DIGITAL TWIN OF A POWER NETWORK

Development, Validation and Application

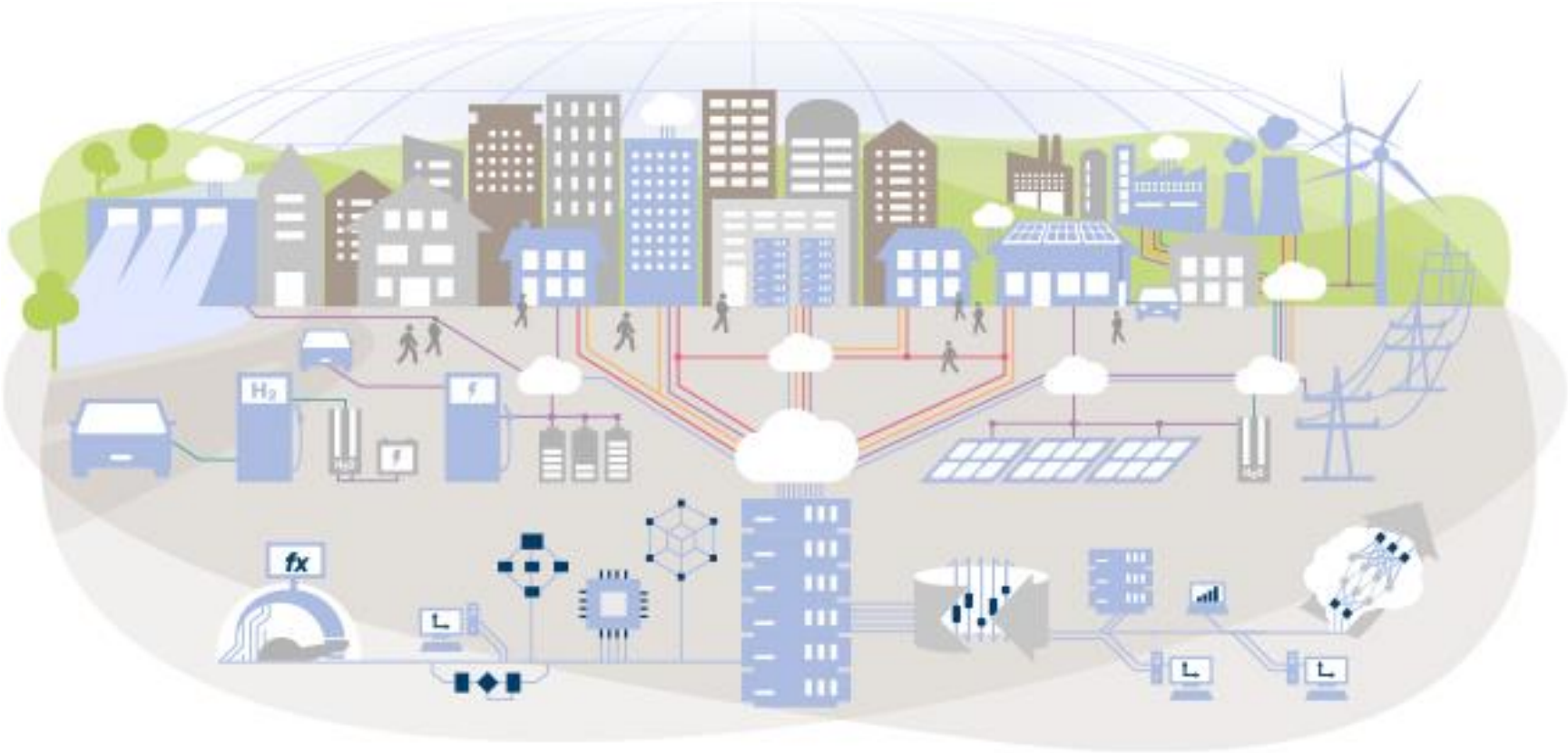
16.09.2021 | DANIELE CARTA

OVERVIEW

- Introduction
- Digital twin of the Forschungszentrum Jülich (FZJ) campus
  - Overview on the real campus
  - Simulink model (development and validation)
- Application
- Conclusions

INTRODUCTION

IEK-10 @ Forshungszentrum Jülich

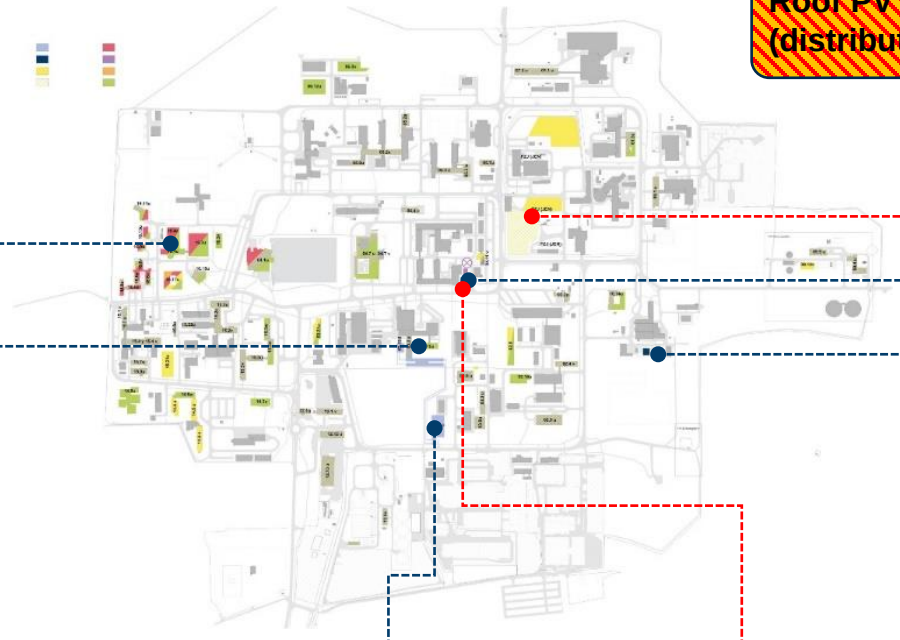


LIVING LAB ENERGY CAMPUS (LLEC)

Overview of Demonstrators

Waste heat grid (1.2 MW)

V2G
(planned)



Roof PV / BIPV
(distributed on Campus)

- Planning phase
- Tendering phase
- Construction phase
- Operation phase

PV (1.5 MW)

Li-ion Battery Storage
(2 MW / 2 MWh)

LOHC-System
(300 kW / 150 MWh)

Elektrolyser (400 kW)

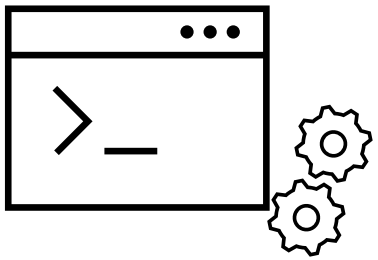
CHP with H2-cofiring

kW-scale
Energy Demonstrators

JuLab Smart building

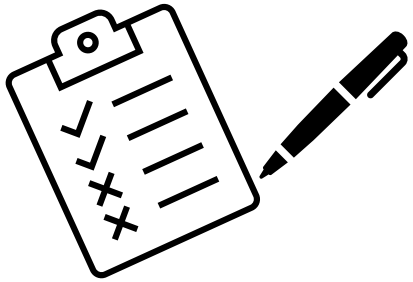
DIGITAL TWIN OF THE FZJ CAMPUS

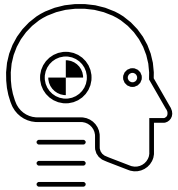
General info on DT



Development
Data collection (measurements, parameters, etc.)

Validation
Are the behaviours comparable?

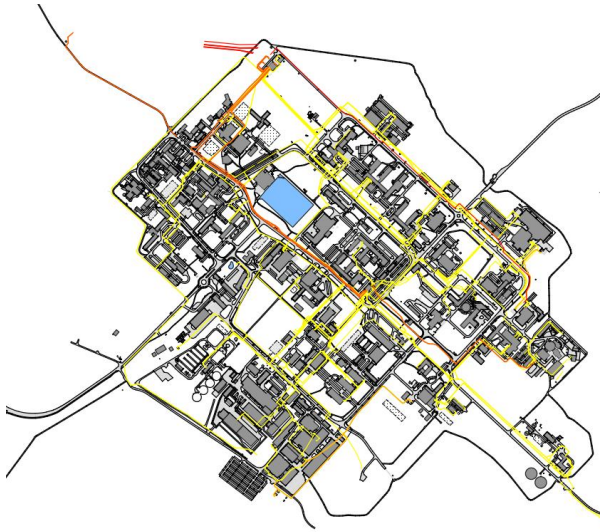


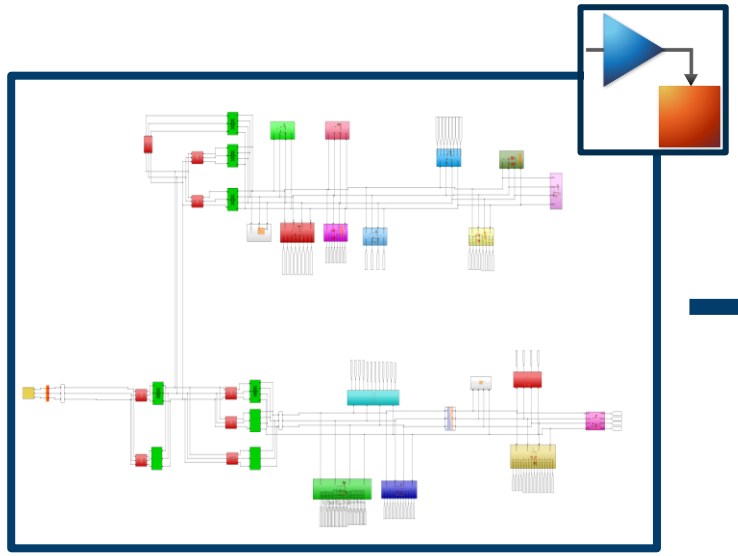


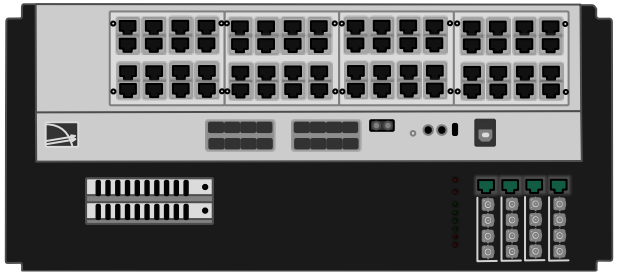
Application(s)
monitoring, controls, planning, and so on

DIGITAL TWIN OF THE FZJ CAMPUS

General info on campus network





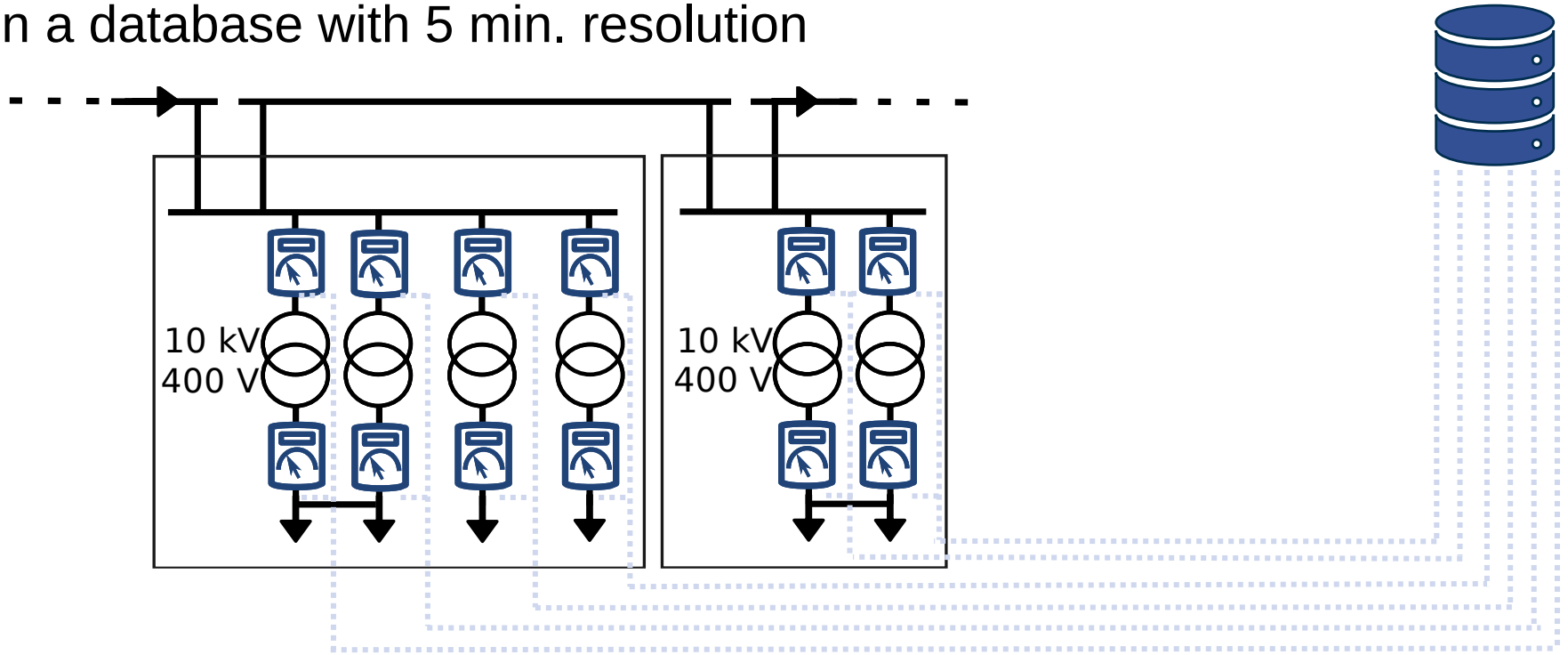


121 loads
136 transformers
76 cables

DIGITAL TWIN OF THE FZJ CAMPUS

Measurement infrastructure

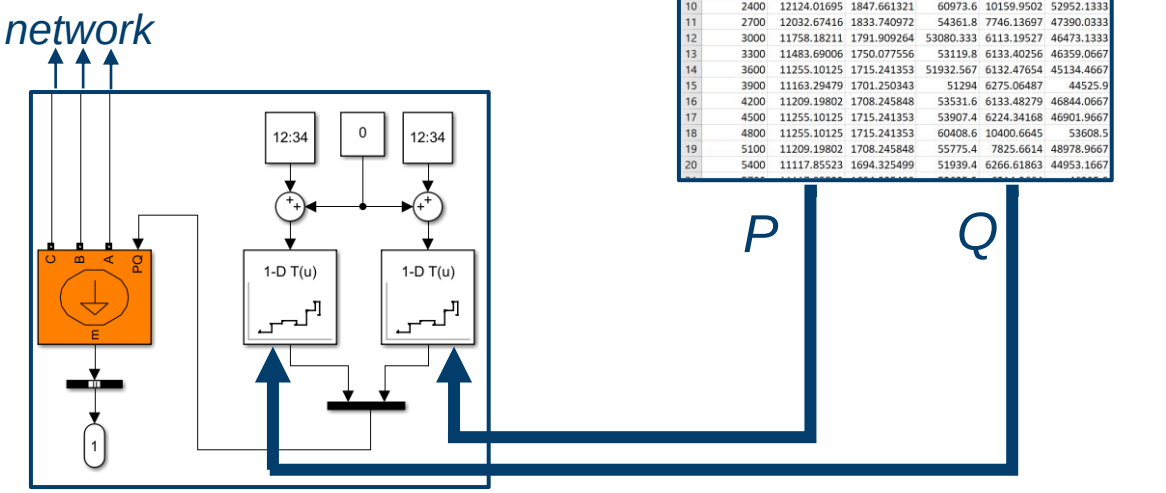
- accuracy class 1 (according to IEC 61036)
- installed on both sides of each 10/0.4 kV transformer
- stored on a database with 5 min. resolution



SIMULINK MODEL

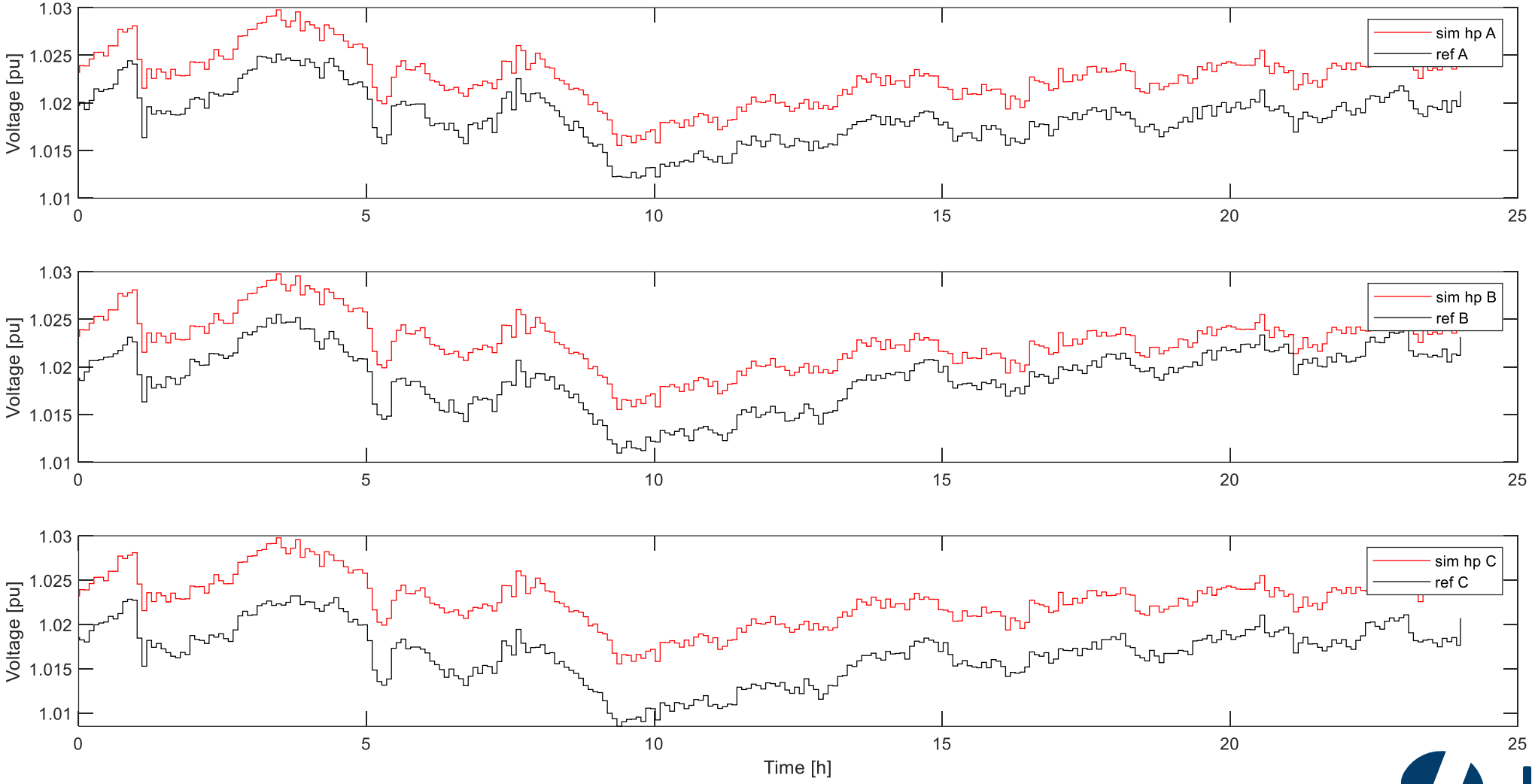
Focus on variable parameters

- Voltage source -> Three-Phase Programmable Voltage Source
  (need V)
- Loads -> Three-Phase Dynamic Loads
  (need P and Q)



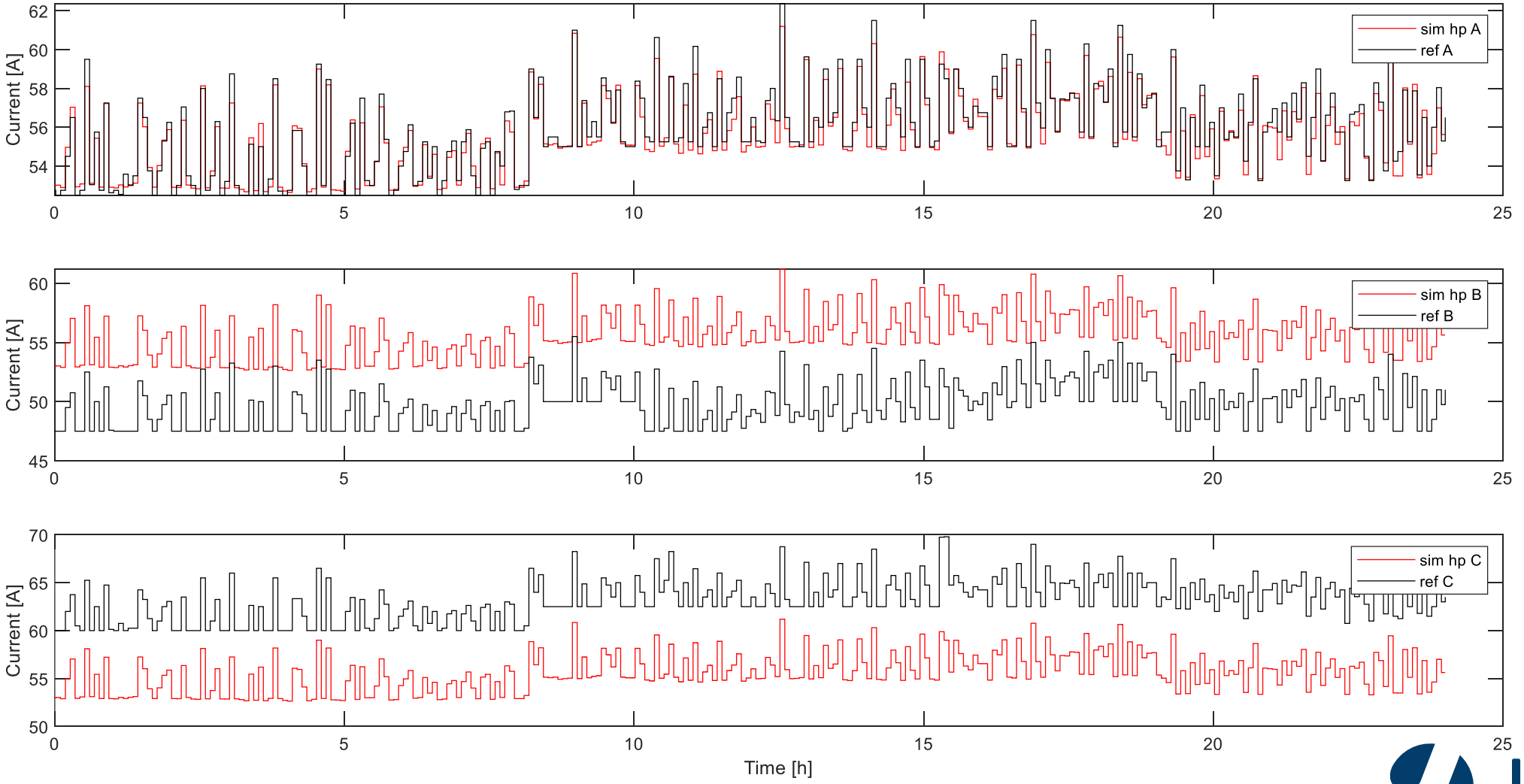
SIMULINK MODEL

Voltage profile example



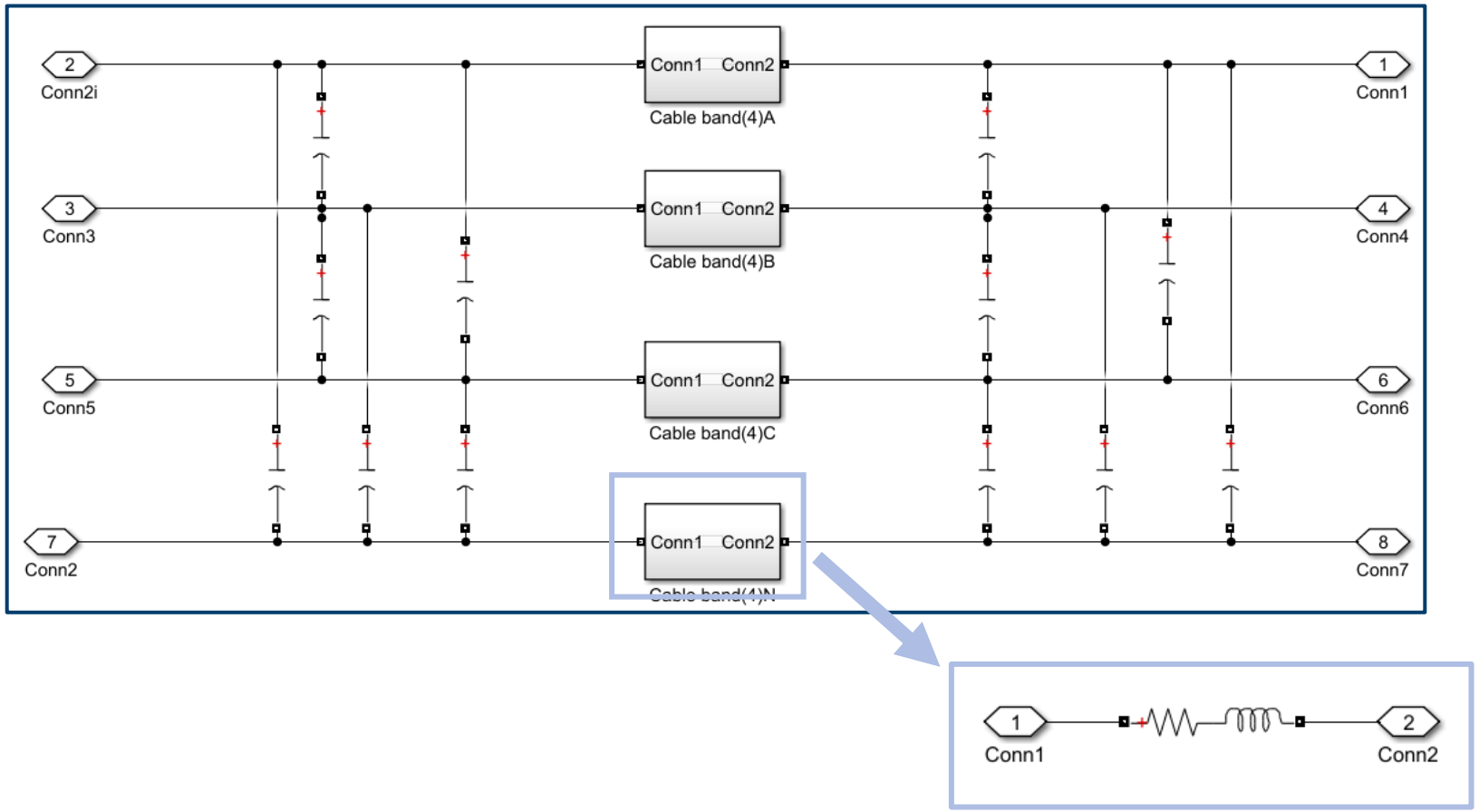
SIMULINK MODEL

Unbalanced loads example



SIMULINK MODEL

Focus on power cables



SIMULINK MODEL

Time step considerations

Starting timestep
500 µs

Implementation of SSN blocks

SSN blocks [#]	Groups [#]	Time step [µs]
6	19	900
5	19	550
2	16	200
2	3	150

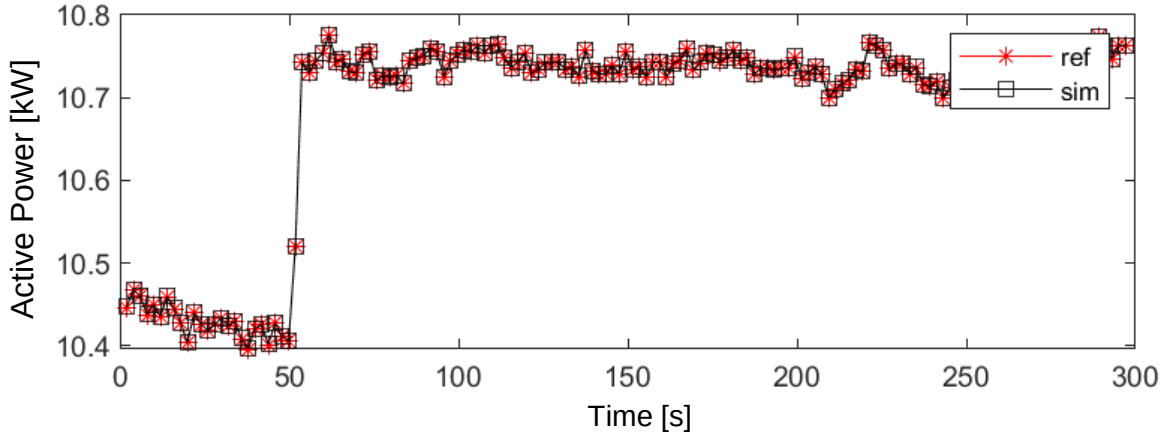
Decoupling (Stubline-based transformers or others)

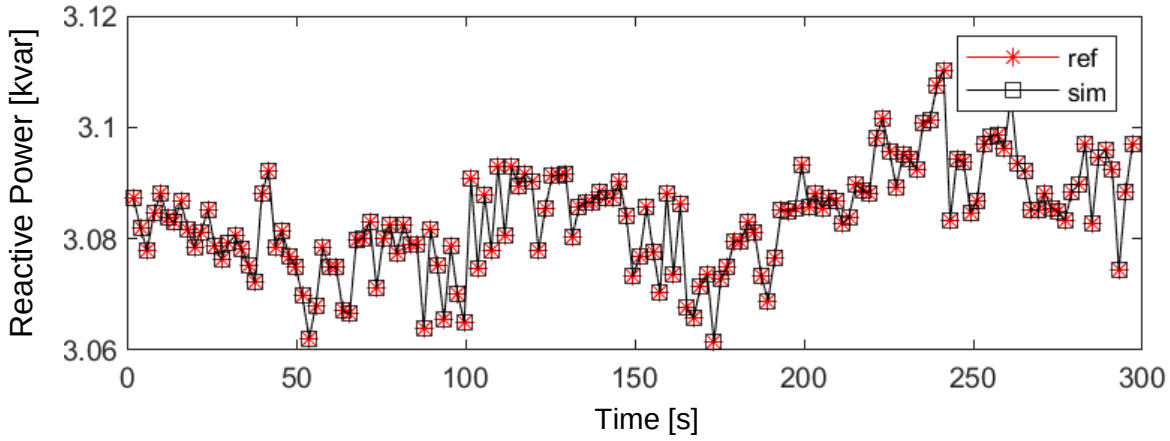
Final timestep
<100 us

SIMULINK MODEL

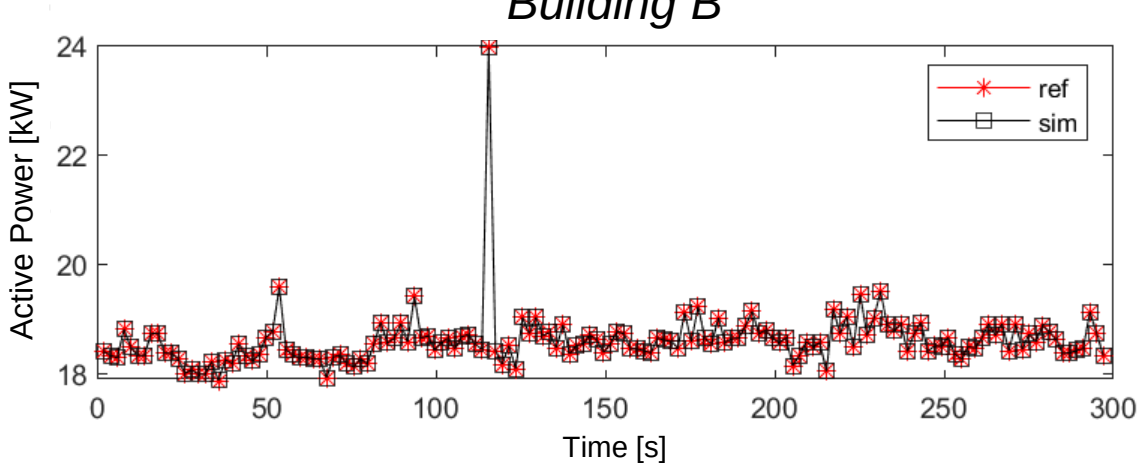
Validation

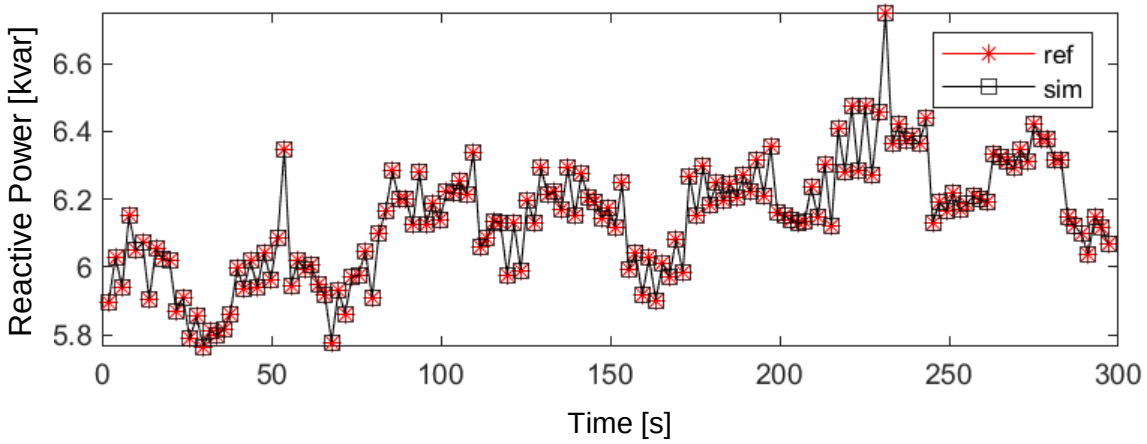
Building A





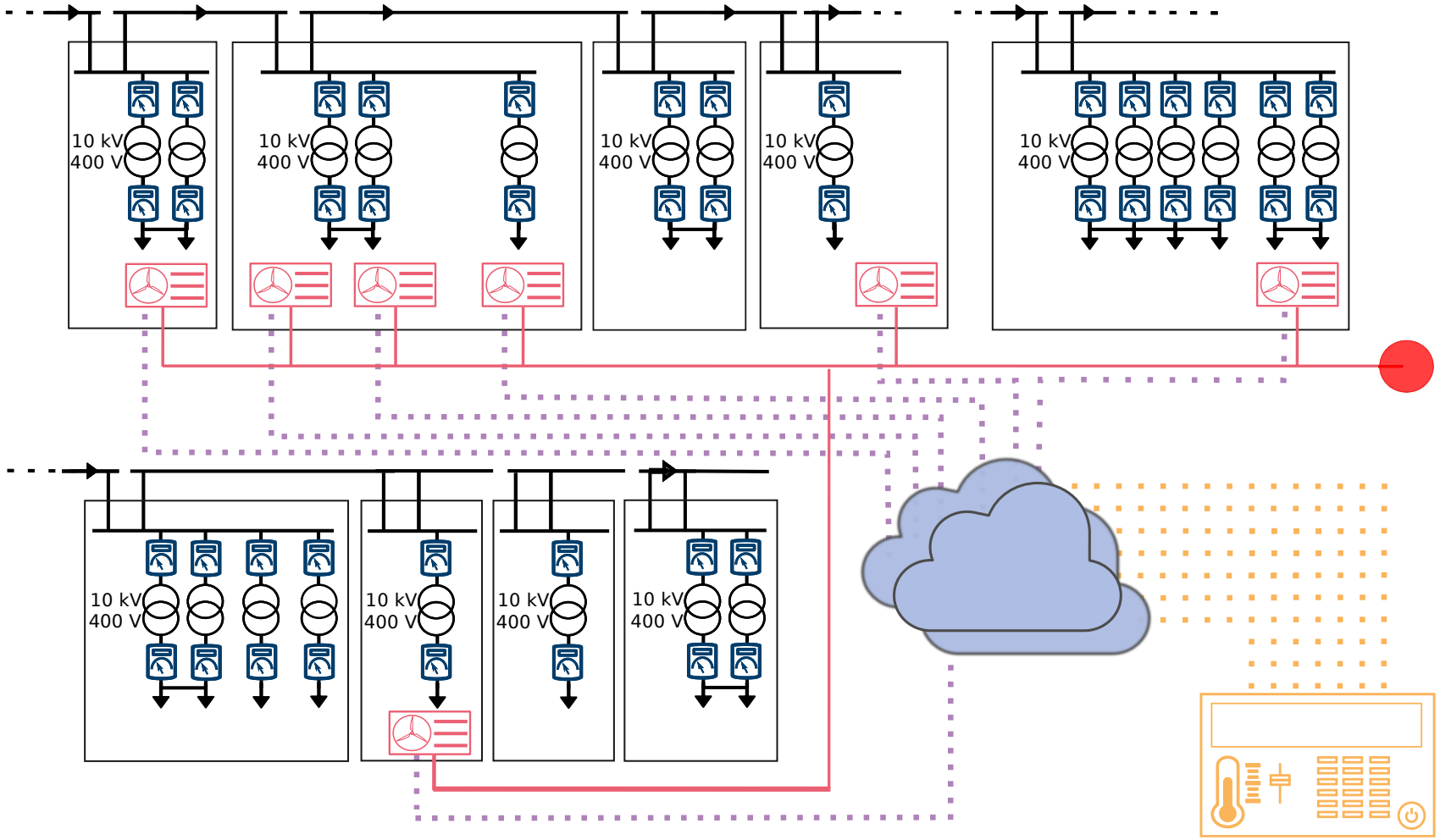
Building B





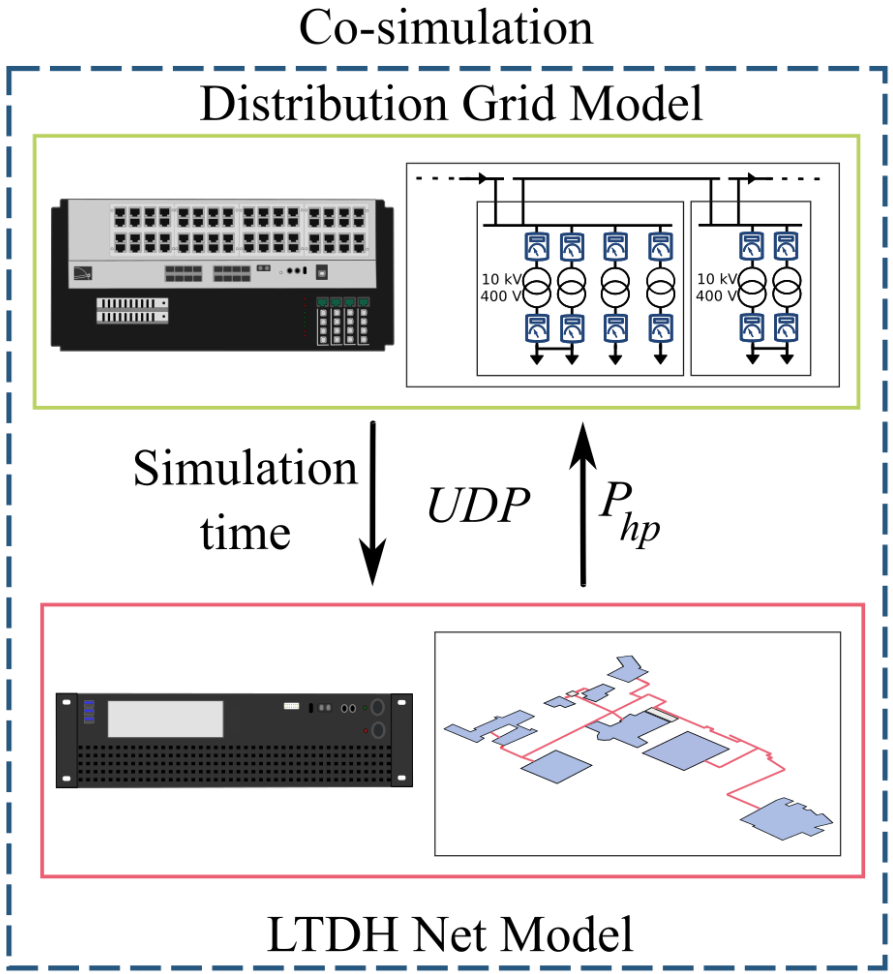
APPLICATION

Test of multi-modal energy systems



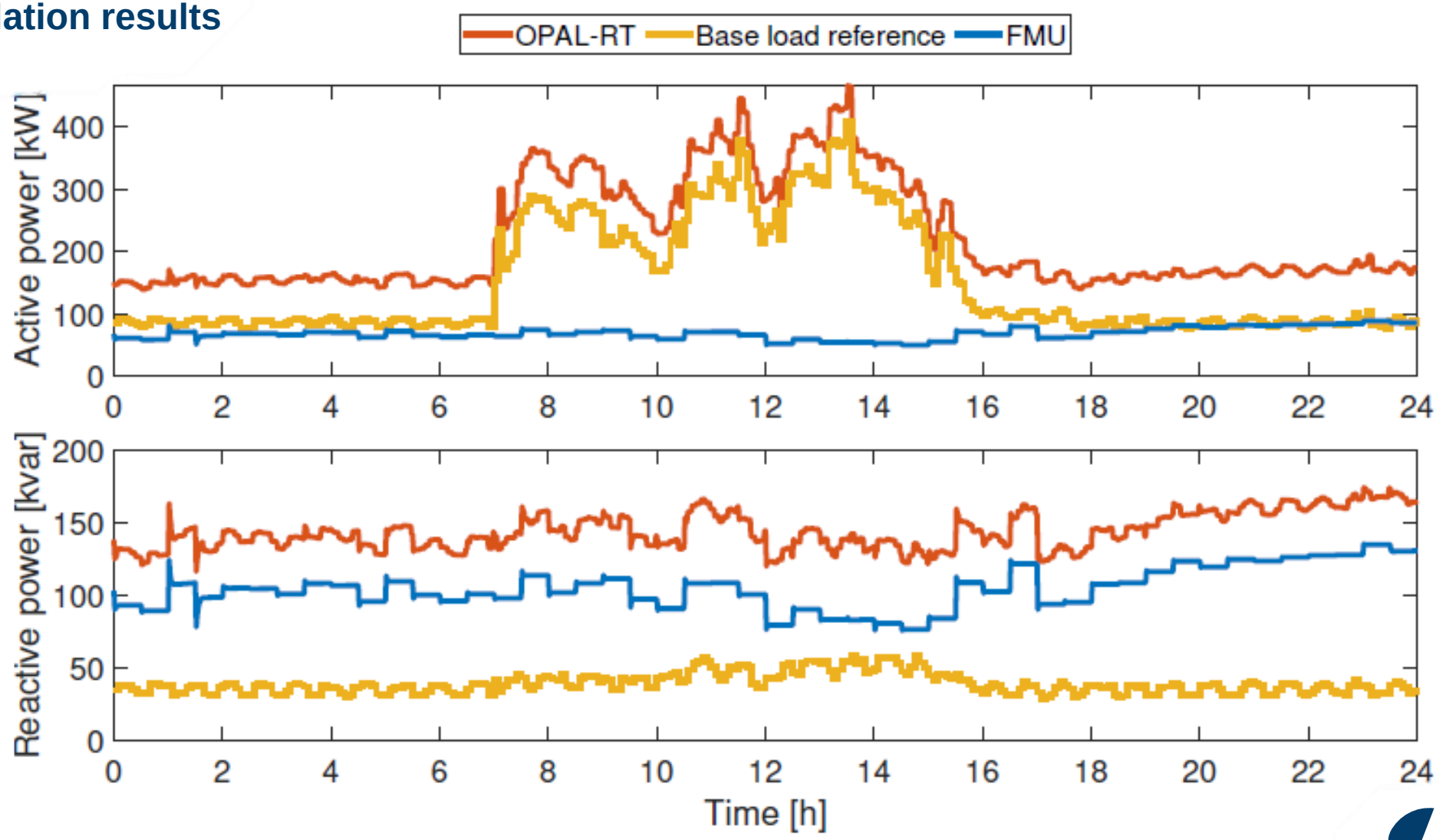
APPLICATION

Co-simulation architecture



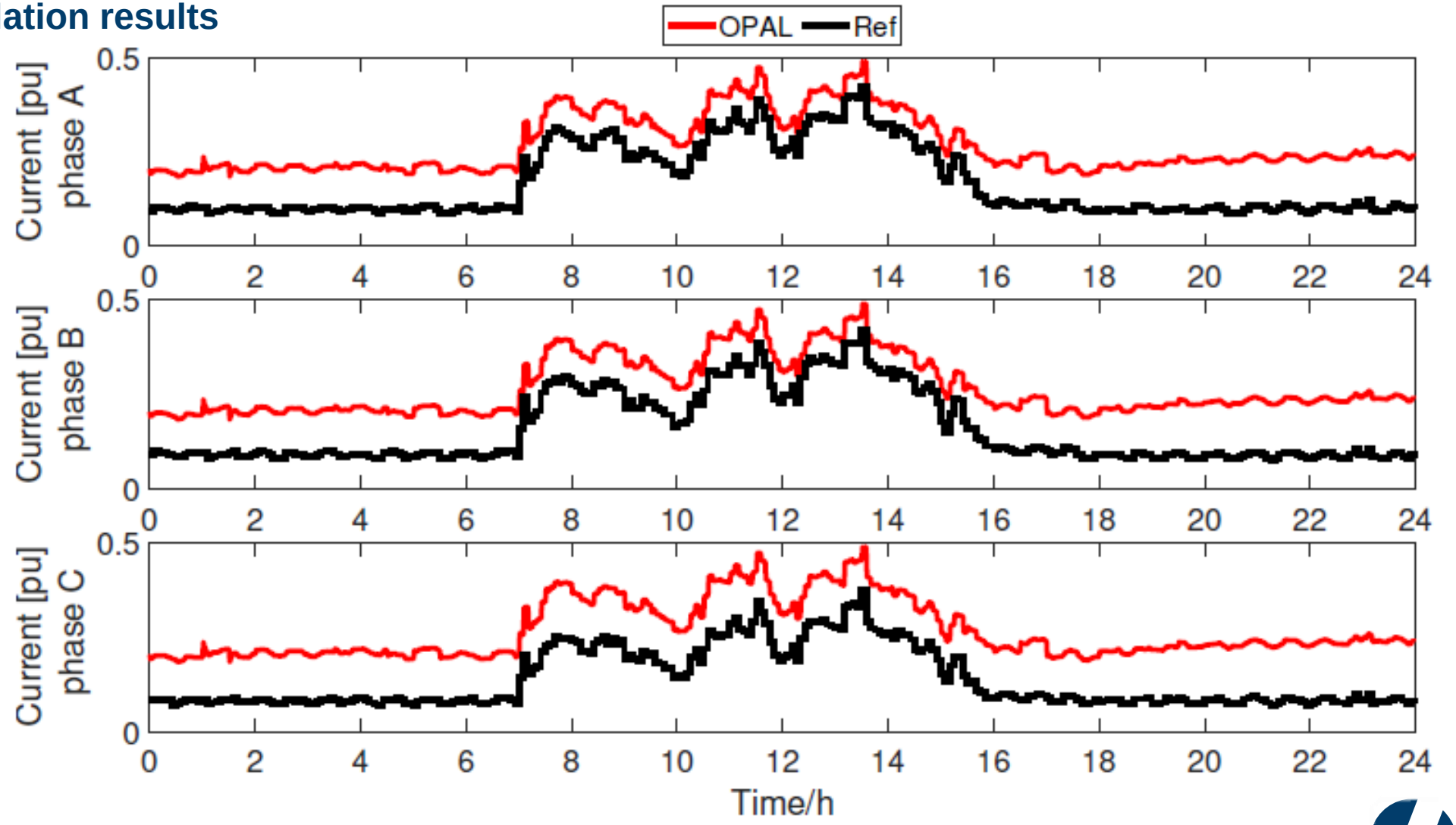
APPLICATION

Co-simulation results



APPLICATION

Co-simulation results



CONCLUSIONS

Development

- suitable data are required

Validation

- must consider all operating conditions of interest

Application

- various, from simple tests to planning studies

THANKS FOR THE ATTENTION

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