

Forecasting, Control and Modelling

Activities at AIT

Gerhard Zucker

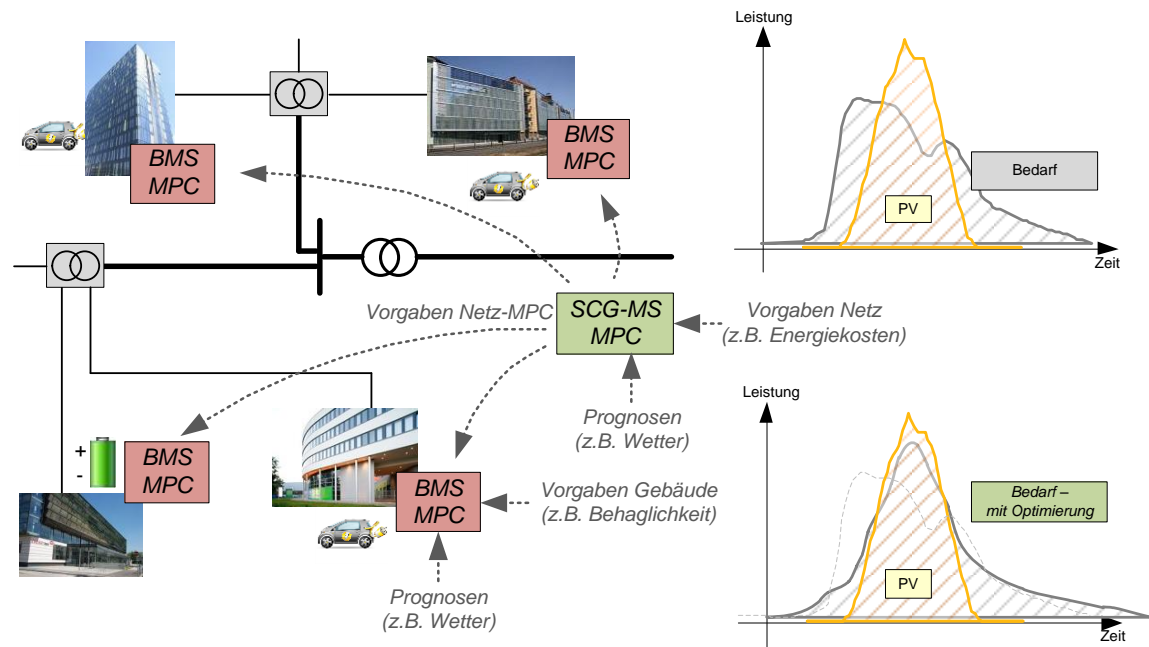
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Model Based Control in Building Management Systems

Model Based Control

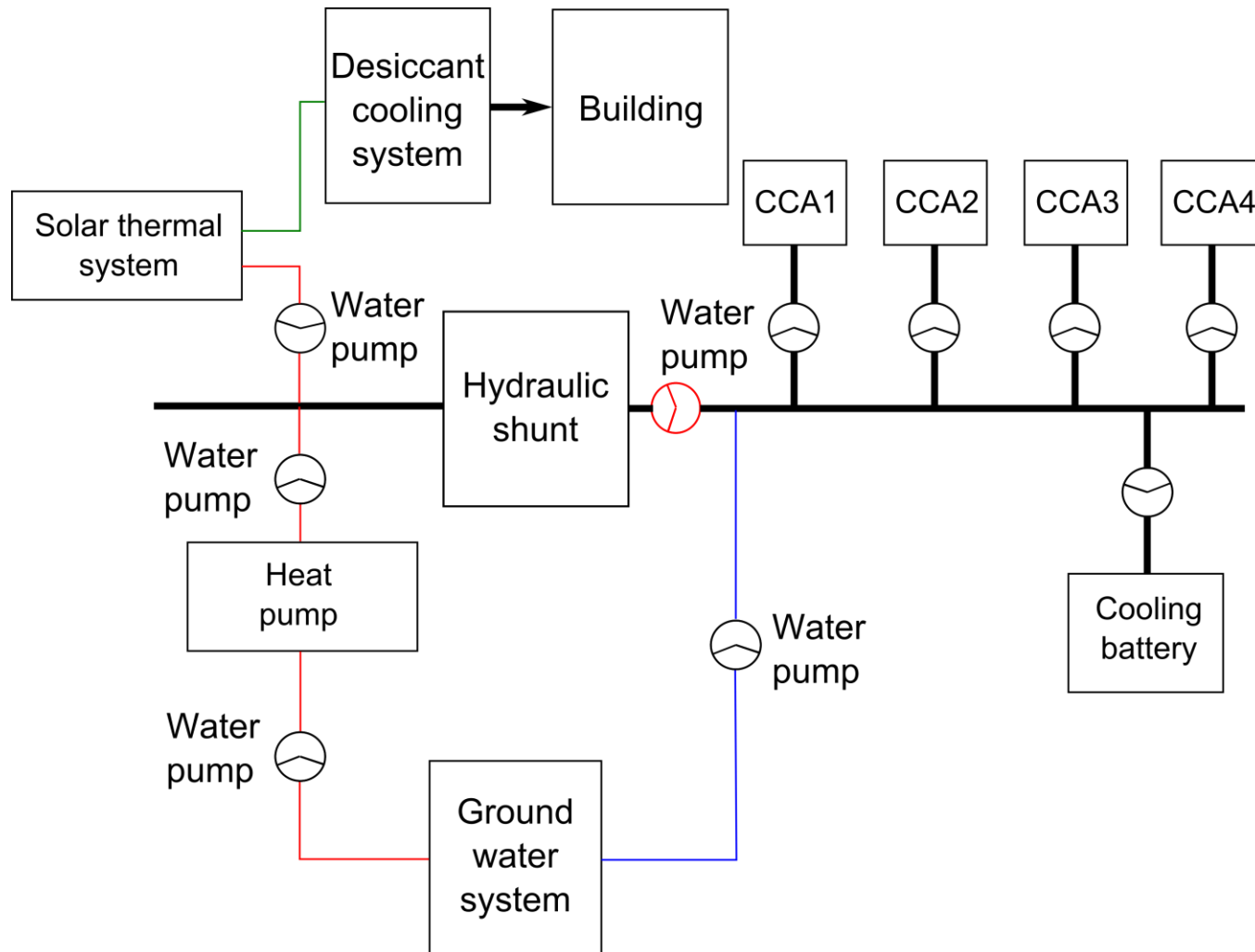
Goals:

- Energy Management in office building
- Demand Side Management: better match of production and consumption
- Support of electric grid



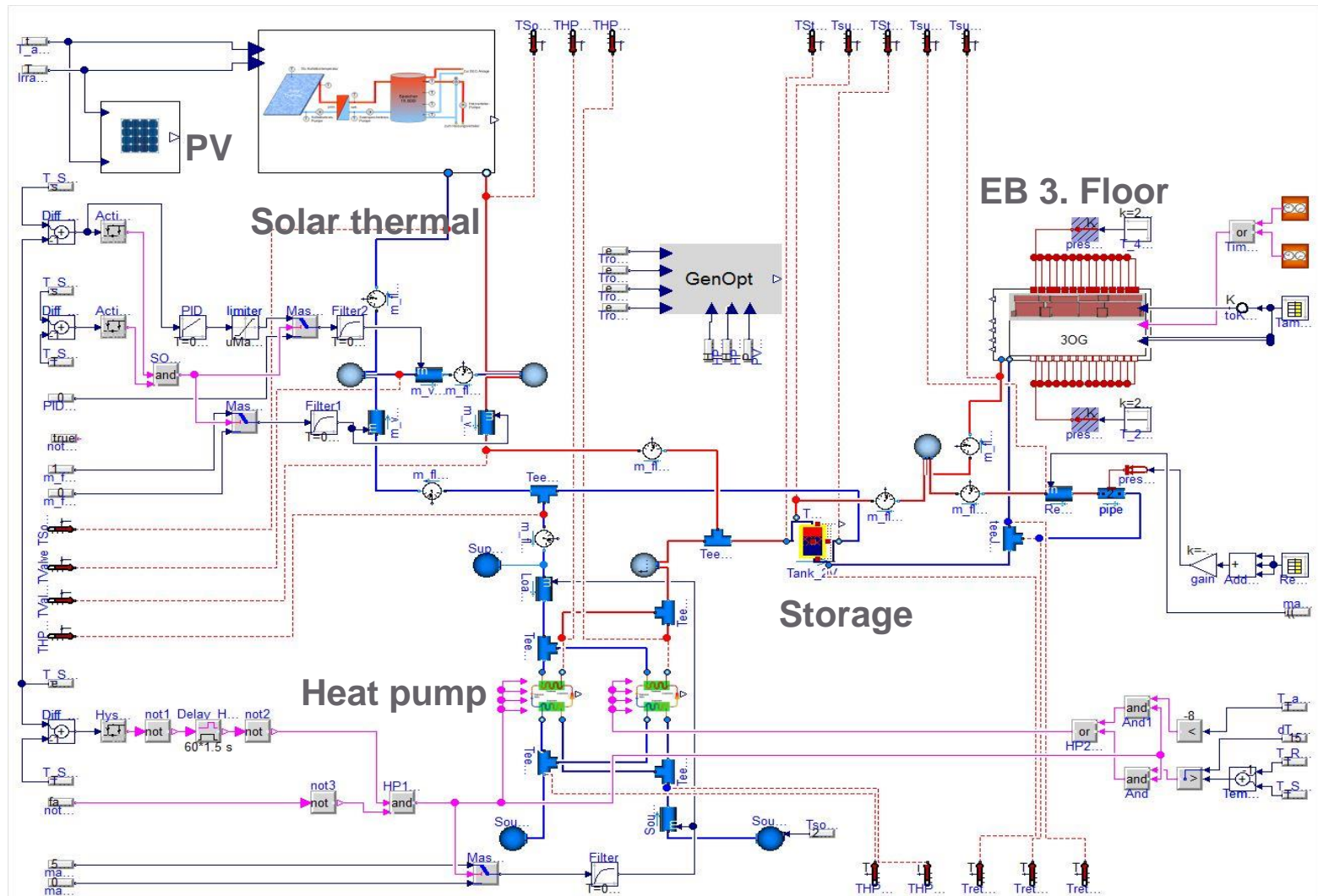
Office Building ENERGYbase

Energy Systems



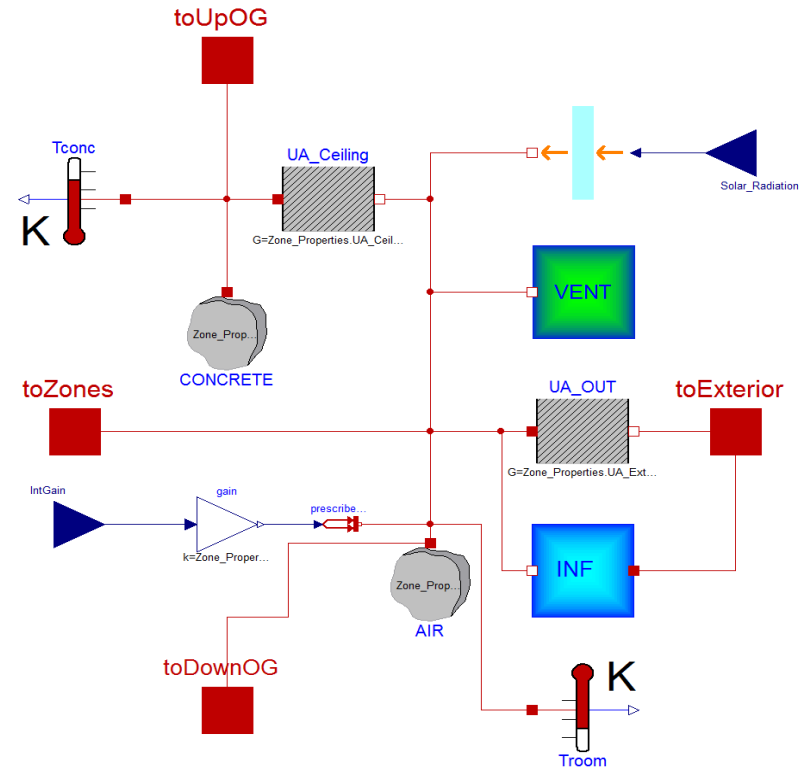
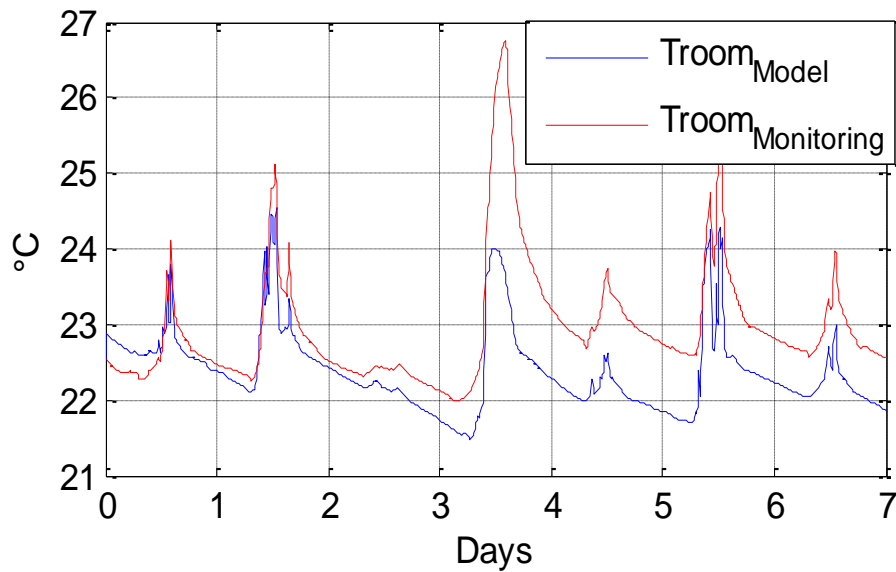
Modeling

Building and energy system model



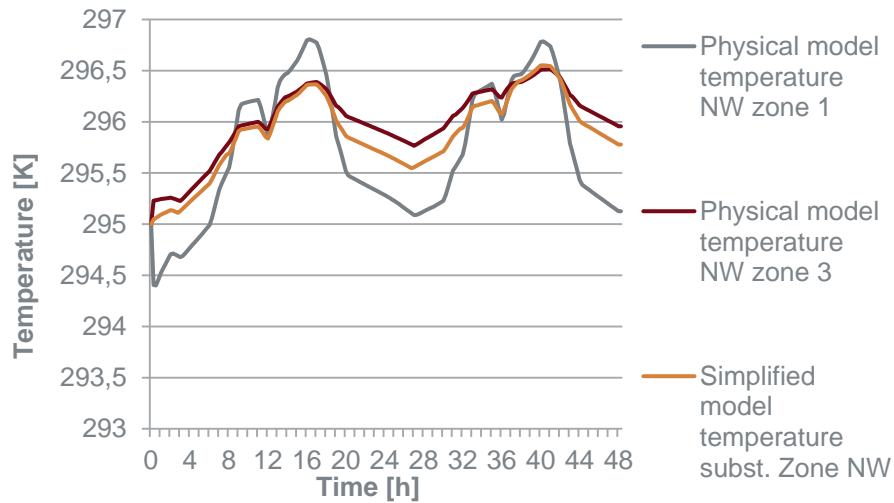
Validation

Building and energy system modeling

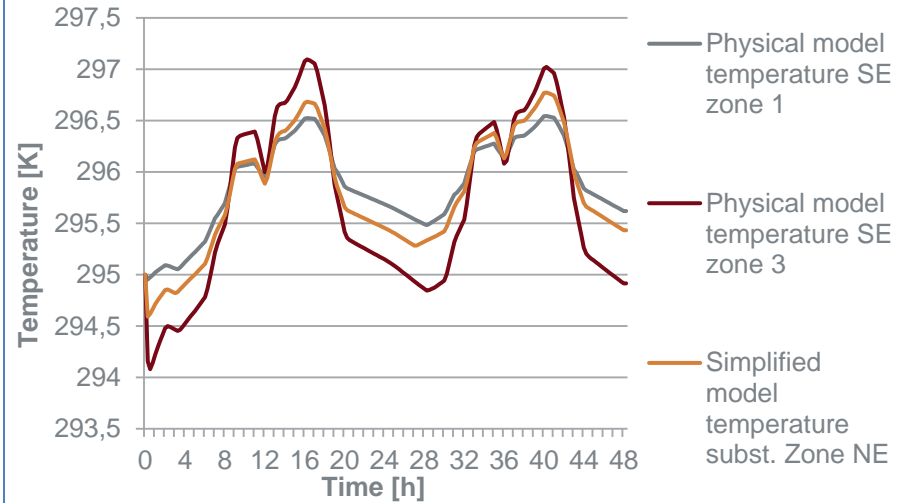


Mathematical modeling and validation

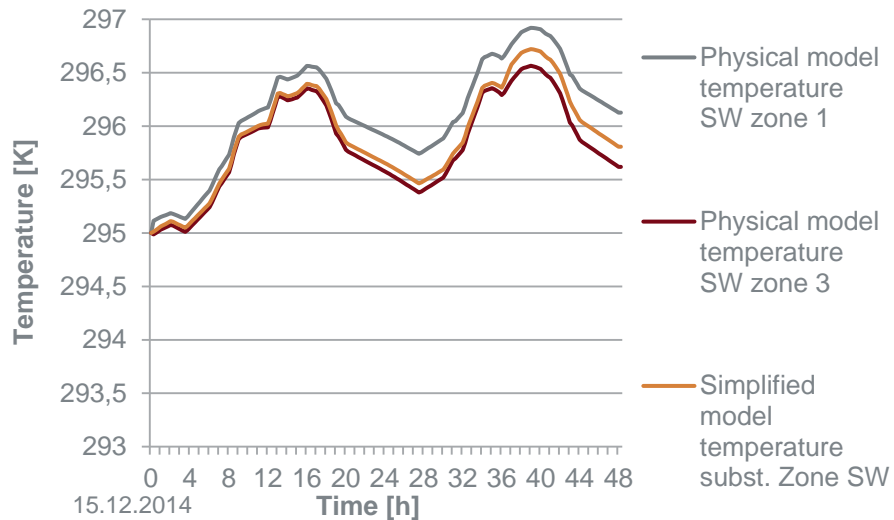
3rd floor - zone NW



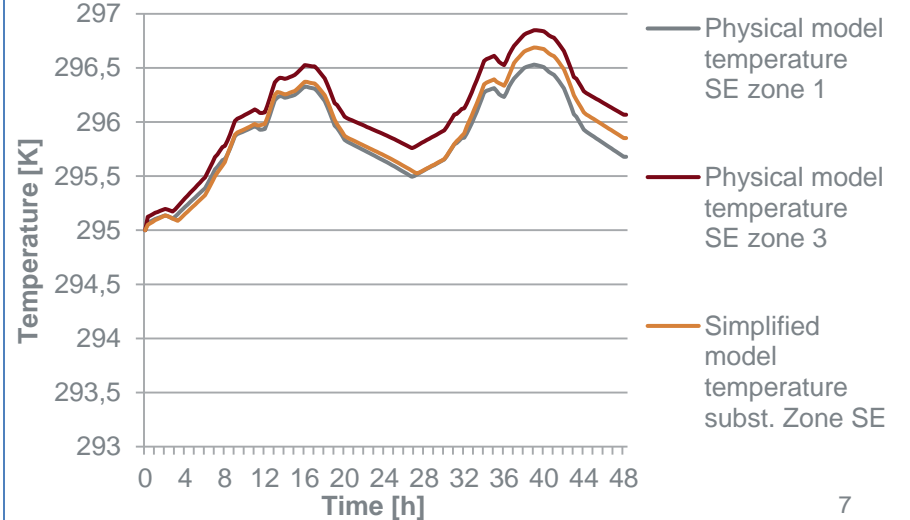
3rd floor - zone NO



3rd floor - zone SW



3rd floor - zone SE



Controller goal(s)

Definition of the objective function

- Heat pump and PV operation
 - Control goal (objective function):

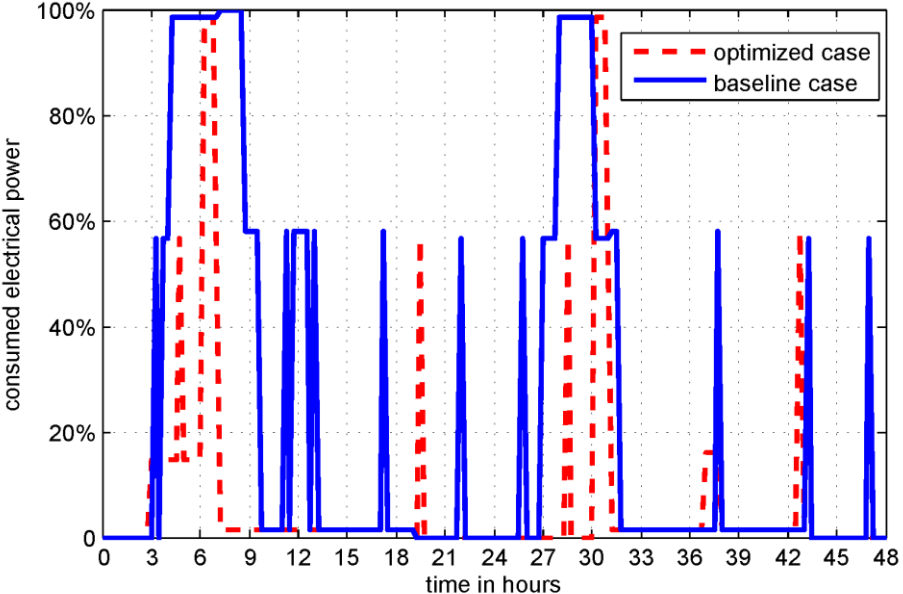
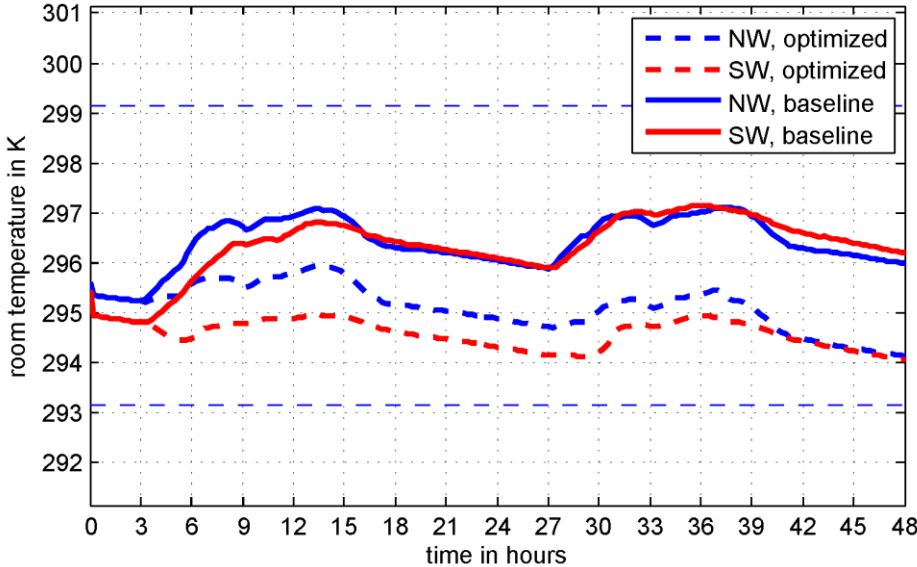
$$J = \int_0^{N_p} P_{\{HP_1\}} dt + \int_0^{N_p} P_{\{HP_2\}} dt - \int_0^{N_p} P_{\{PV\}} dt \rightarrow \min$$

- Constraints:

$$T_{min}^{room} < T_{opt}^{room} < T_{max}^{room}$$

- Actuated variables: Setpoint values for the room ceiling temperatures in each zone of the building T_{opt}^{ceil}

Application in the Building Management System



Automated Building Model Generation

Methodology

- The generated building **models require only a limited set of data** about the existing building
 - **Energy Performance Certificate** (EPC) is mandatory in most countries (legal implementation of Directive 2010/31/EU) and therefore a good starting point for reasonable simplified models
 - **Unknown building data** (e.g. u-values of walls or internal loads) can be **estimated** based on e.g. the building construction year or its usage (e.g. office, residential, mixed usage, etc.)

Methodology – Building Energy Modeling (BEM)

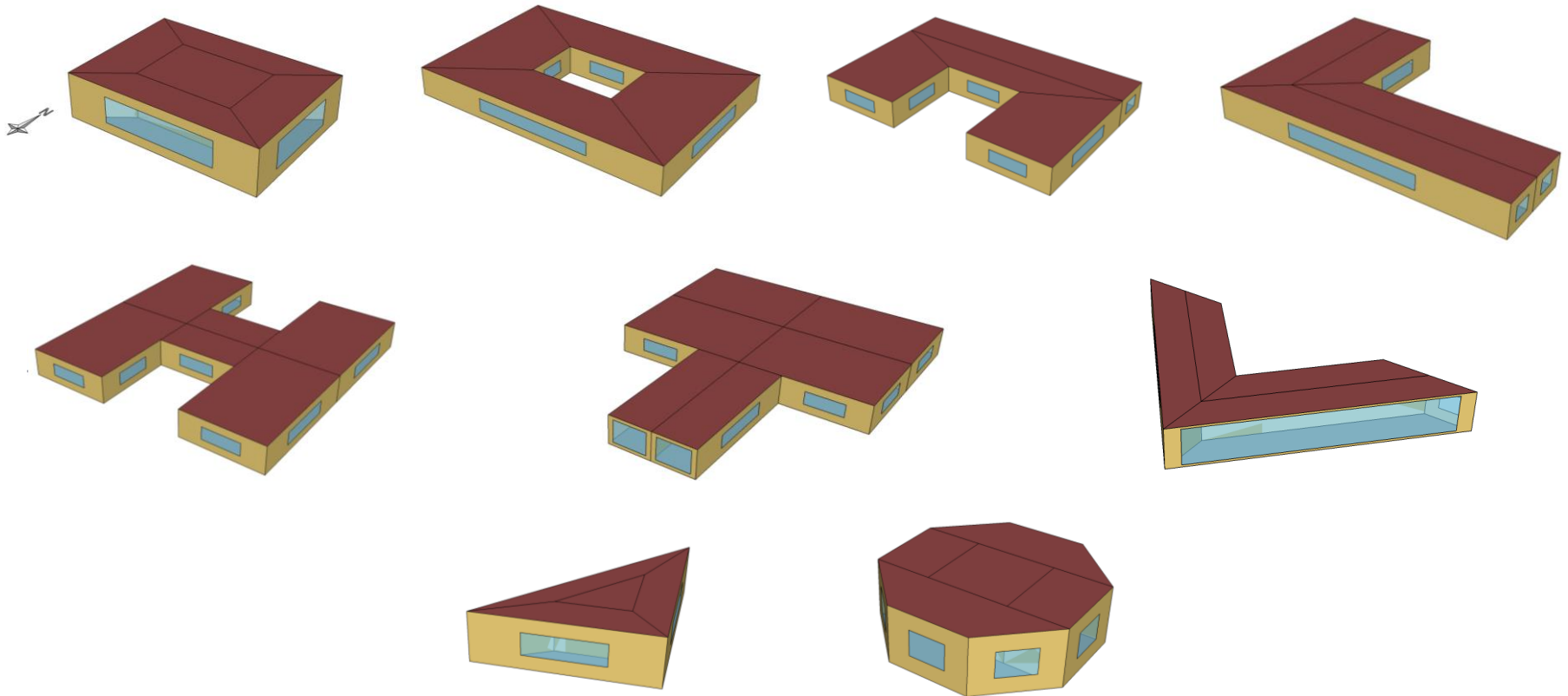
The fundamental step is the building geometry generation

- **Case 1:** using predefined floor plan templates based on the most common building geometries
 - + makes the modeling process very fast
 - + most of the existing buildings can be simulated based on these simplified geometries
 - the flexibility simulating more complex buildings is limited

- **Case 2:** merge floor plan templates to more complex geometries
 - + more complex buildings in terms of geometry can be simulated
 - a limited user-interaction is needed using e.g. a user interface

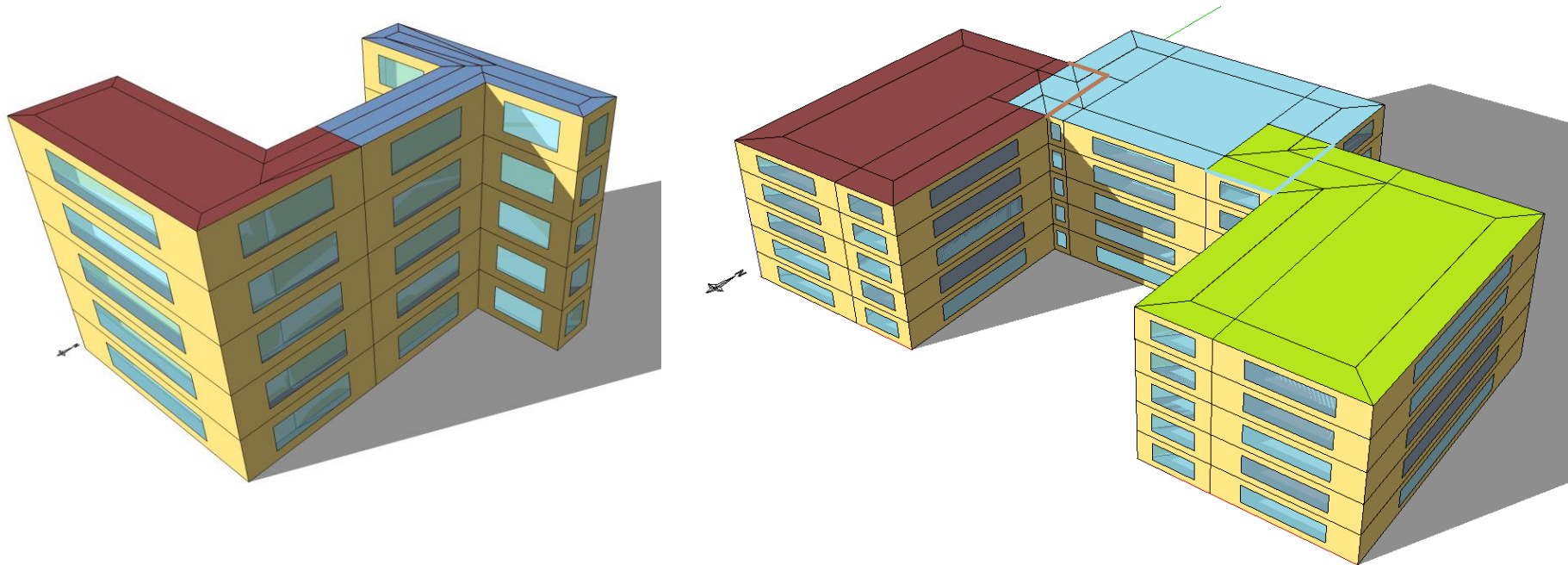
Methodology – Building Energy Modeling (BEM)

- Case 1: using predefined floor plan templates based on the most common building geometries and parameterizes them



Methodology – Building Energy Modeling (BEM)

- Case 2: using predefined floor plan templates and merge them resulting in a more complex building geometry



Next Steps

- System Identification
 - Black Box models of energy components
 - Ventilation system
 - Heat pump
 - Online identification based on monitoring data

- Model based energy management
 - HVAC system: design controller
 - Concrete core activation
 - Challenge: applicable to systems in different buildings

- Tight integration in building automation

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