



PLUG-N-HARVEST

WP1: THE PLUG-N-HARVEST ADBE SYSTEM

ORGANIZATION: RWTH

PRESENTER: SEBASTIAN REMY, MARIUS VONTEIN

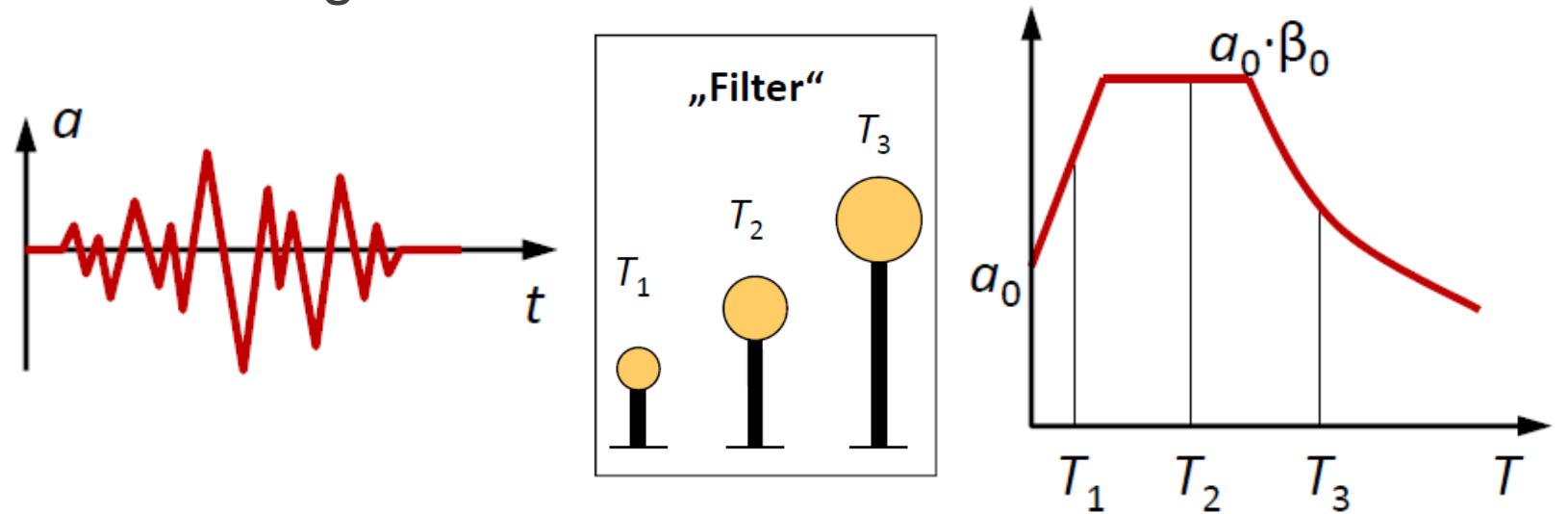
MEETING: 7TH MEETING 26-27 FEBRUARY, BRUSSELS, BELGIUM

Building response and earthquake resistance:

- Dynamic, short-term effects from ground movements

- Usual representation:

- Acceleration time curves
- Elastic response spectra
- Excitation via base points
- Dynamic reaction of buildings
- Influence of stiffness
- Influence of the masses
- natural frequencies



Dimensioning concepts:

- Elastic dimensioning
 - Prerequisite: Building response remains largely elastic
 - Internal forces with elastic response spectrum
 - Verification according to EC 2, EC 3, EC 4, EC 5
- Plastic dimensioning
 - Assumption: Essential parts of the building may plasticize
 - Prerequisites:
 - Components do not fail prematurely Ductility + dissipation
 - Component connections do not fail prematurely Capacity dimensioning
 - Building remains stable
- “Reward”: Evidence at a lower load level (coefficient of behaviour q)
“Price”: Significantly higher deformations and associated requirements



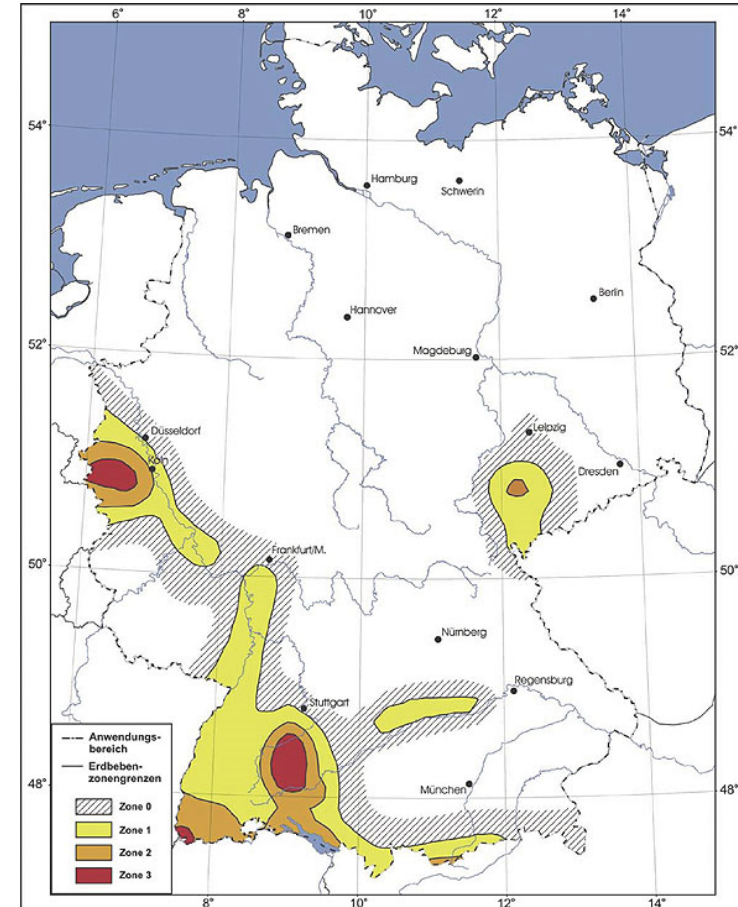
Earthquake design of existing buildings:

- In Germany, the grandfathering principle applies
- Protection of existing stock not applicable for
 - Changes to the supporting structure (not relevant for ADBE)
 - Change of use (loads) → ADBE leads to additional loads
- Situation:
 - Recalculation of existing buildings according to DIN 4149
 - Requirements as for new buildings
- Problem:
 - Many of the existing buildings were never designed for earthquakes.
 - Expensive training required
- → The ADBE will introduce new loads into the building. A new earthquake proof is to be led by the building statistician. The ADBE itself does not have to be proven separately.



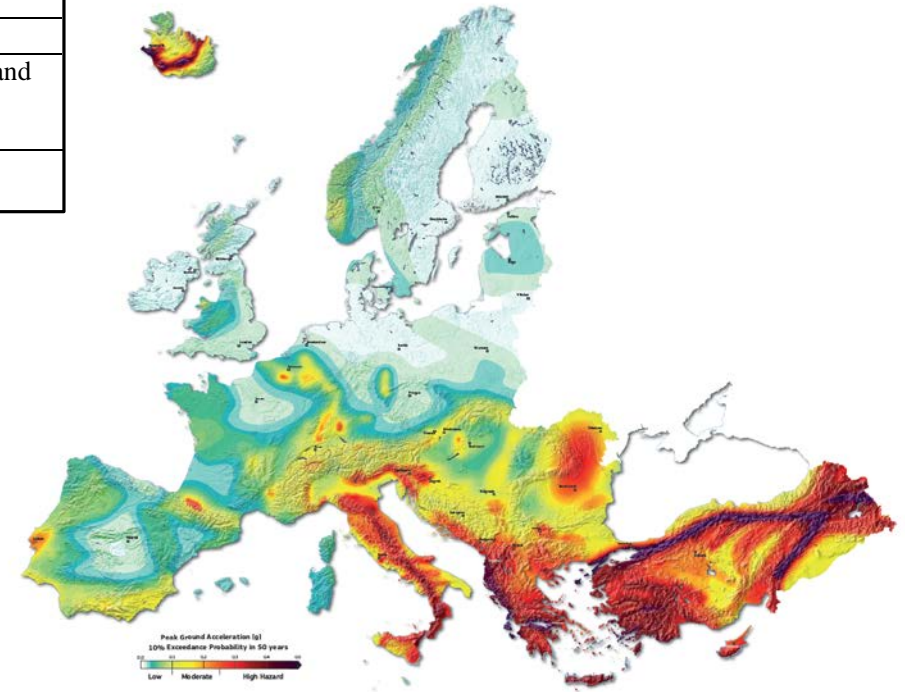
Dimensioning according to earthquake standards in Germany:

- DIN 4149 (2005)
 - Building Inspectorate introduced
 - No longer distributed by DIN
- Eurocode 8 + NA
 - Building supervision NOT yet introduced
 - Eurocode 8 available as "white" print
 - NA available as draft version
- Eurocode 8, part 3 (existing buildings)
 - Available as "white" print
 - Not introduced by the building authorities
 - Introduction not expected in the near future



Additions to WP1, D1.4

| Requirement No.6: loading requirement of wall cladding | | | | | |
|--------------------------------------------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------|---------|
| Pilot site | AHC | CCC | CU | RWM | RWTH |
| Pilot type | Dwelling | Dwelling | Office | Office | Office |
| Pilot Country | Spain | UK | UK | Greece | Germany |
| Building regulation level | Requirement value/key content | Seismic demands on façade elements are strongly dependent on the seismic zone and local soil conditions of the building site as well as dynamic building properties. It cannot be specified as a generalized single-number value. | | | |
| | Requirement source | EN 1998-1:2010/NA | | | |





PLUG-N-HARVEST

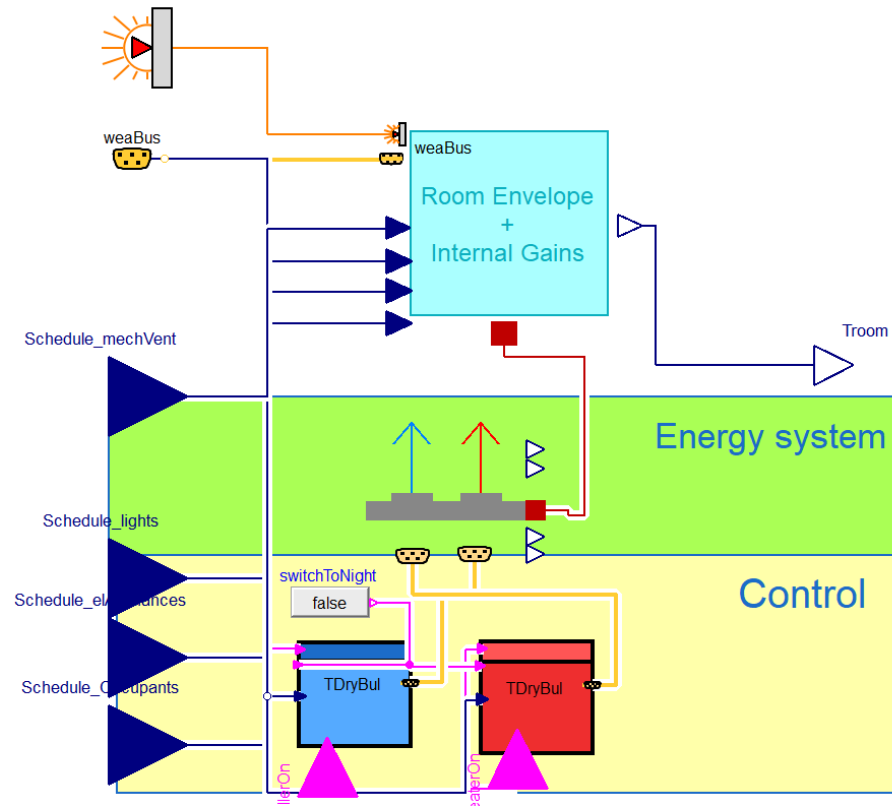
WP2: THE ADBE ADVANCED DESIGN

ORGANIZATION: RWTH

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Simulation:



Envelope:

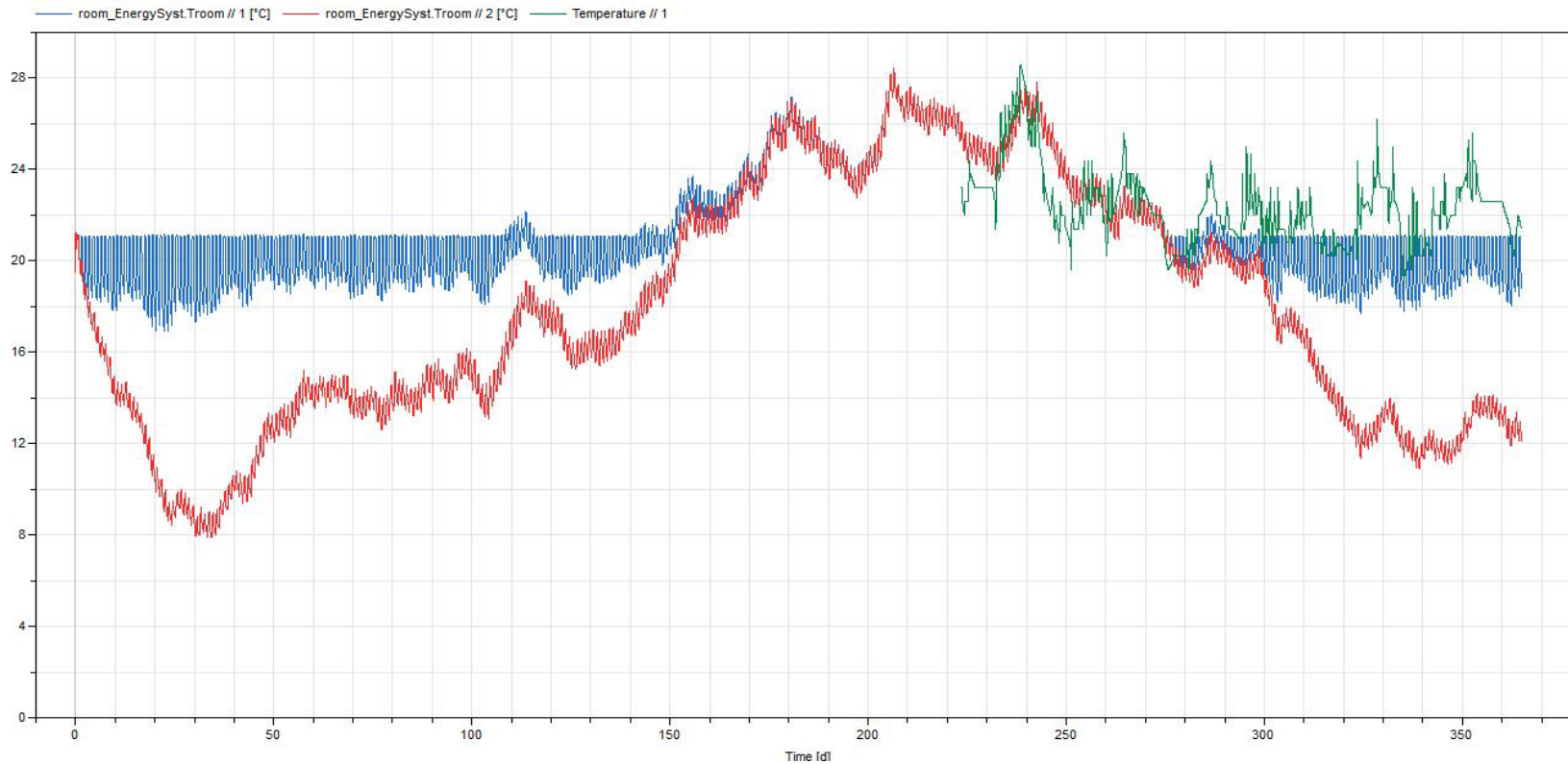
- One outer wall, the rest inner walls towards the building
- General: room height, length and width, wall and window type
- Advanced: Outer walls: solar absorbance, heat convection model, Sunblind, Infiltration, Heat bridge
- Hidden: Initial temperatures of walls

Energy System & Control:

- General: Maximal power output for heater / cooler, Set temperature for heating / cooling, Outside temperature under which heater starts
- Advanced: Is heater / cooler electric, Electrical efficiency of heater / cooler
- Hidden: Parameters for internal PI controllers



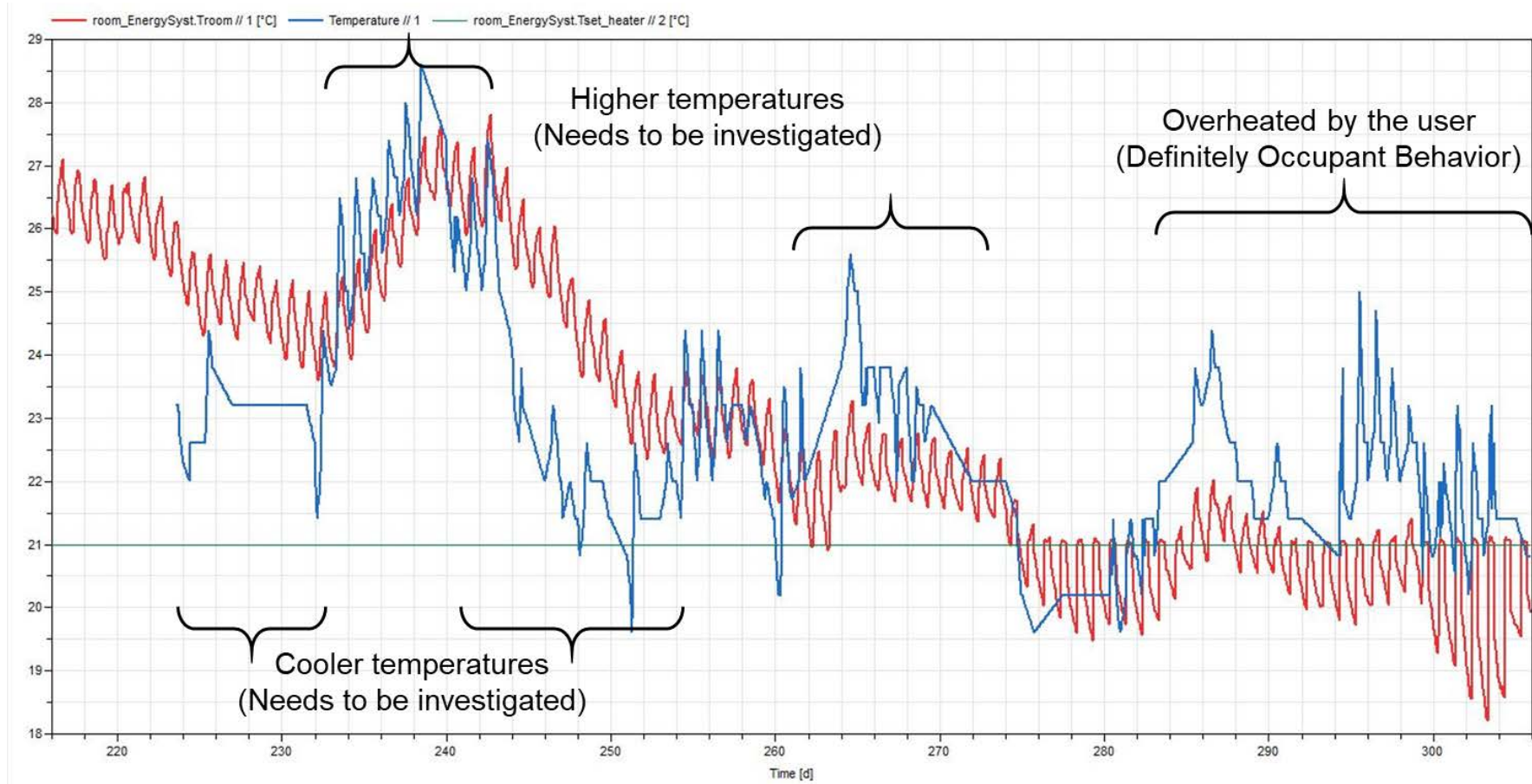
Simulation: Validation



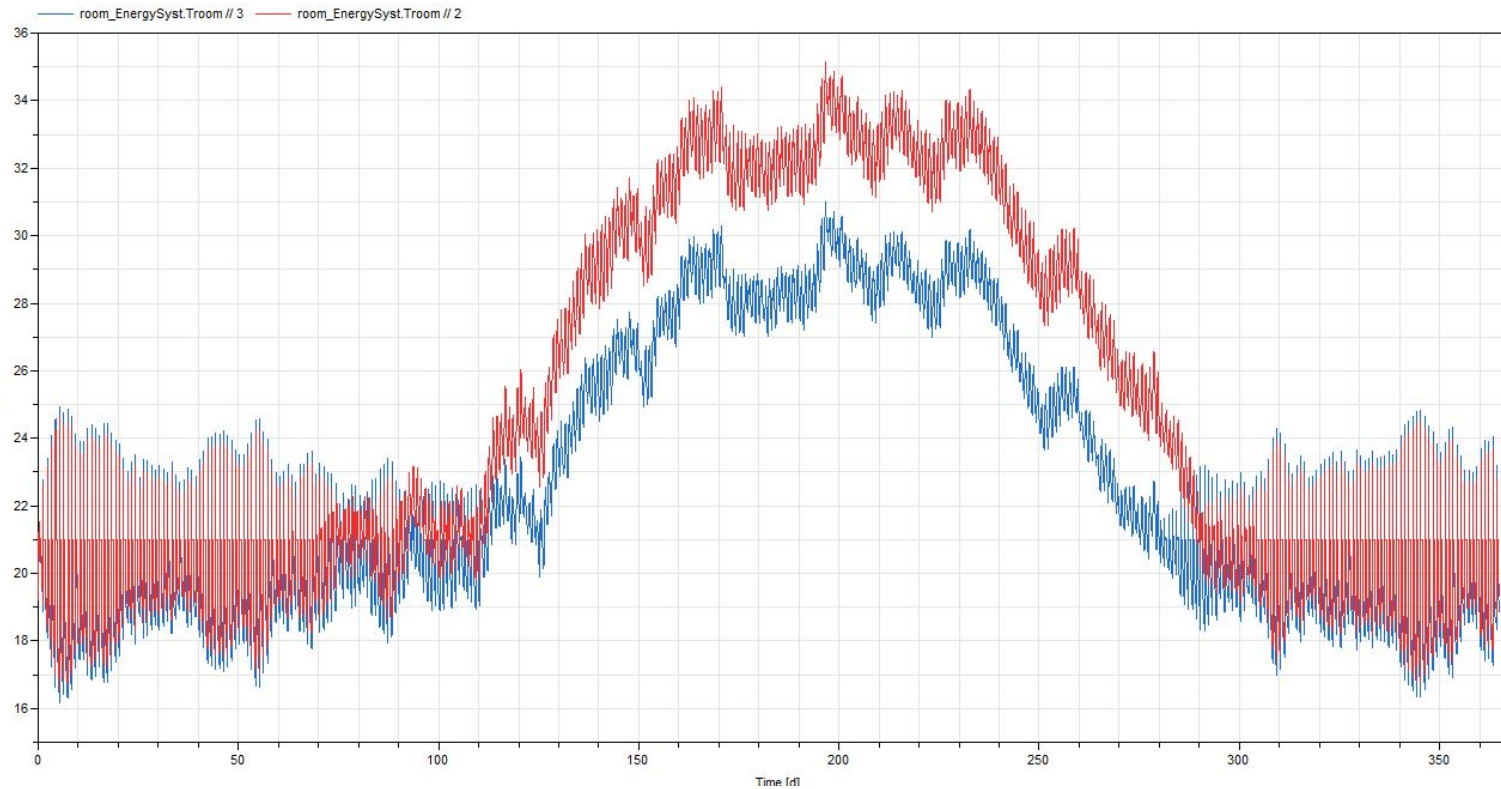
- Temperature without any HVAC
- Room temperature with ideal heater
- Room temperature as measured



Simulation: Validation



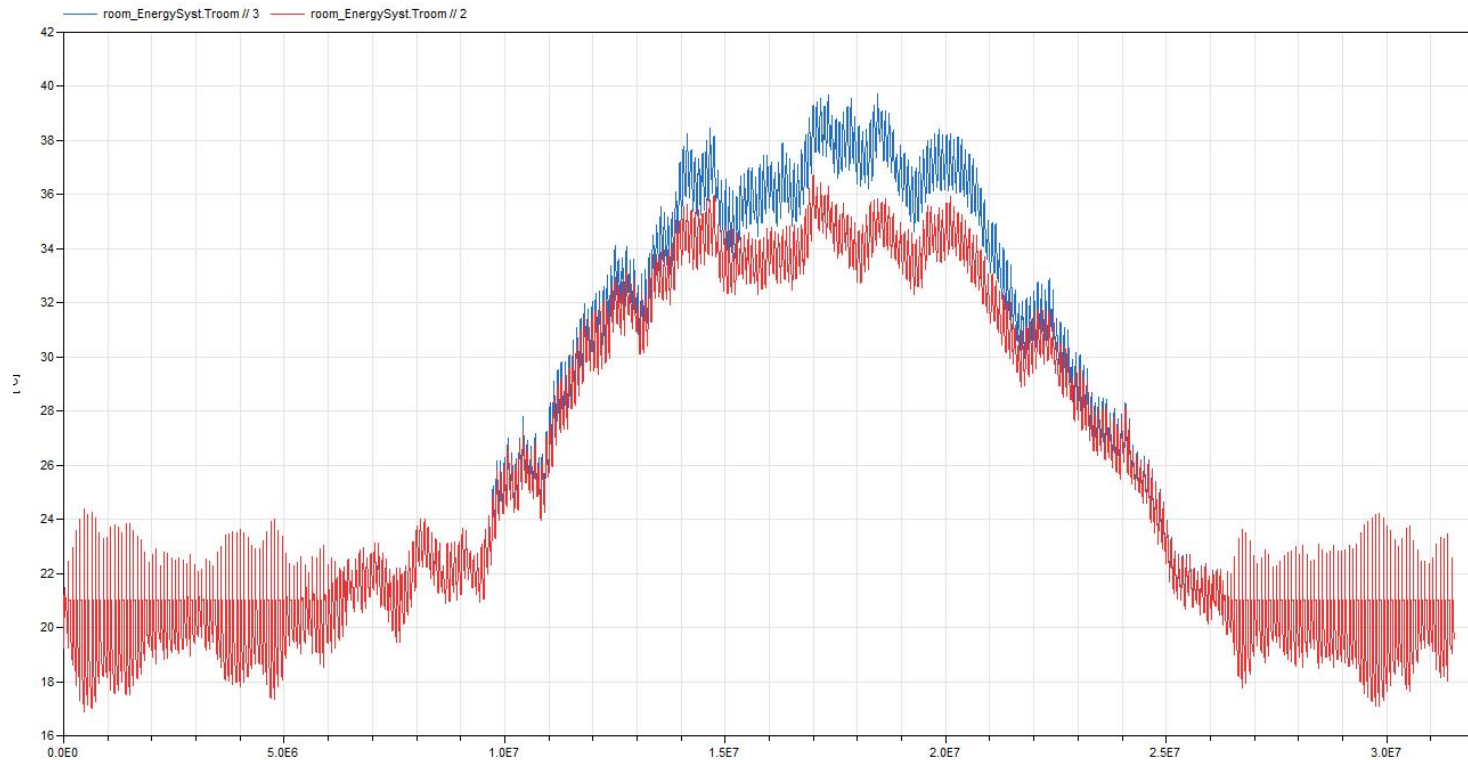
Simulation: Sensitivity Analysis



Lighting Profile Effect
0 W/m² vs 9 W/m²







Simulation: Sensitivity Analysis



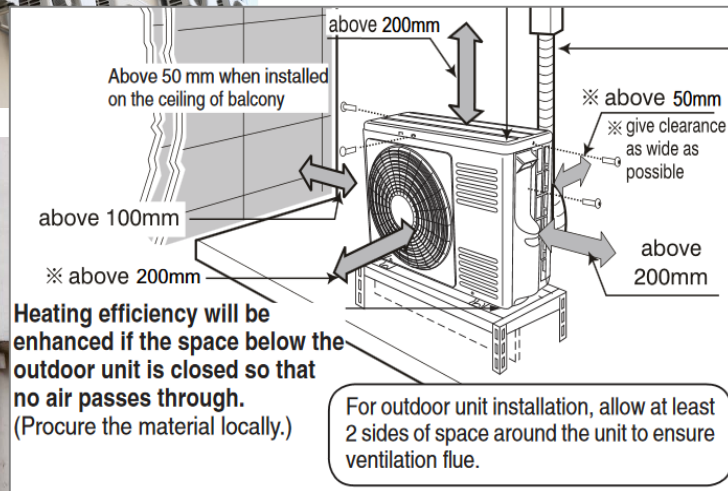
- Irradiation effect through sunblind 180 W/m² vs 1000 W/m²








Last Meeting: Components for the ADBE

- Photovoltaics & Solar air heater 
- Ventilation Units (central & decentral) 
- Storage systems 
- Heat pumps & air conditioner 

Last Meeting: Heat pumps & air conditioner

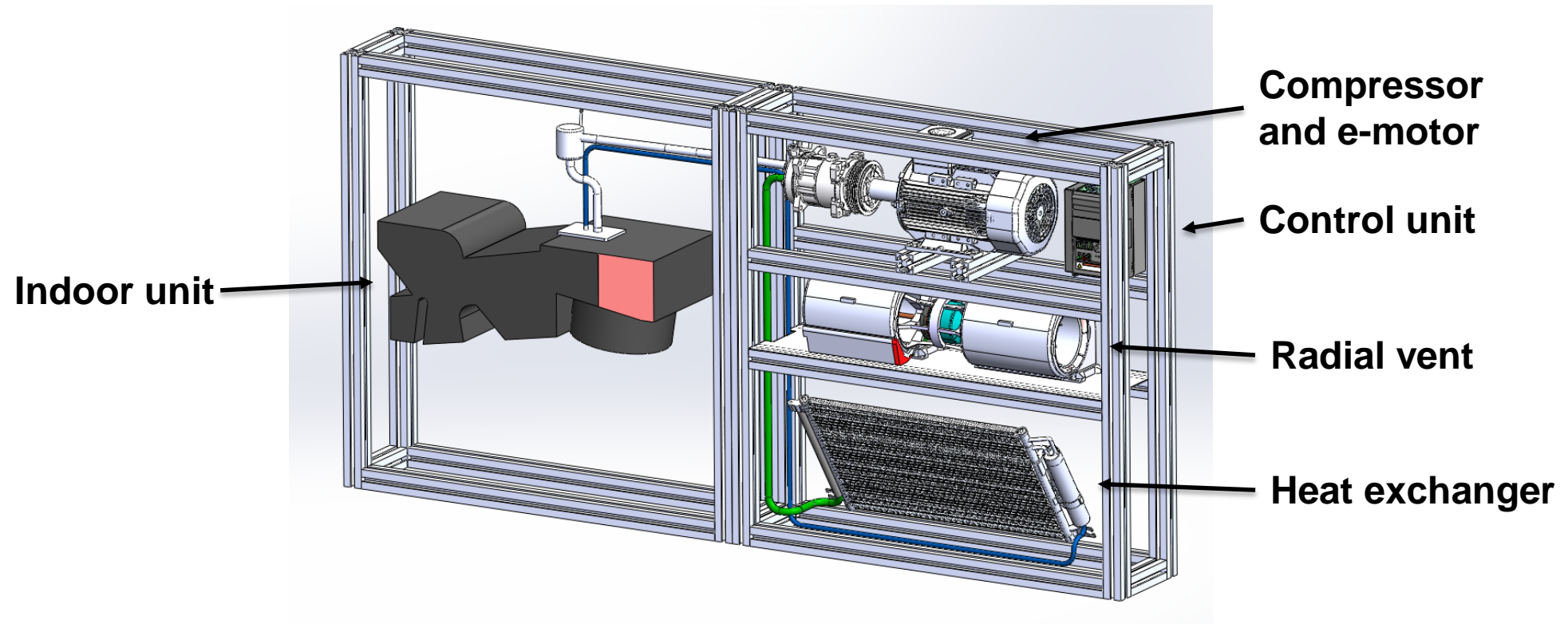


- Suitable dimensioning 
- Sufficient performance 
- Marketability in building sector 
- Technical feasibility for facade integration 
- Safety aspects 

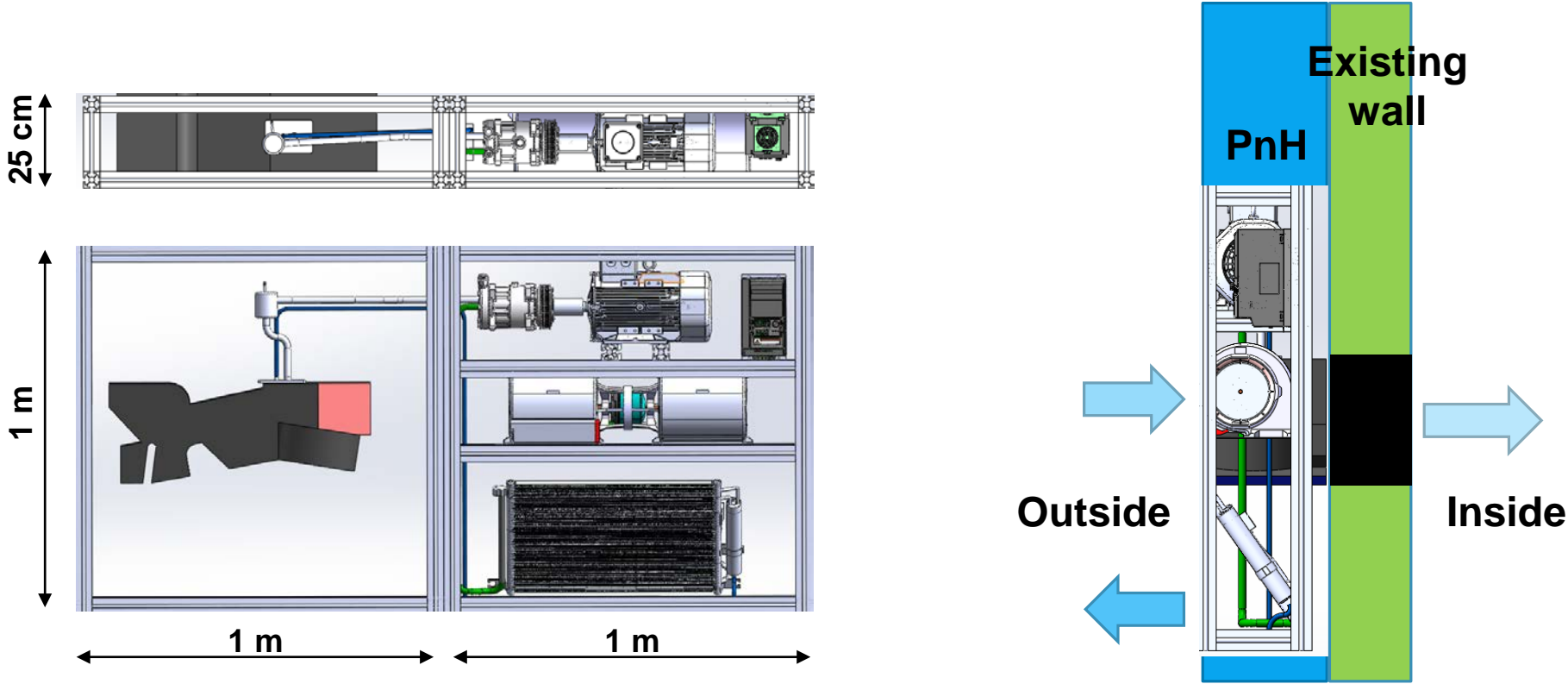
Will be investigated in the next months.



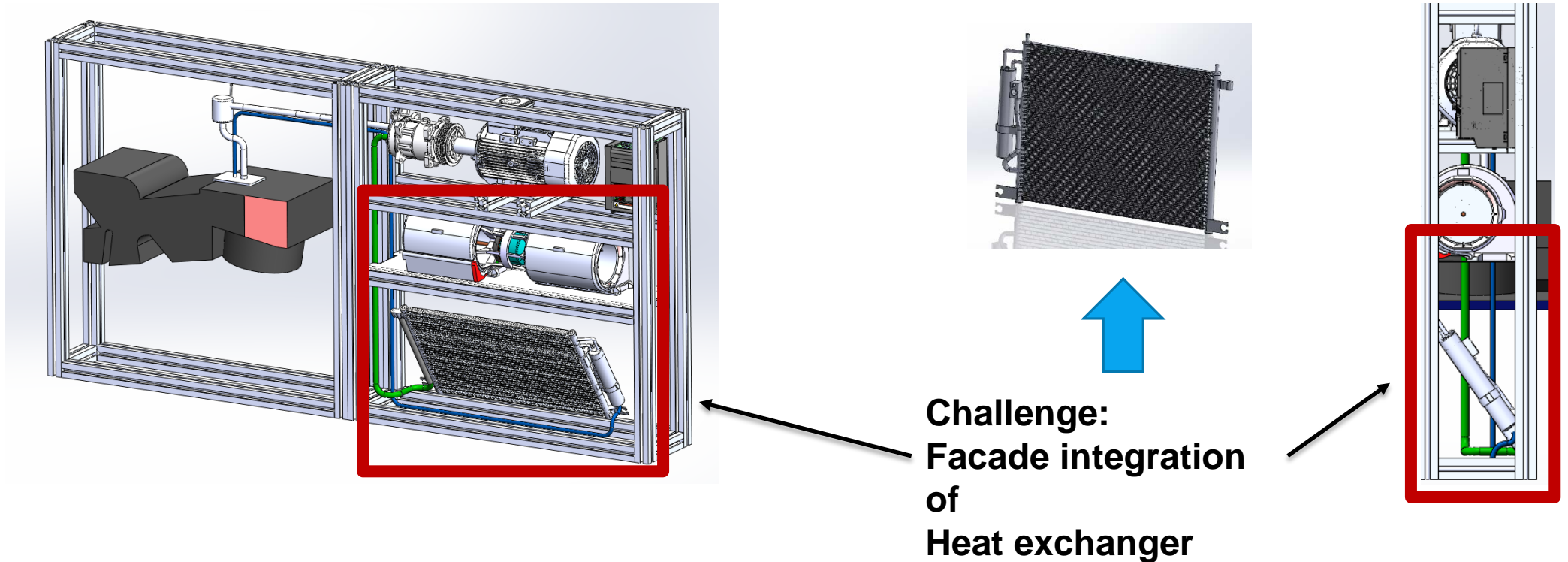
Facade integrated heat pump system: CAD model



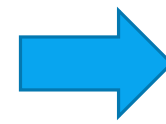
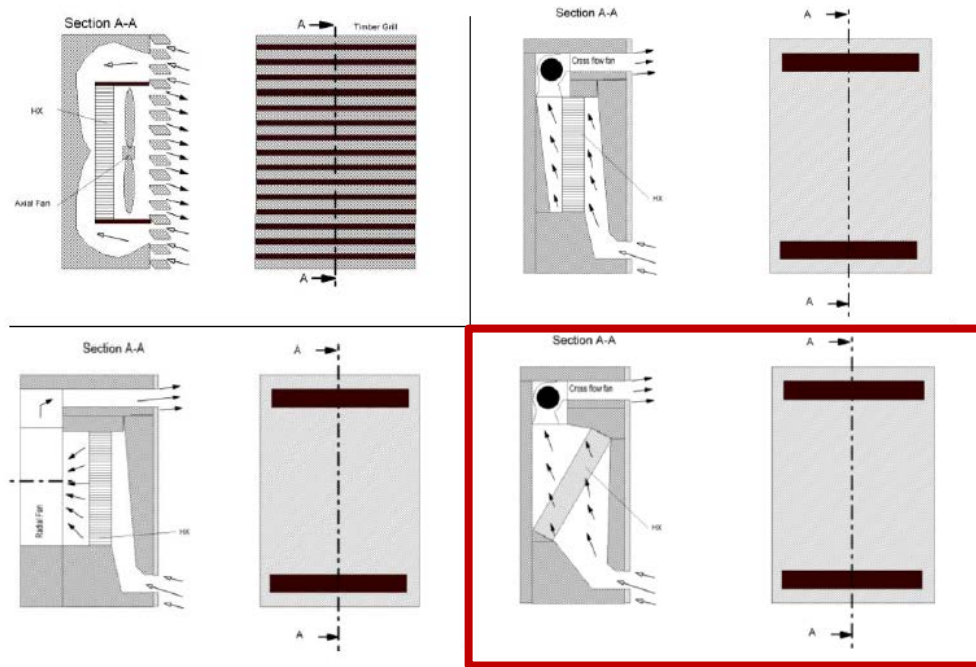
Facade integrated heat pump system: CAD model



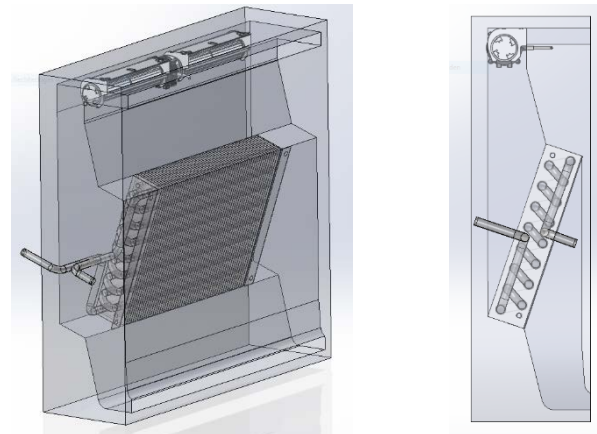
Facade integration of heat exchanger



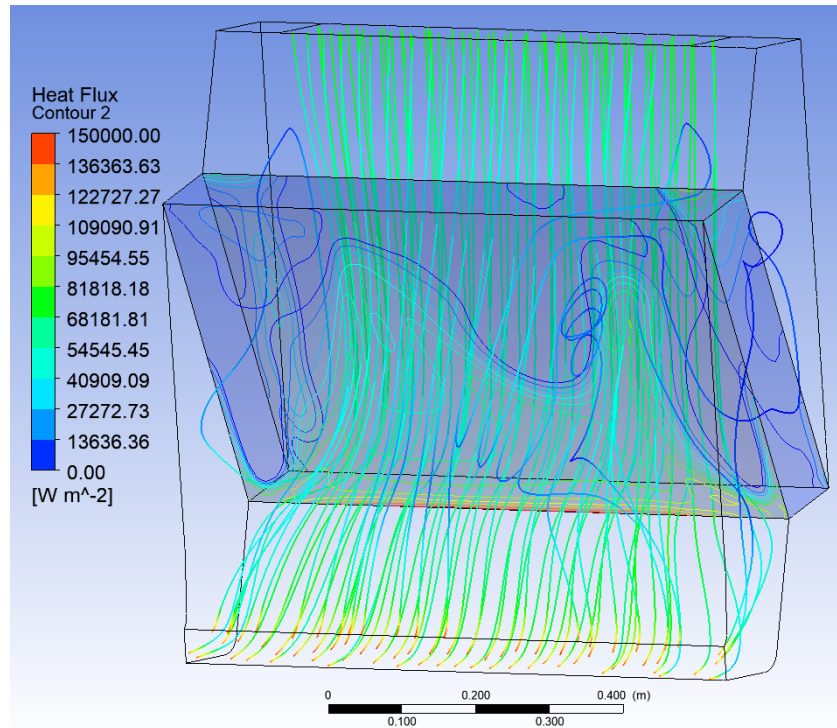
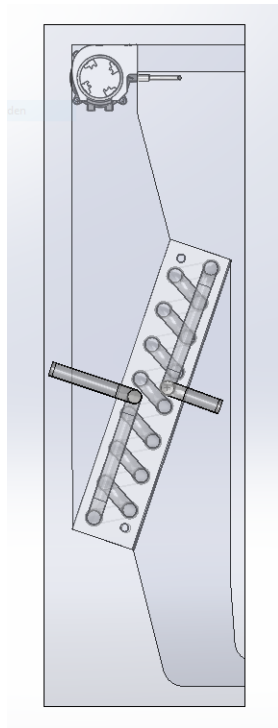
Facade integrated heat exchanger



- Based on a literature research we have considered different designs
- In the end we decided on the fourth design



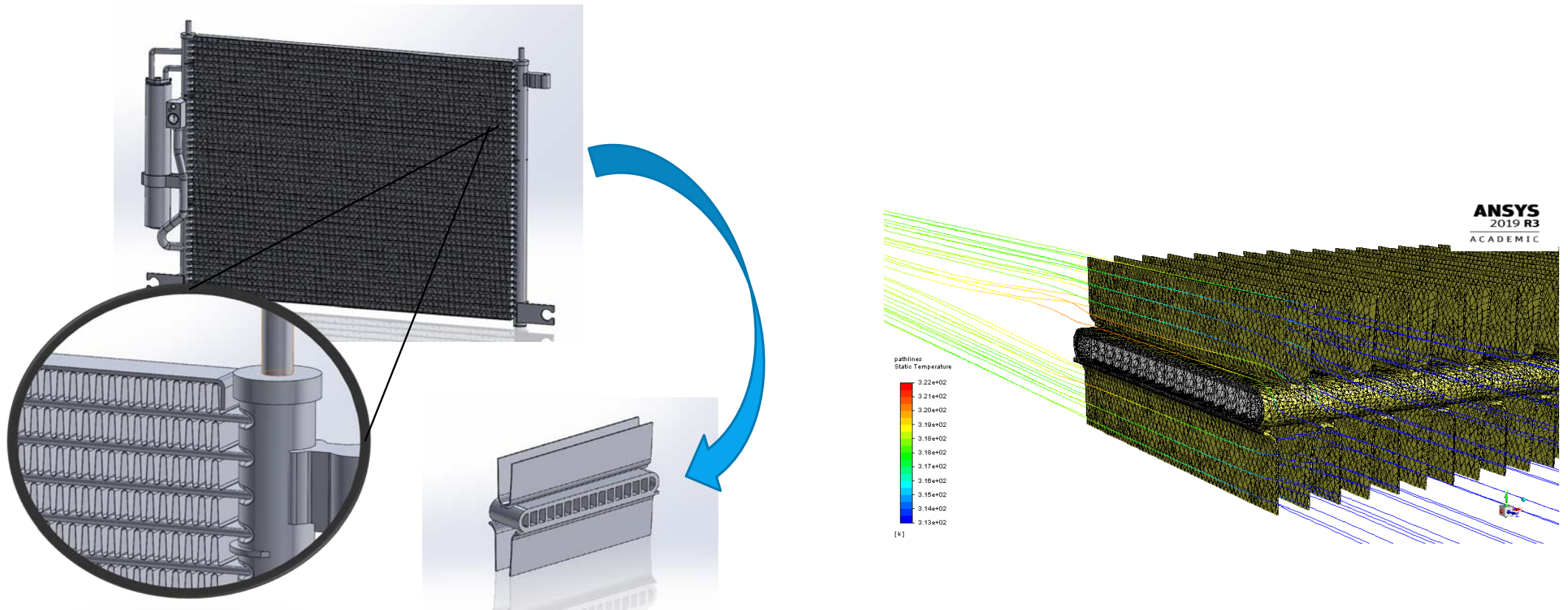
Facade integrated heat exchanger: CFD model



- CFD simulations are currently being carried out to optimize the design of the air duct
- Due to the compact design we have decided to use a microchannel heat exchanger
- The aim of optimization is to reduce pressure losses and improve the heat transfer rate



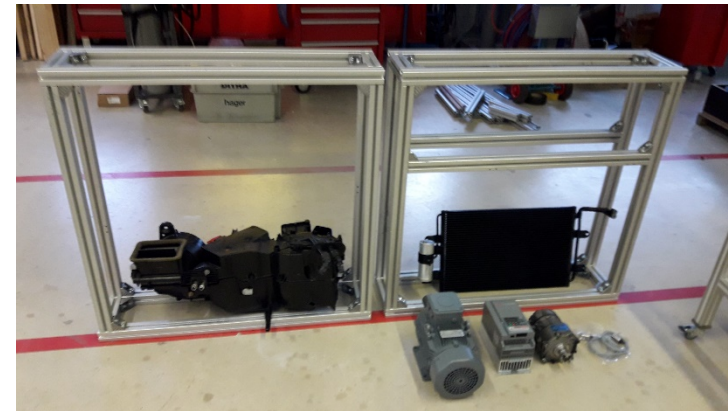
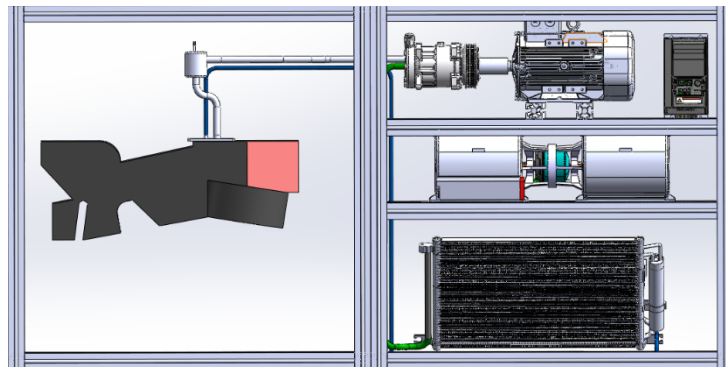
Facade integrated heat exchanger: CFD model



Facade integrated heat pump system: Target



Facade integrated heat pump: Construction



- We are currently in the process of ordering the required components
- The first commissioning is planned for the **end of March**.
- The first prototype is operated with 134a as refrigerant. Other refrigerants are to be investigated, however

