

**A NOVEL MODEL BASED APPROACH
OF AN INTEGRATED VENTILATION
AND HEATING MODEL FOR
MONITORING AND CONTROL**

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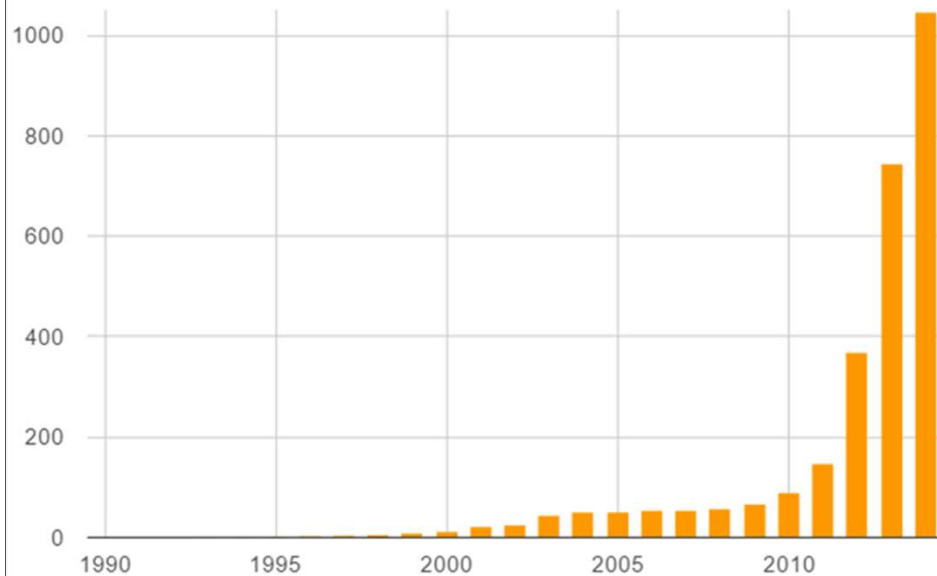
TNO (www.tno.nl) is an independent and not-for-profit organization. TNO connects people and knowledge to create innovations that boost the competitive strength of industry and the well-being of society in a sustainable way. This is our mission and it is what drives us, the over 3,400 professionals at TNO, in our work every day. We work in collaboration with partners and focus on nine domains.



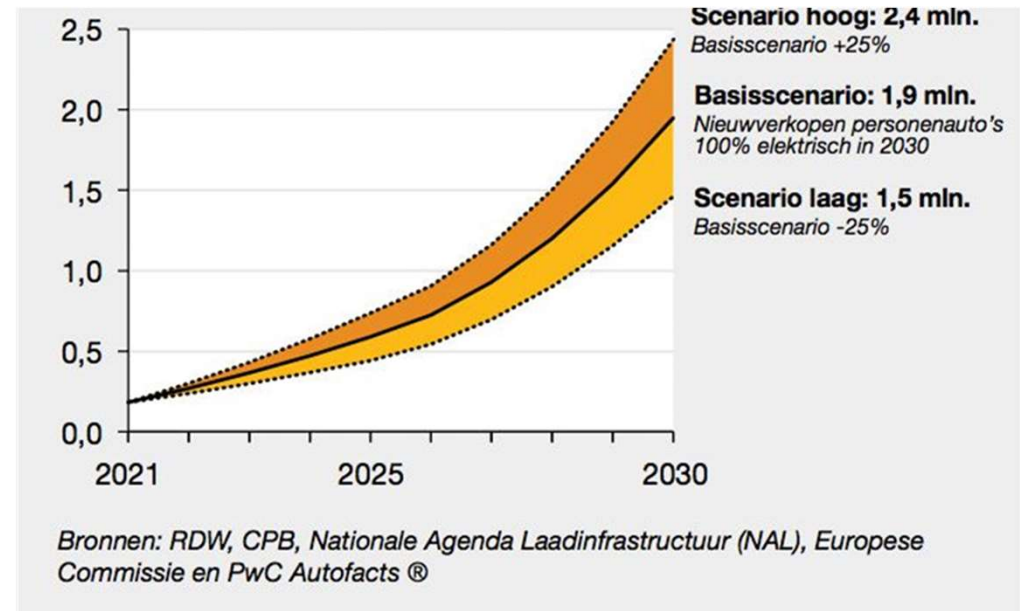
Towards Networks of predictive twins in the Built Environment, Arjen Adriaanse, Wouter Borsboom, Rob Roef, 2021

<https://repository.tudelft.nl/islandora/object/uuid:ba8043dd-1dfc-4469-bfeb-53006de6e88a>

FAST GROW OF SOLAR, ELECTRICAL VEHICLES, HEAT PUMPS IN THE NETHERLANDS

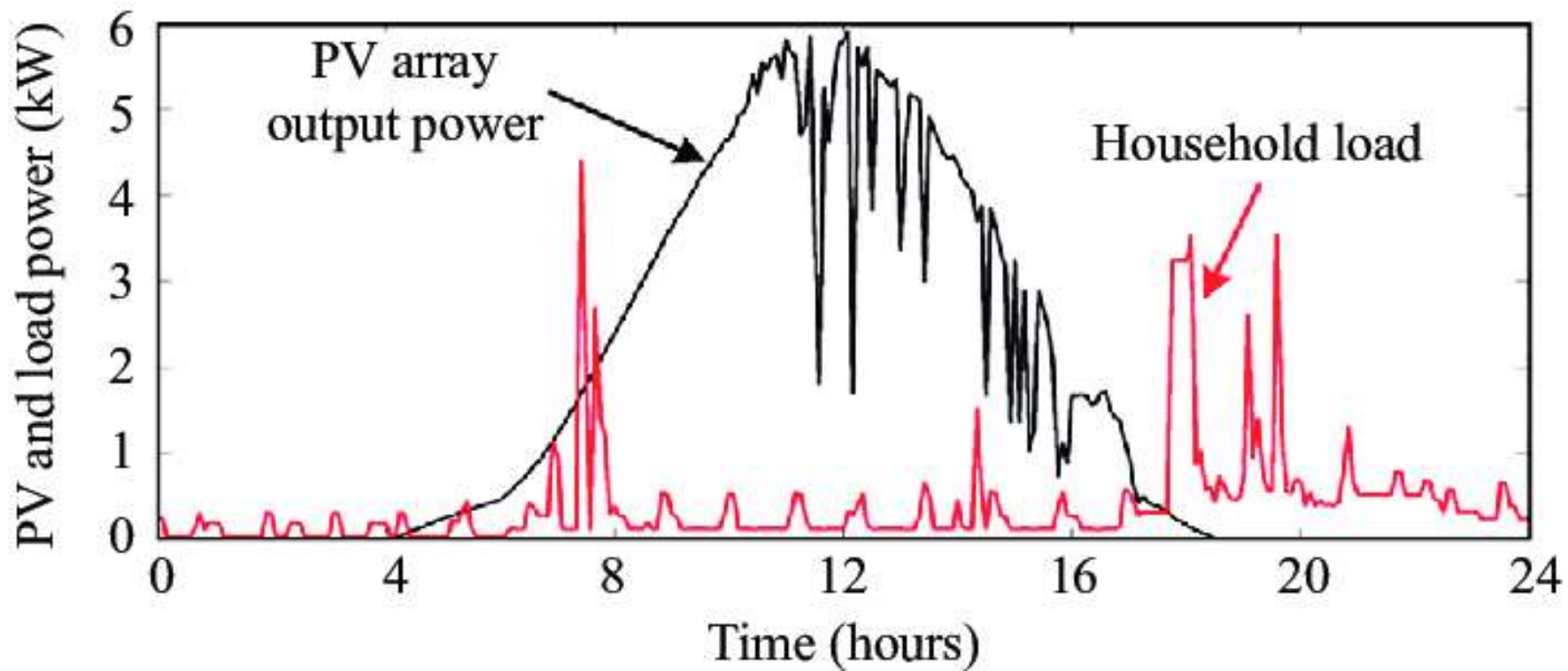


Number of solar panels



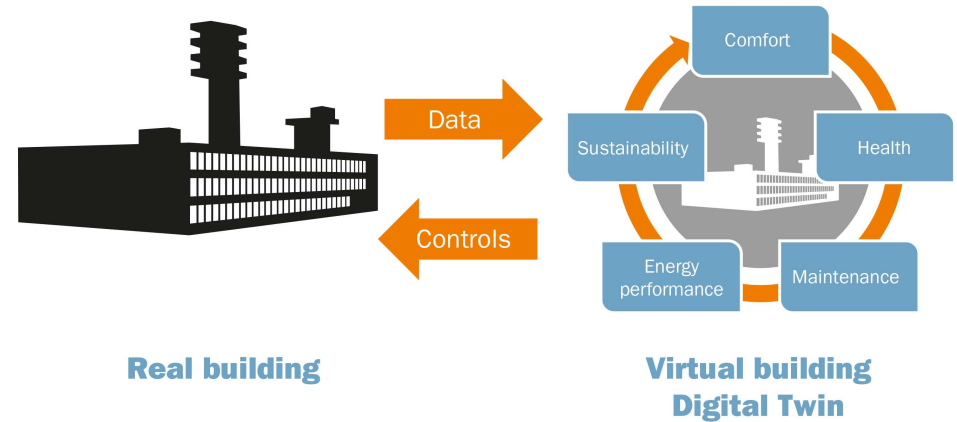
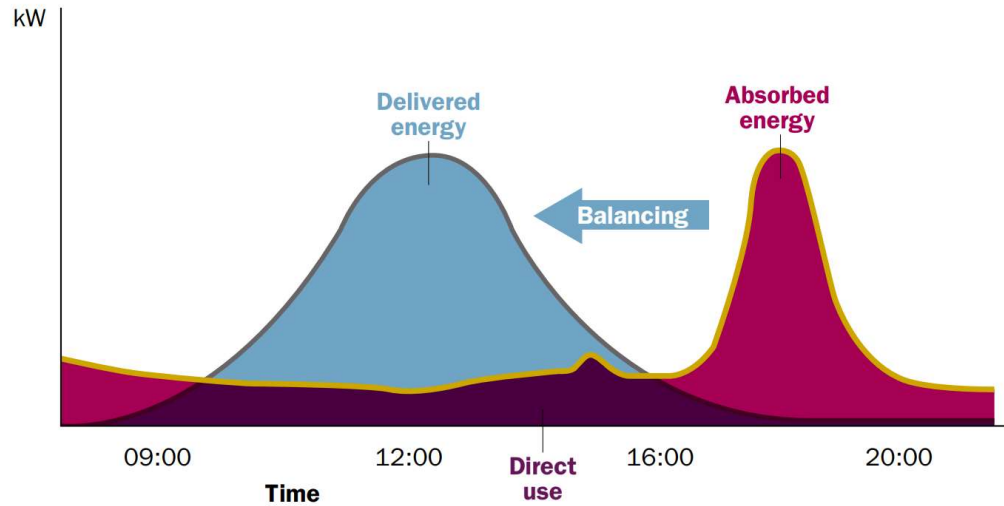
Different scenario's of electric cars in Netherland

DEMAND OF ELECTRICITY AND SUPPLY OF PV



SHIFTING ENERGY TO REDUCE PEAK LOAD WITH CONTROL

Absorbed energy versus delivered energy

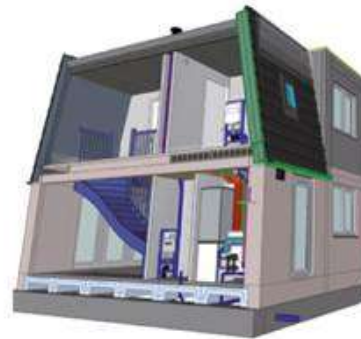


DIGITAL TWIN SYN.IKIA: AREA APARTMENT BUILDING

BIM-Information



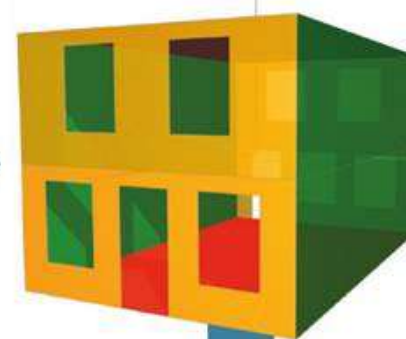
Building Information Model (BIM)



Revit



Building Energy Model (BEM)

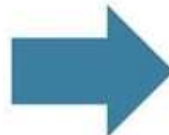


IFC / gbXML



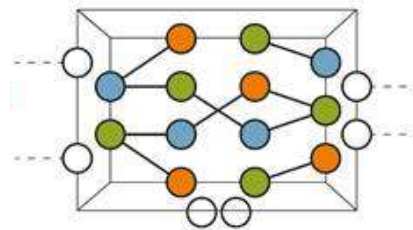
TNO Sirin-E Predictive Twin

**Dynamic data
(measuring
data)**

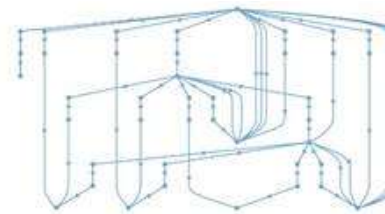


HayStack

User behaviour model (data en machine learning, Federated learning))

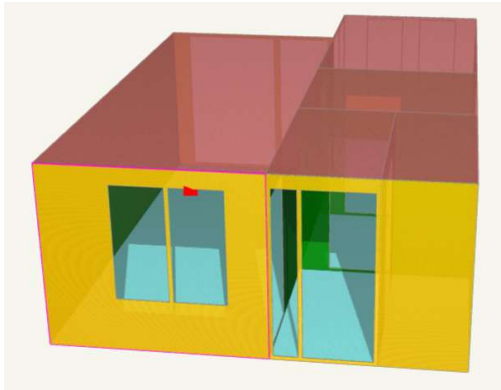


Physical model energy use



SirinE
Hybrid building model, analyze, predict, control

BIM INFORMATION: EXAMPLE OF GBXML 2 MODEL



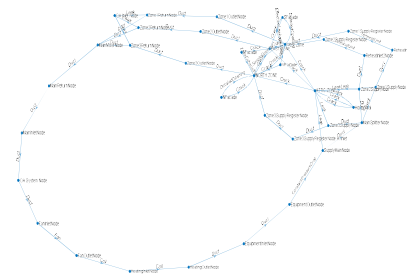
Uden gbXML apartment

gbXML data container & IDF (Energy plus)
for installations

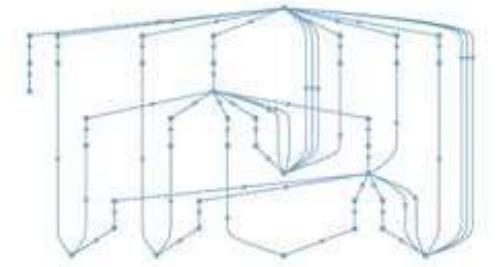
File import / data selection



Generation of a general struct containing all
information needed for building simulation

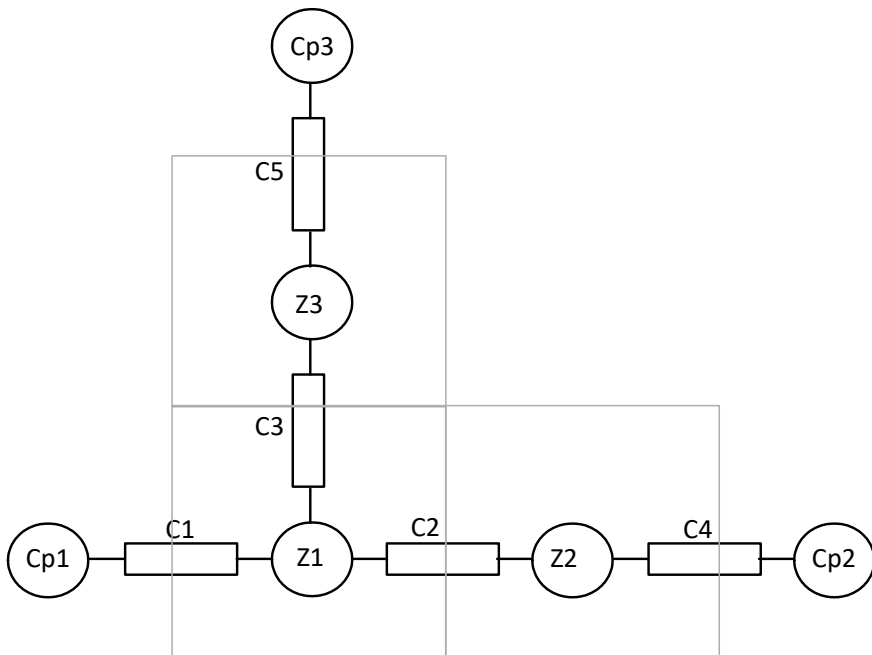


TNO AirMaps ventilation
model



TNO Heat transfer model

EXPANSION HYBRID MODEL WITH AI USER MODELS



C are the zones, c are the connection and CP are the outside nodes represented by a pressure due to wind.

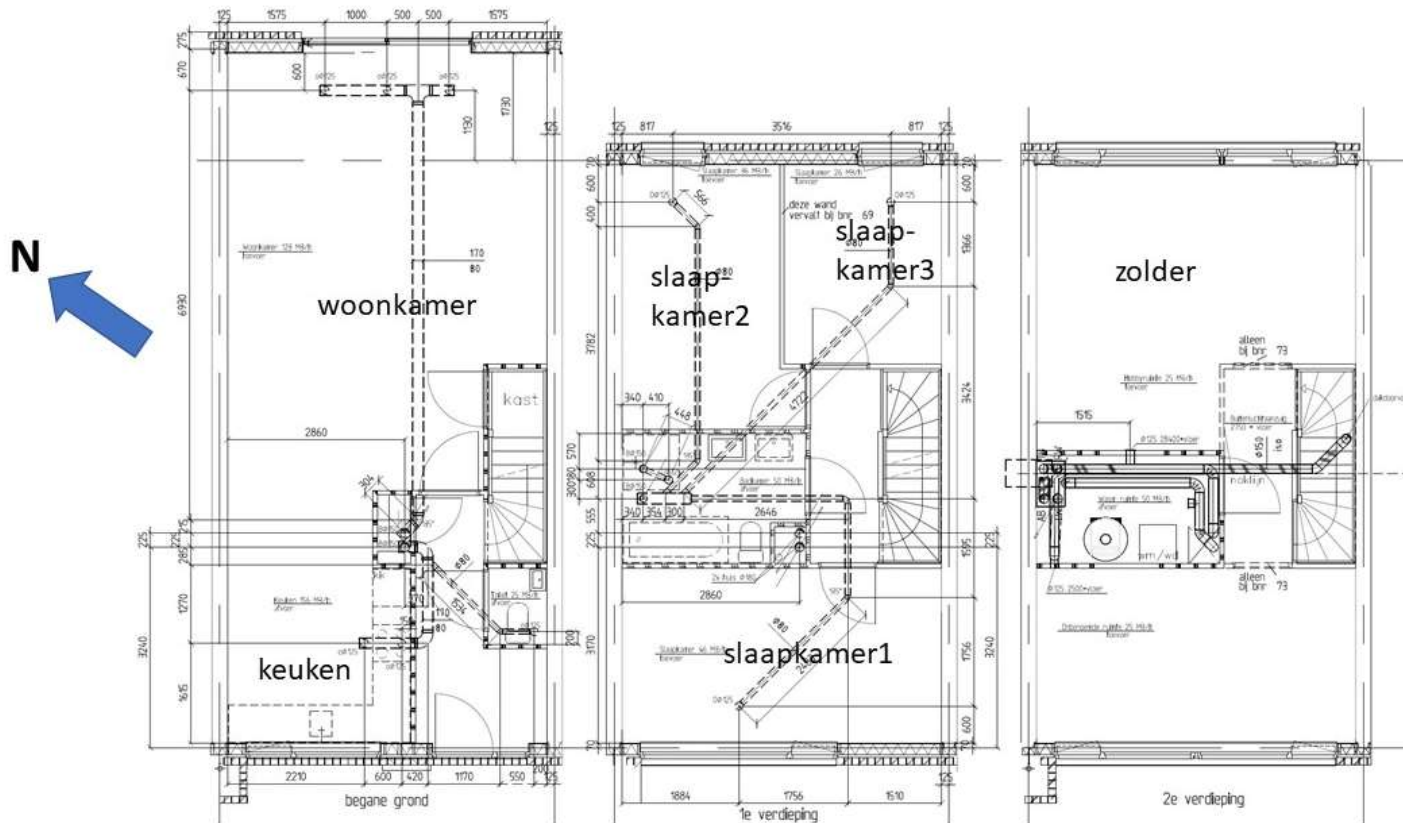
In the ventilation model AirMAPs the following driving forces are consider:

- wind
- attackthermal stack
- fans

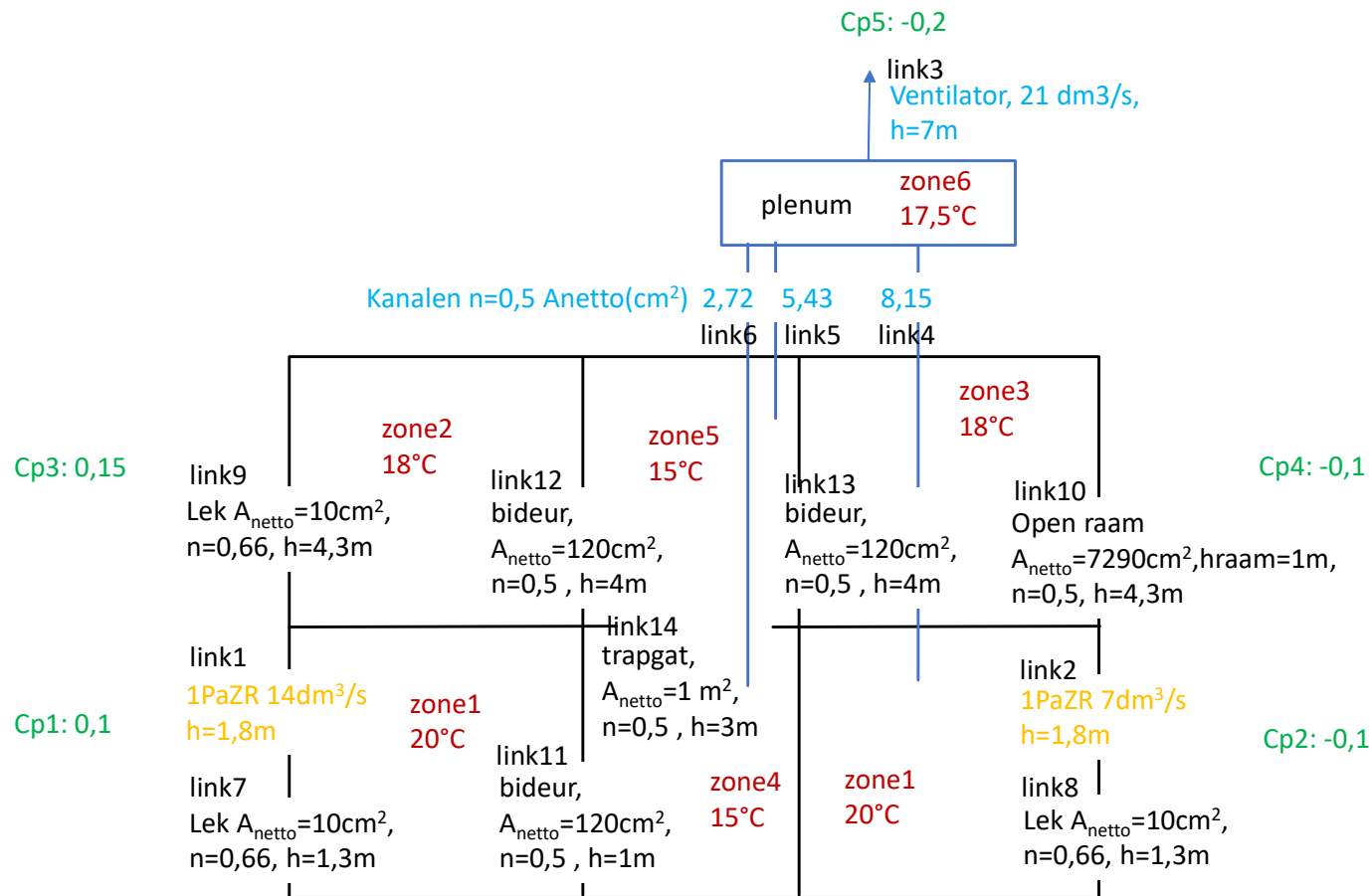
The ventilation model AirMAPs, 3 types of connections can be modelled:

- 1) an opening (marked CR)
- 2) a test data component (denoted by TD)
- 3) an open window or door (marked OW)

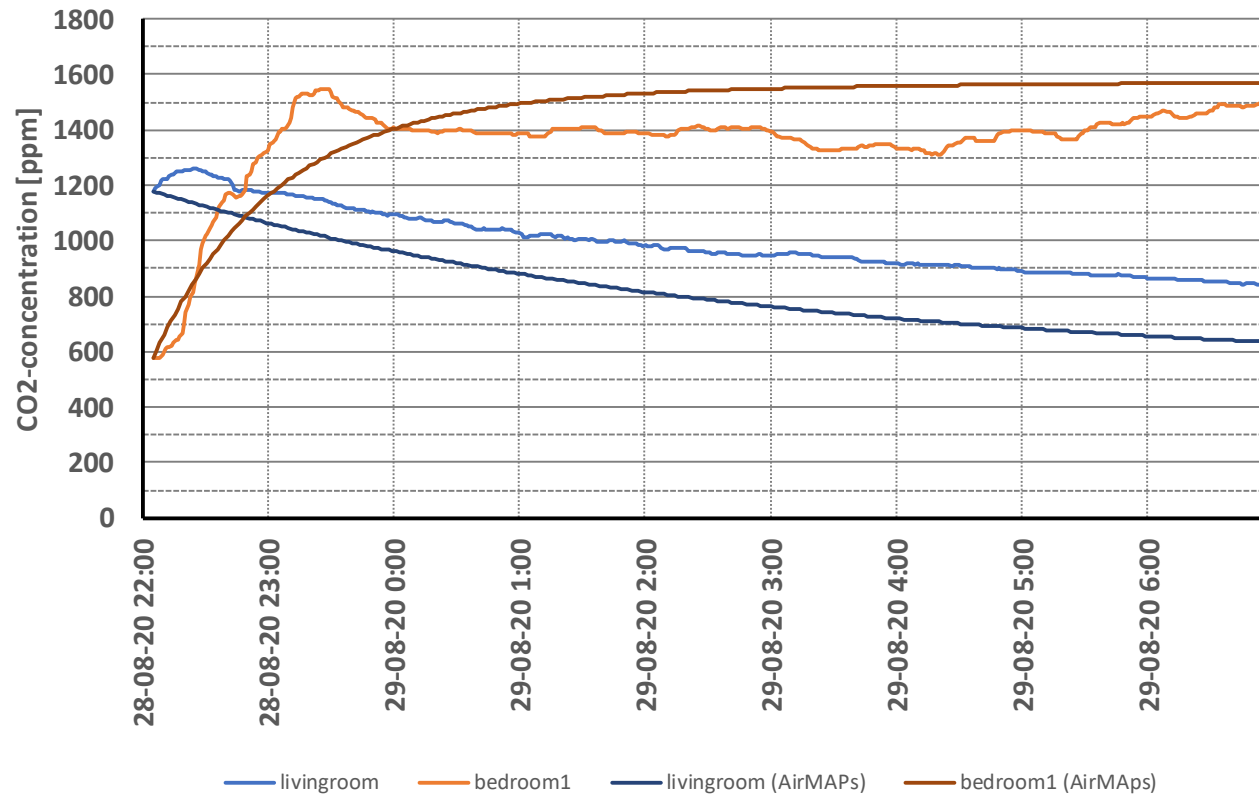
FLOOR PLAN OF FIELD TEST OF THE VENTILATION MODEL



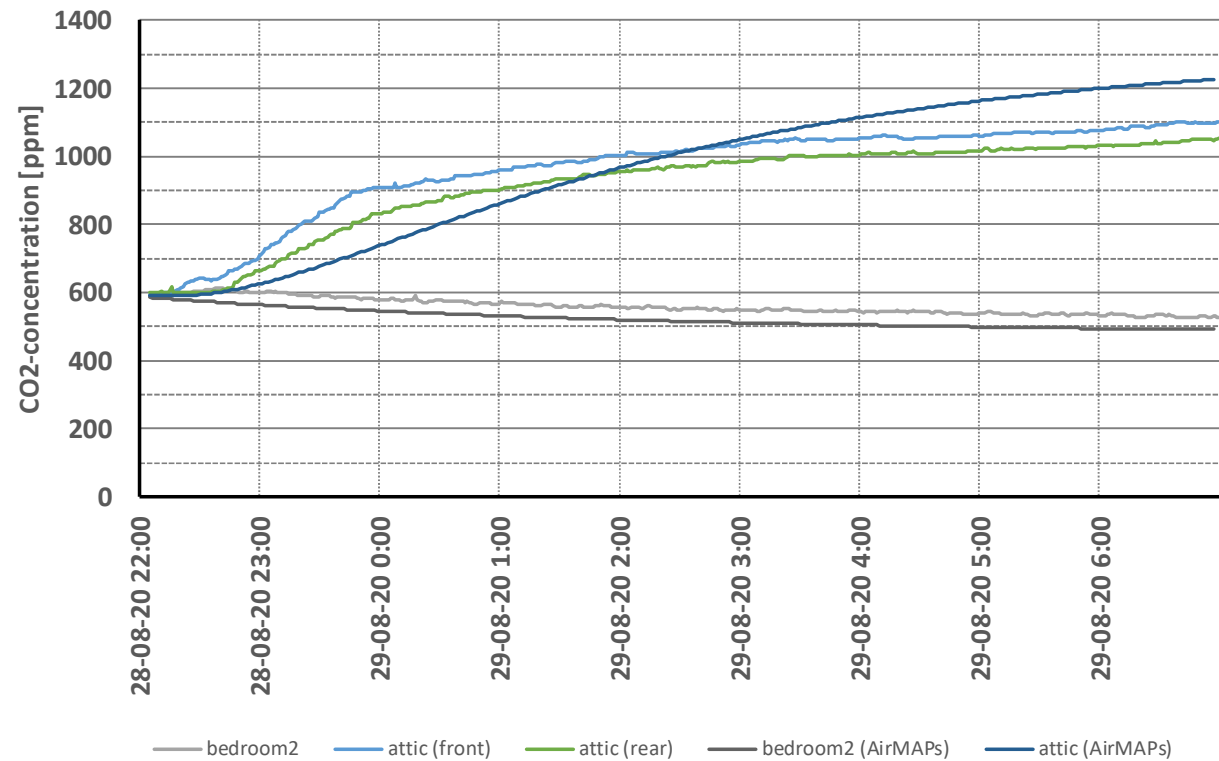
› VENTILATION MODEL



FIELDTEST VERSUS AIRMAPS SIMULATION



FIELDTEST VERSUS AIRMAPS SIMULATION 2





› QUESTIONS?



Sustainable
plus energy
neighbourhoods



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