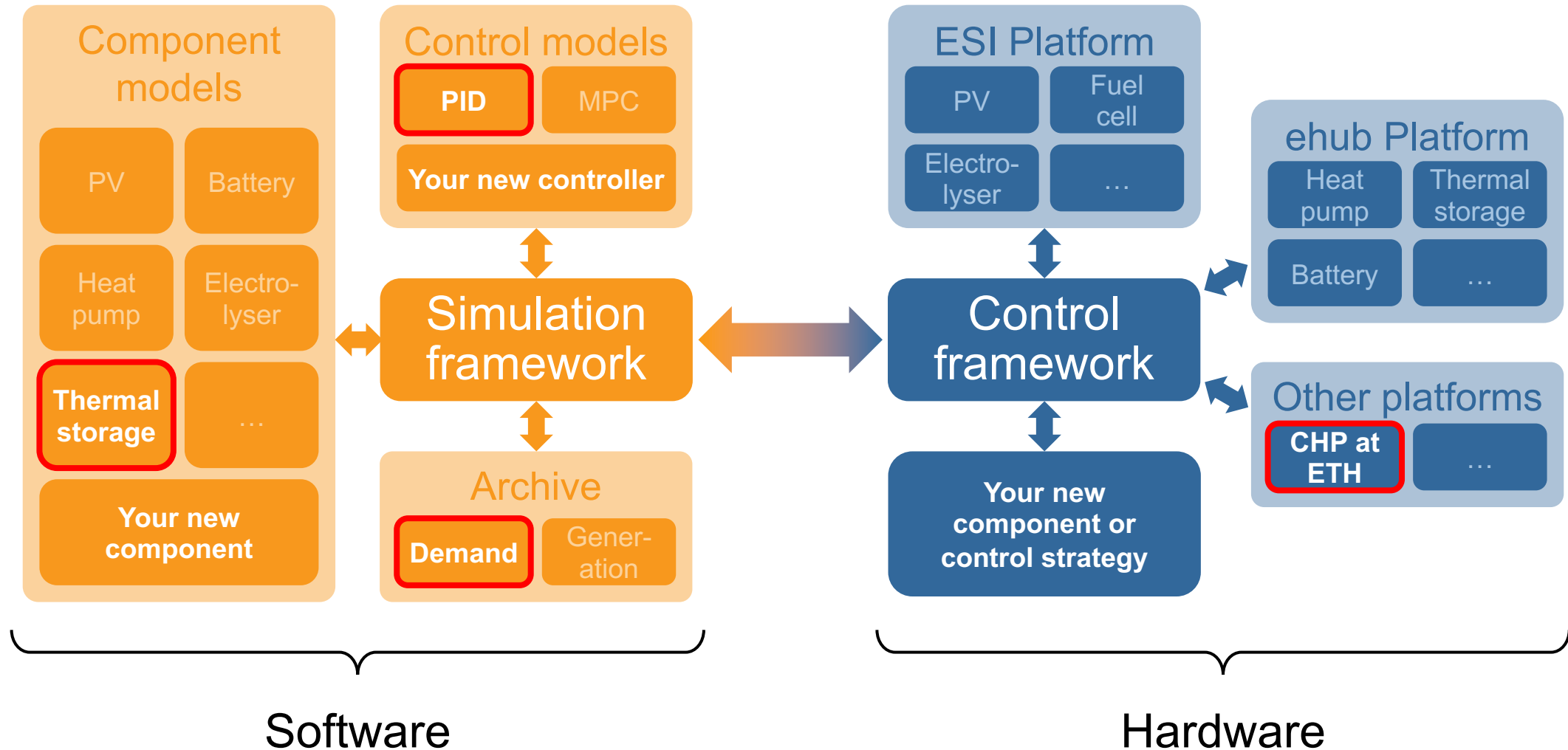


Objective: merge these two worlds to allow for a better control of distribution grids

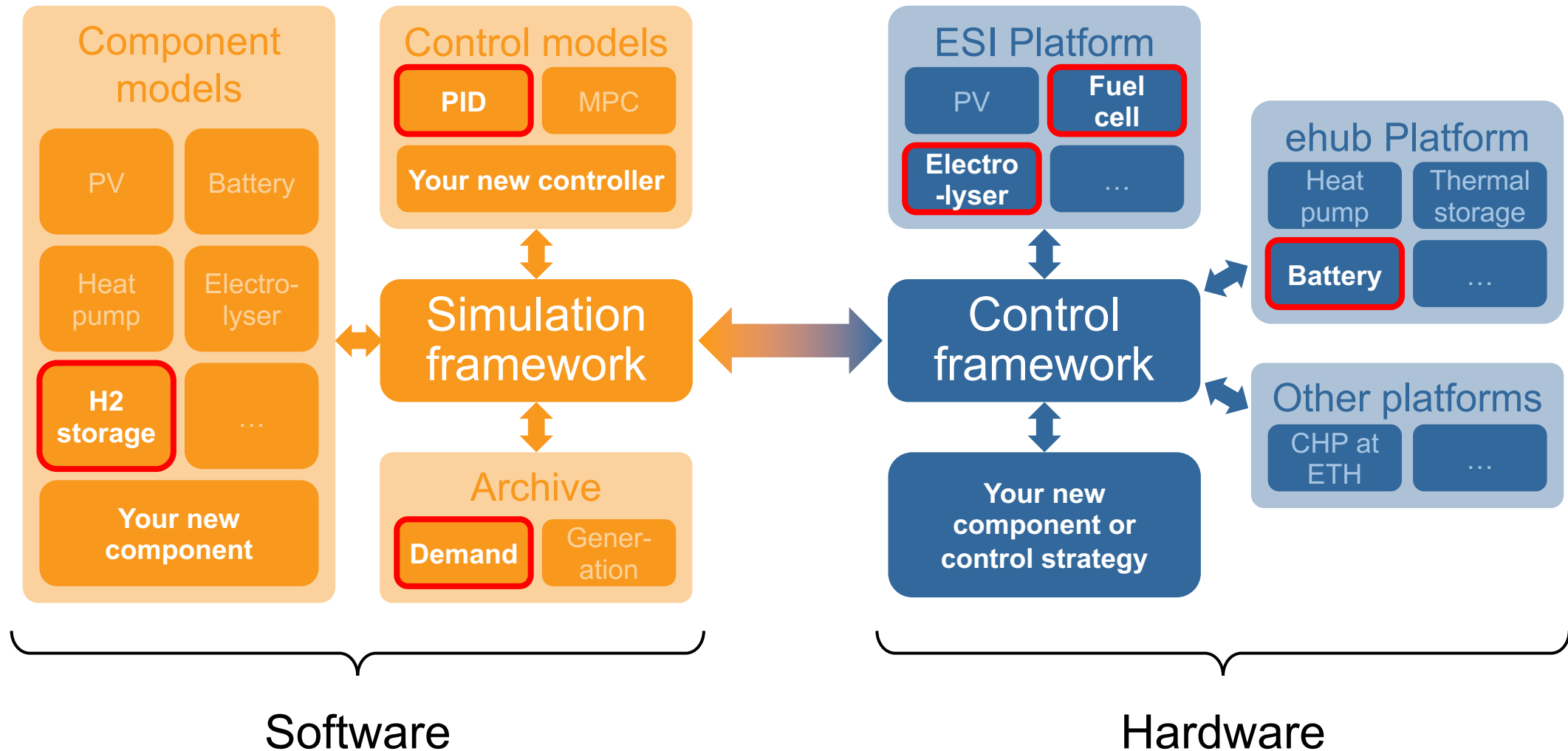
The ReMaP Platform



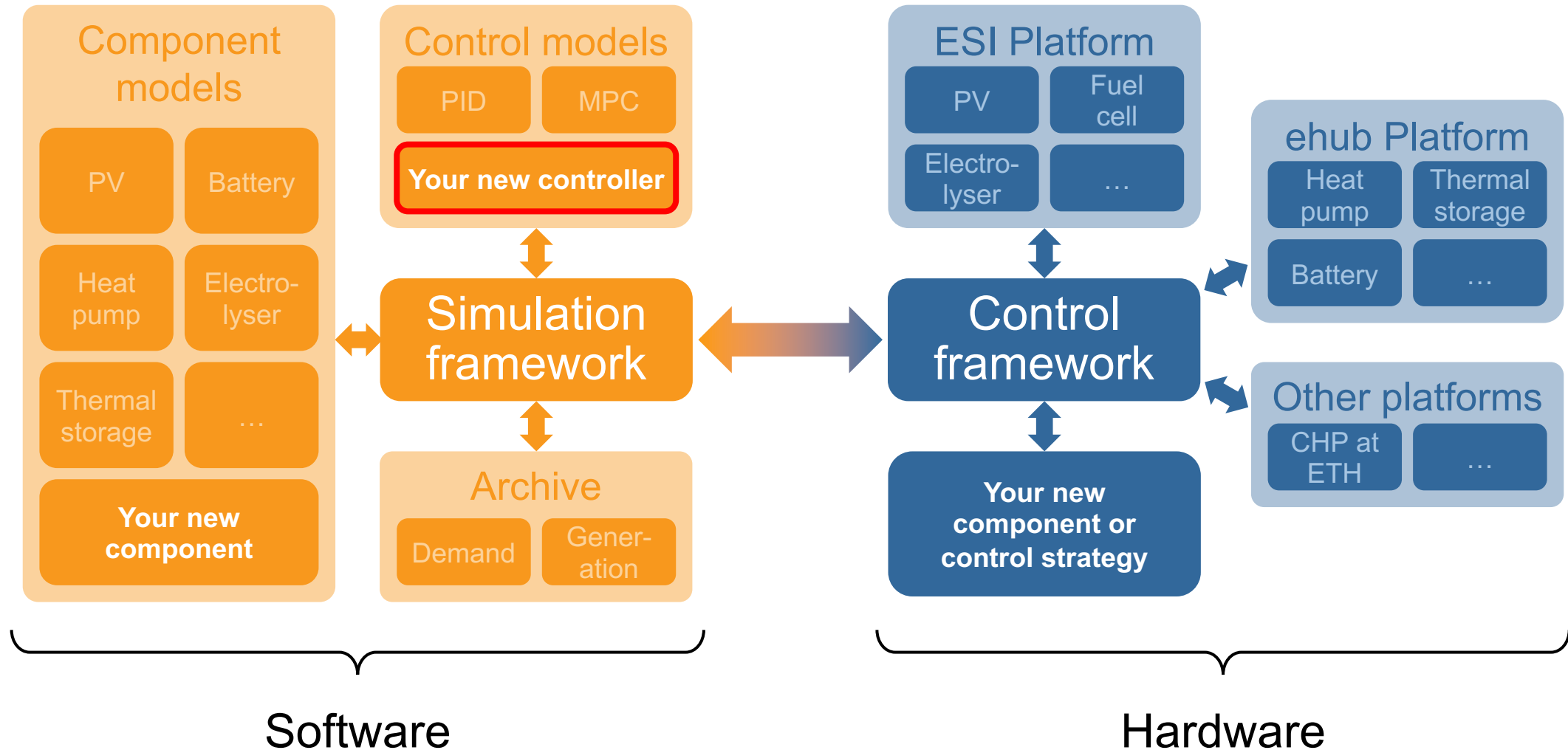
The ReMaP Platform – Case #1



The ReMaP Platform – Case #2



The ReMaP Platform – Case #3



Linkage to other tools of the PATHFNR project

- Exchange of power system data (demand, supply, etc) with other simulation tools (Nexus-e, Expanse, FlexECO, Calliope)

Limitations

- Current setup does not foresee time resolution in sub-second range
- Limited to available hardware

Source or Reference: APA citation style

Spatial and temporal resolution

- Spatial coverage: n/a
- Spatial resolution: multi-energy system at district level
- Temporal coverage: Boundary conditions to be defined by scenarios
- Temporal resolution: > seconds
- Sector coverage: Electricity, heat, mobility (e.g. via EV-charging)

Users

Current users:

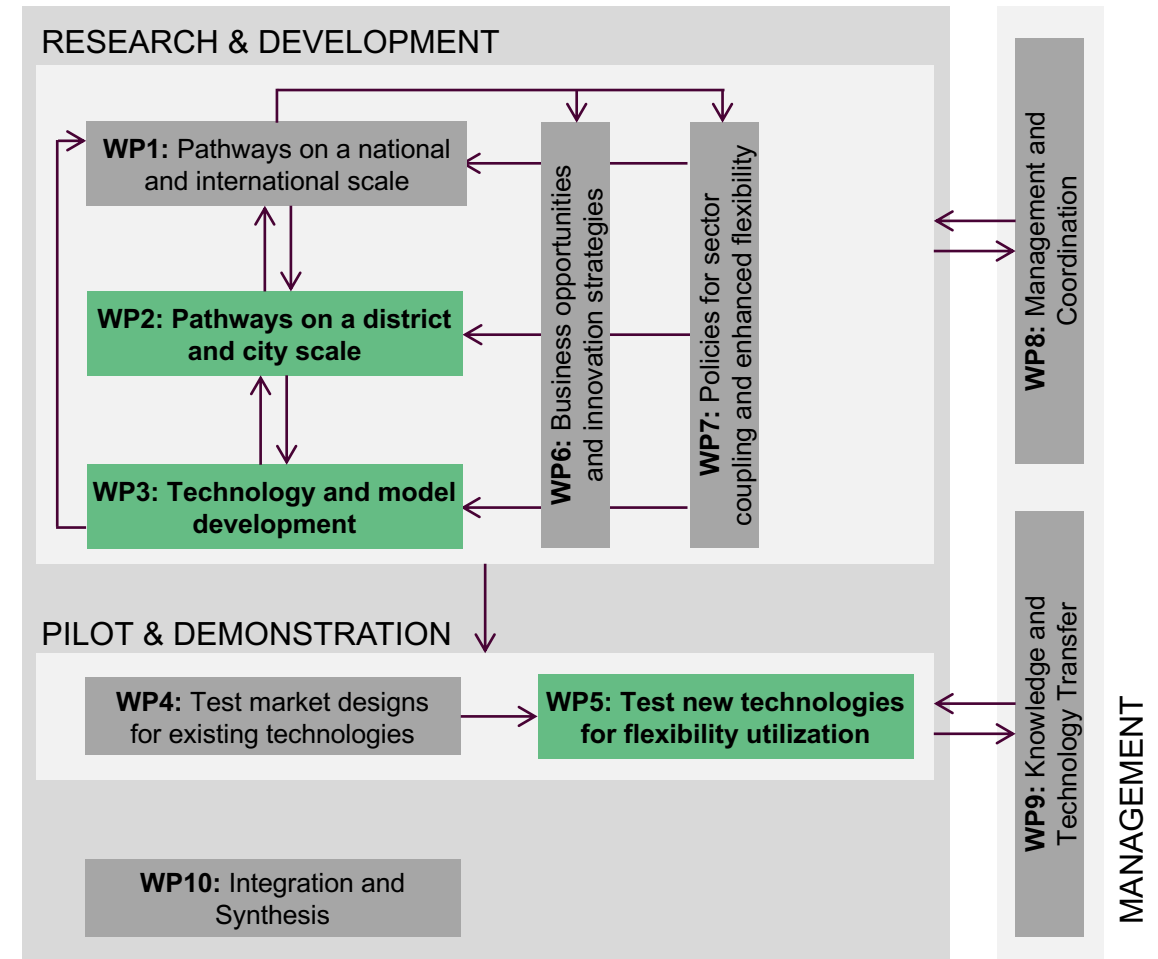
- Various PI at ETH Zurich, Empa, PSI

Potential users:

- Other researchers within PATHFNDR or DeCarbCH
- Utilities
- Industrial partners

Future development under the PATHFNDR project

- Critical issue within the transition pathways will be identified
- ReMaP will be used first as a simulation platform to later transition to partial or full hardware-based experiments



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