# Wie testet man Regler für Reallabore?

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AI4Grids Symposium
Konstanz, 26. September 2023
www.ise.fraunhofer.de

# Agenda

1. Motivation: Why digital grid?
2. Hardware-in-the-Loop Testing
3. Testing Grid Control
4. AI4Grids Test Environment


 

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# Motivation - Why Digital Grids?

 

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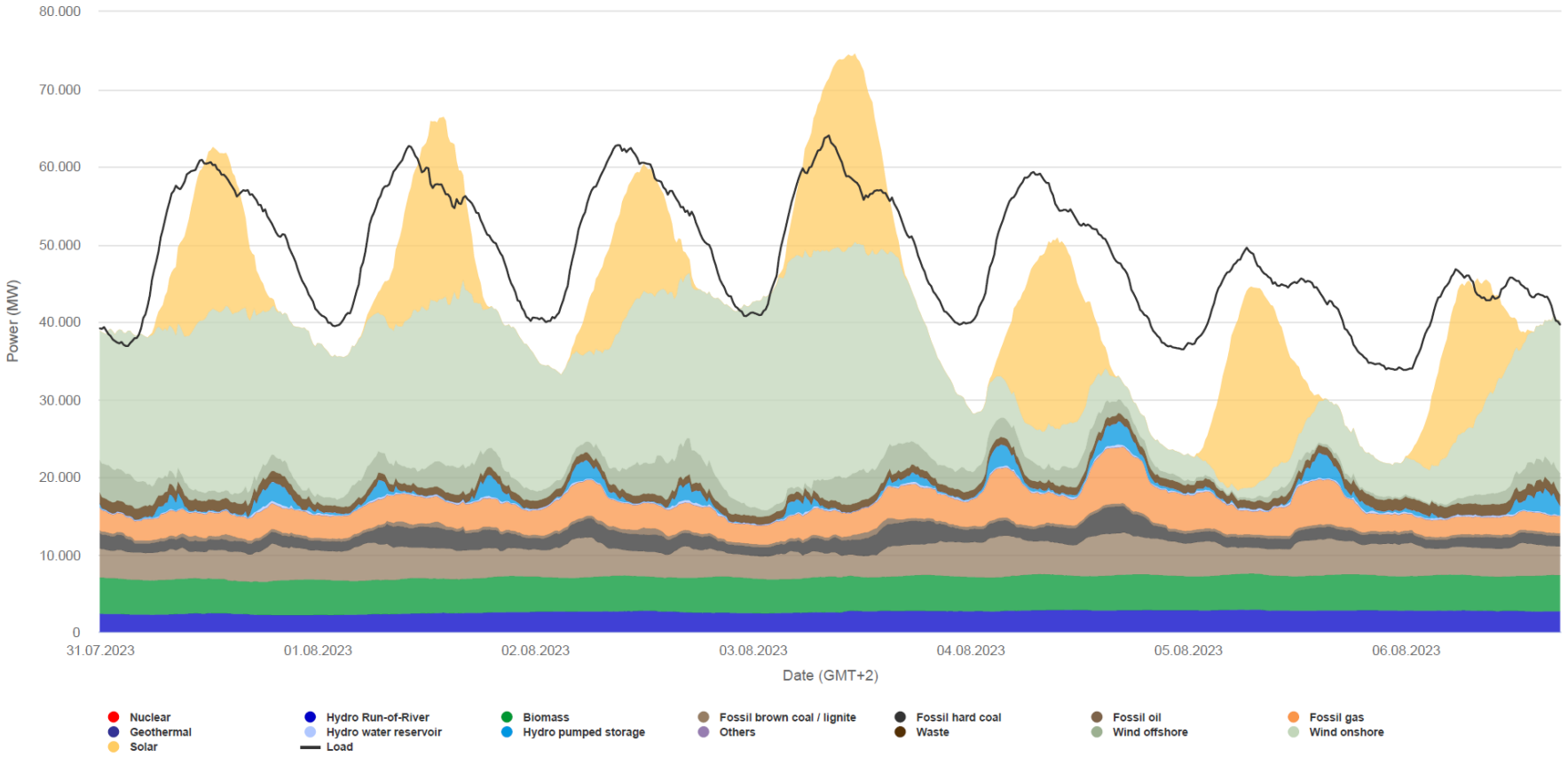
# Motivation

## Power Production in Germany week 31 2023




Renewable share:

2022: 50%

Week 31 2023: 65 – 82 %

Electricity Generation and Consumption must be balanced.

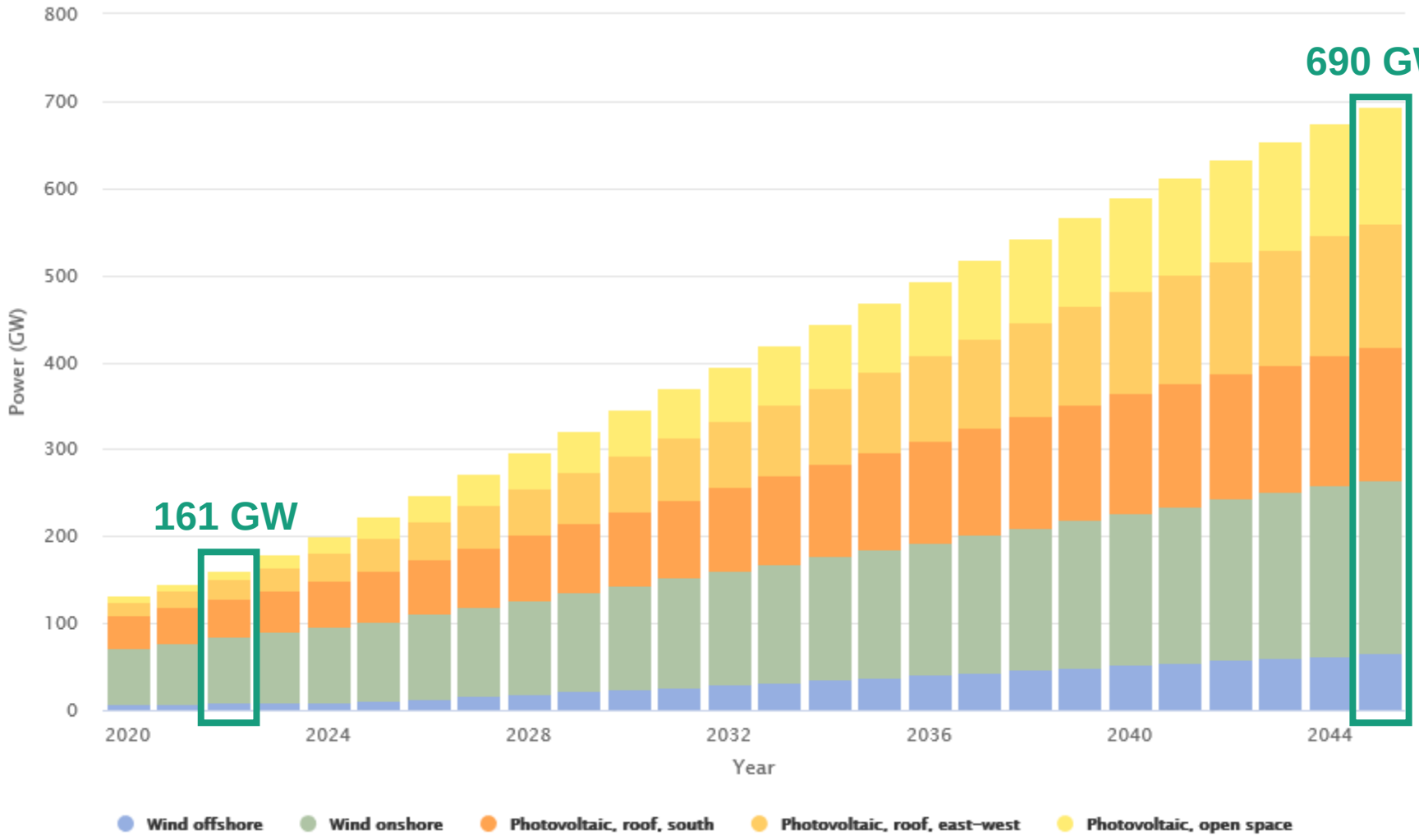
Target is 100% renewable!

Source: https://energy-charts.info

# Motivation

## Installed Capacity of variable Renewables




Energy Scenario 2045

Increase of

PV 77 GW → 425 GW (x 5,5)

Wind 84 GW → 265 GW (x 3)

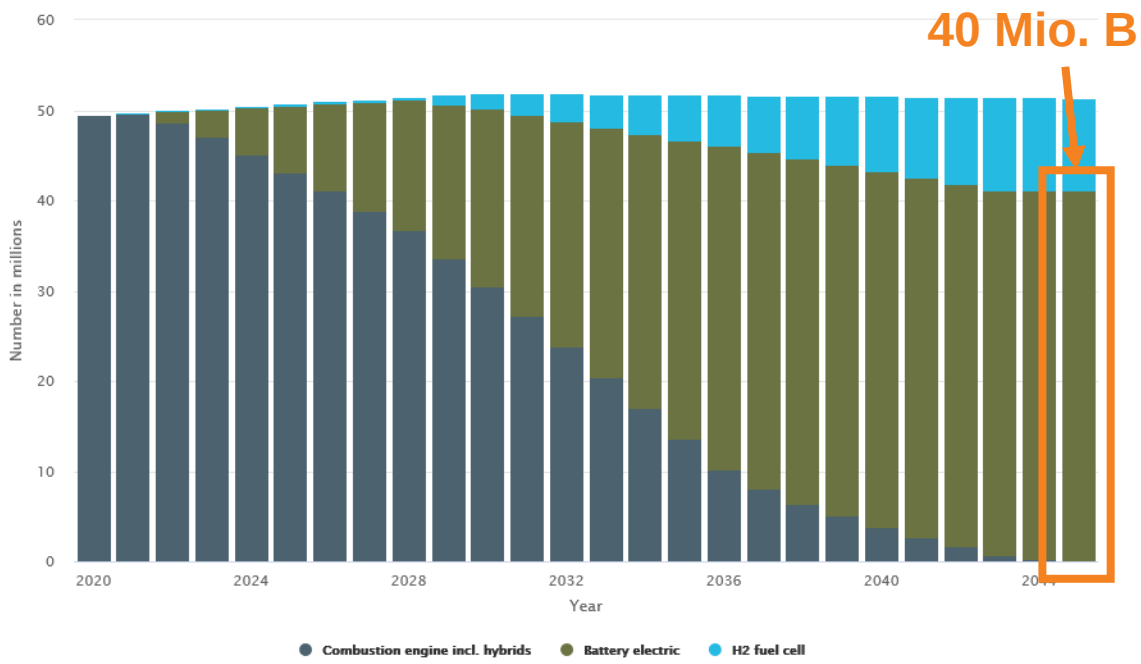
 

Source: https://energy-charts.info

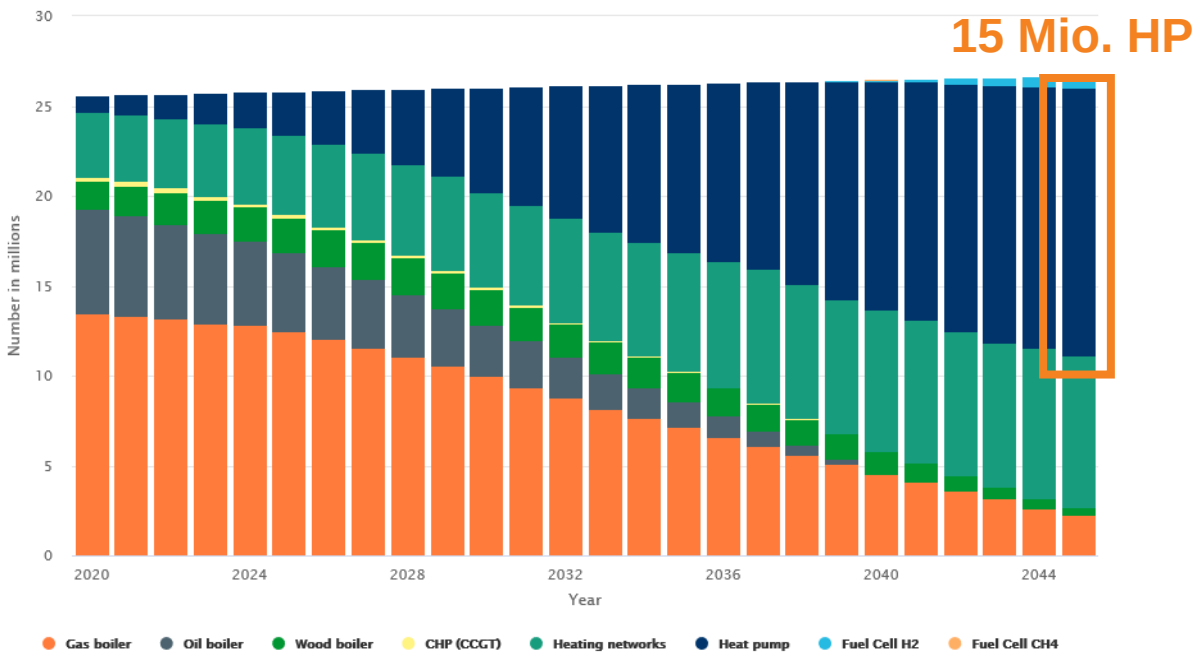
# Motivation

## Electrification of other Sectors

### Technologies in passenger Traffic




### Building Heating Technologies




### 40 Mio. Battery Electric Vehicle (BEV)

x 10 kW = 400 GW connection power

x 50 kWh = 2 TWh battery capacity

### 15 Mio Heat Pumps (HP)

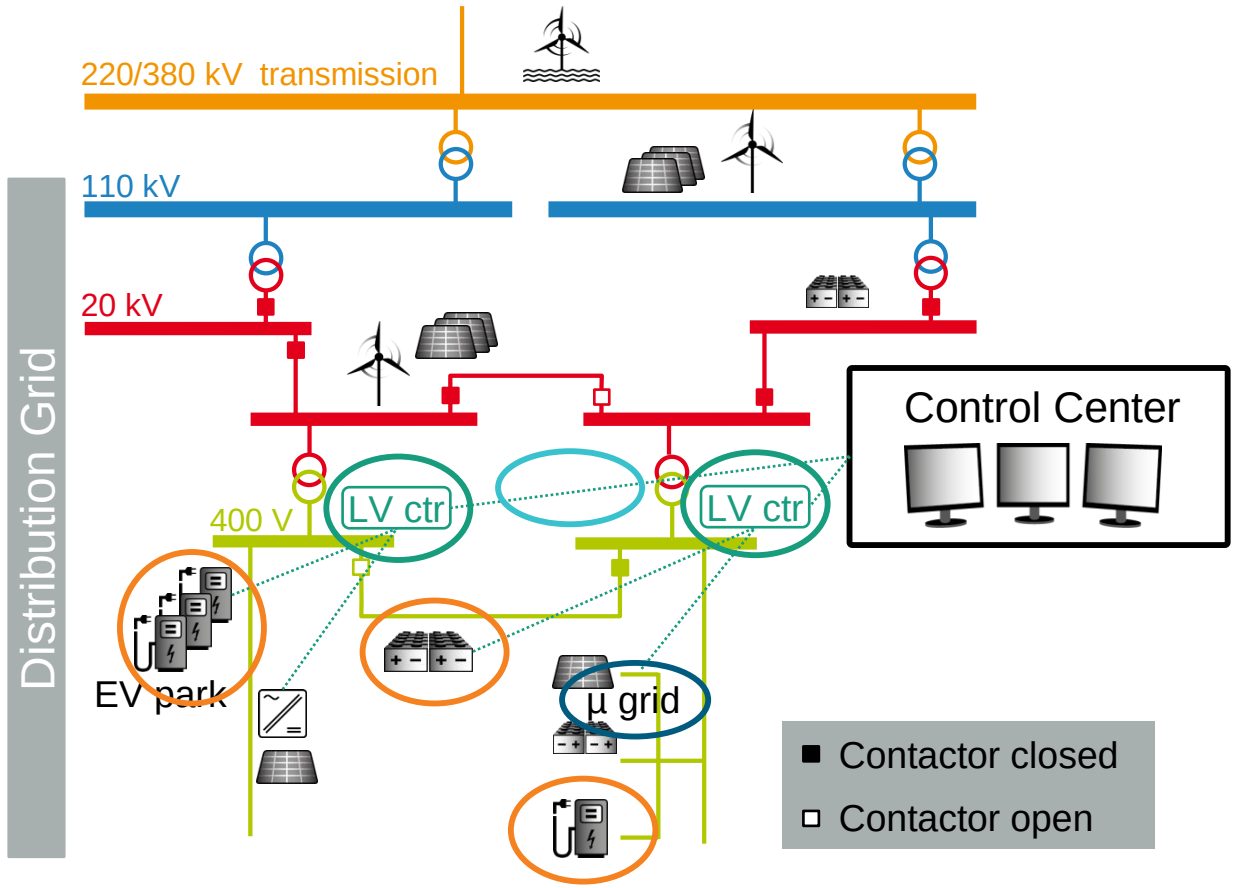
x 5 kW = 75 GW connection power

Source: https://energy-charts.info

# Smart Grid Control

## Motivation




Low voltage controller

energy management (µ grid)

System Component

e.g. EV Supply Equipment, Battery Systems

Communication Interfaces

e.g. Smart Meter, Electric Vehicle

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# Digital Grid:
# Loads must be controlled system oriented!

 

# Hardware-in-the-Loop Test

 

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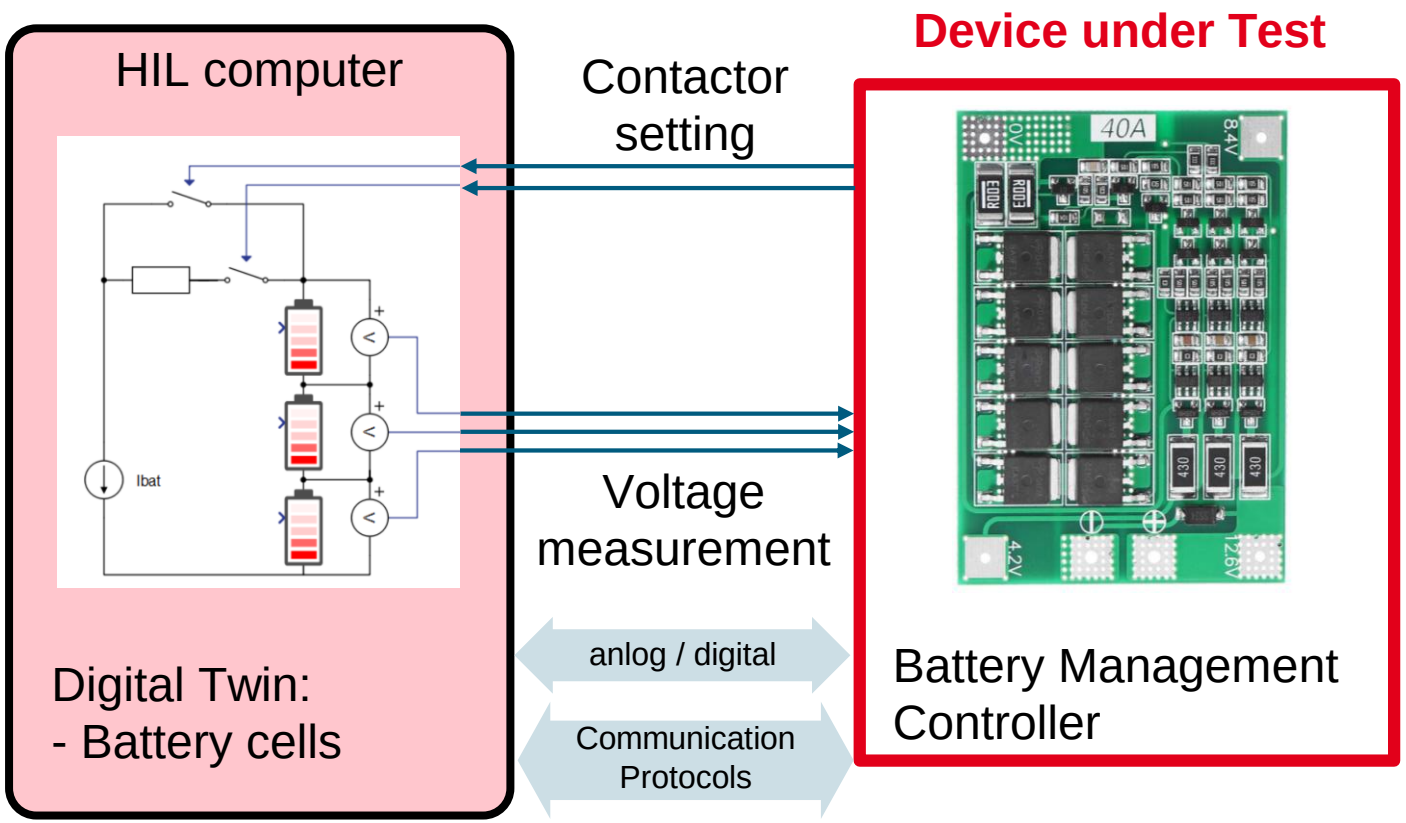
# Hardware-in-the-Loop (HIL)

## Example Battery Management System




### Device under Test

Prototype controller board

### HIL Computer

Model (digital twin) of power part

Emulation of measurements

Evaluation real time signals

### Benefit

Testing without risk

Faster development

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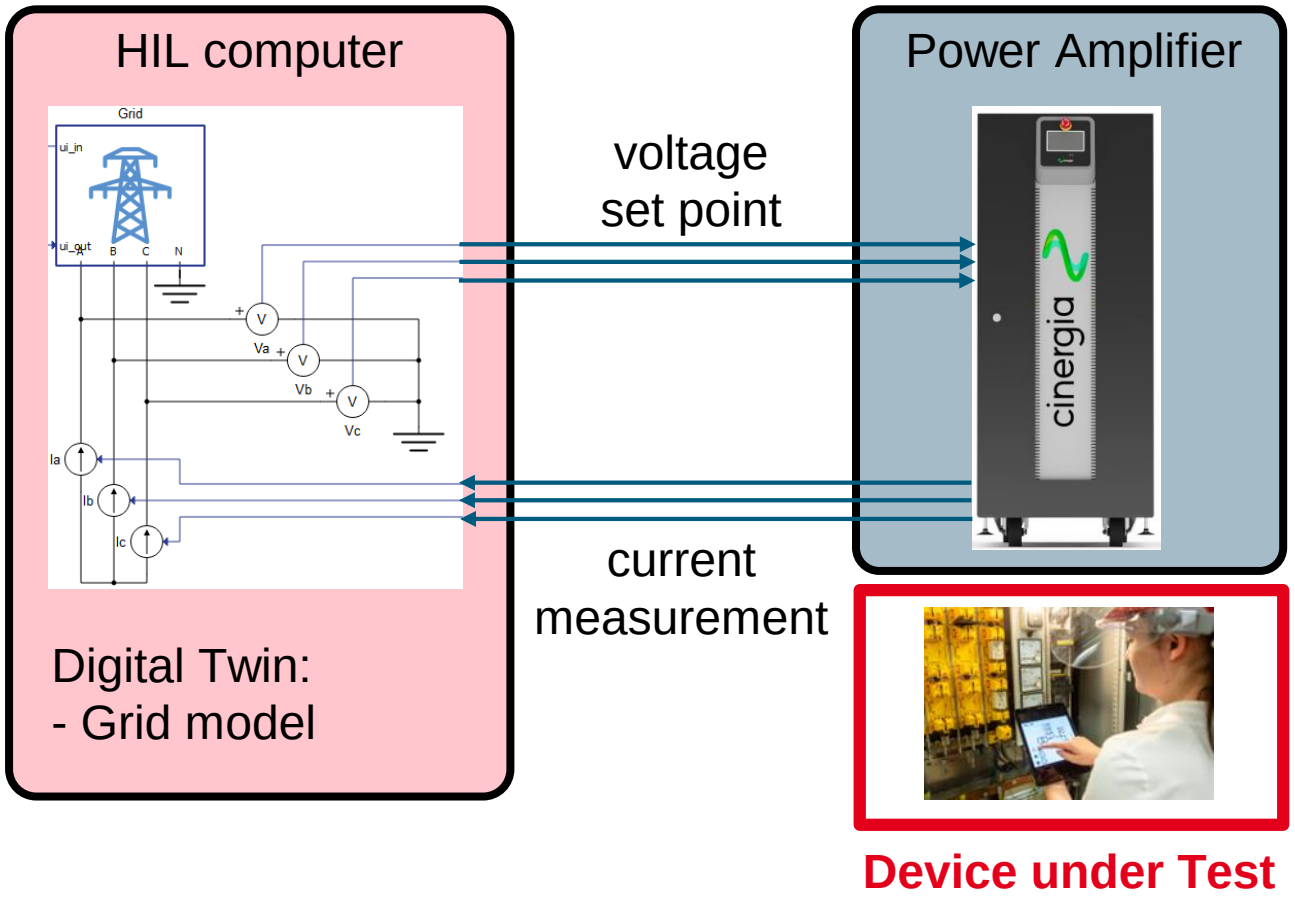
# Power Hardware-in-the-Loop (P-HIL)

## Example Grid Emulation




### Device under Test

Real hardware (prototype)

### HIL Computer

Model (digital twin) of power grid

### Power Amplifier

Interface between HIL computer and DuT

Include current measurement into digital twin

Voltage set points to power amplifier

### Benefit

Testing in critical situations

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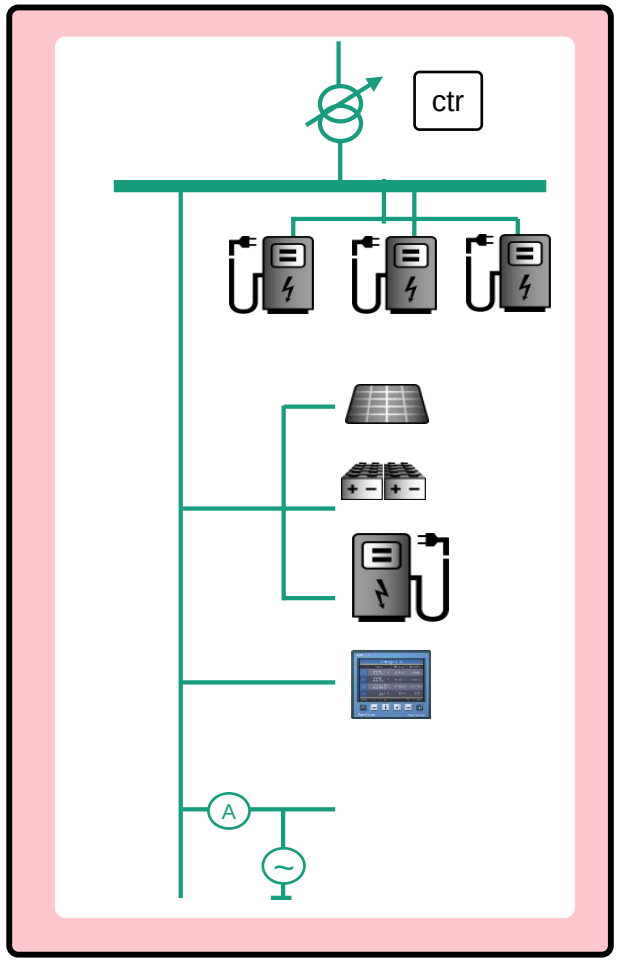


# Testting Grid Control

 

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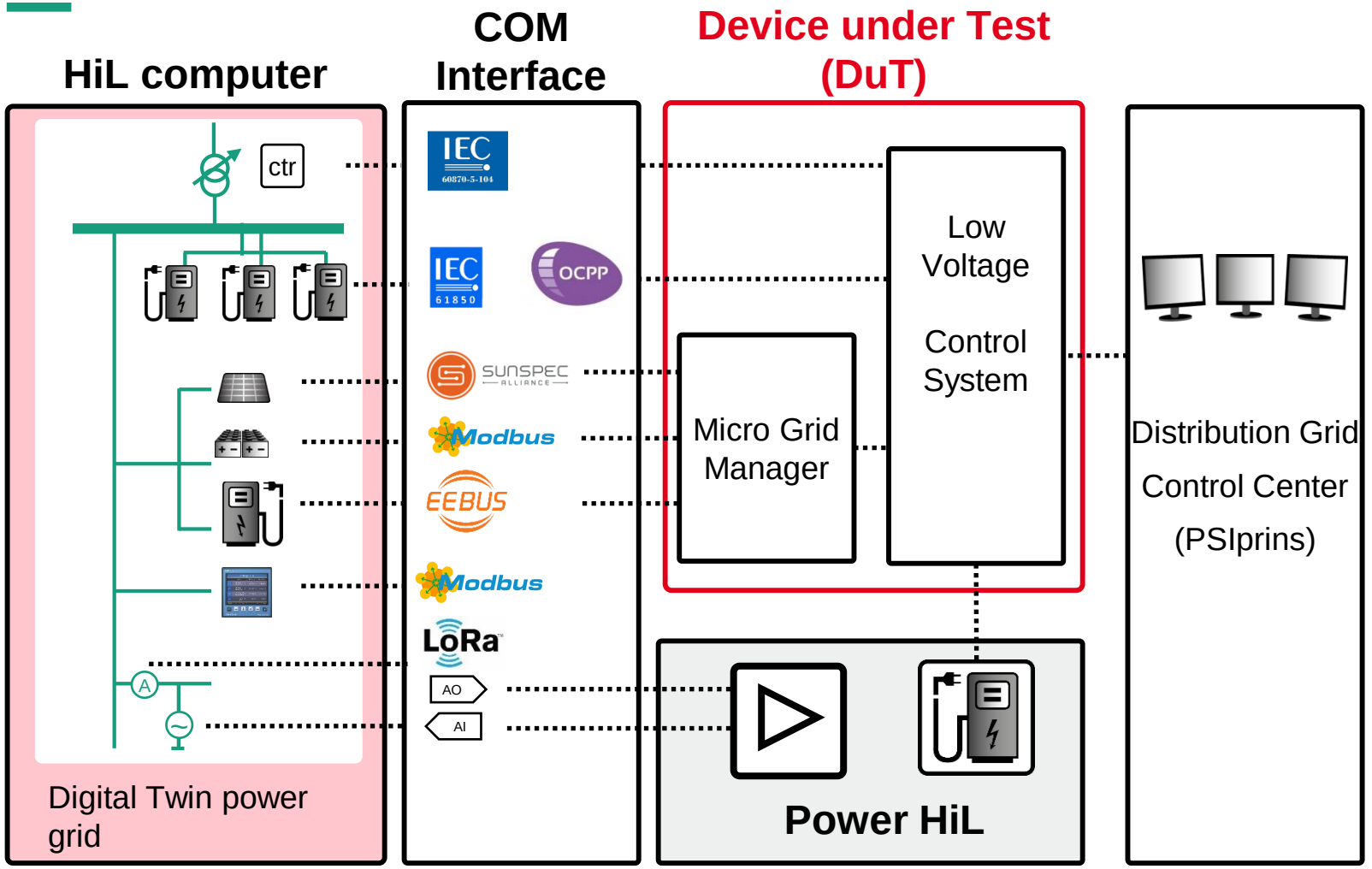
# Low Voltage Grid Control

## Test Setup




HiL-Computer hosts low voltage grid digital twin

Connection to DuT

COM Interface (Communication)

Power-HiL (real Hardware)

Connect to Distribution Grid Control Center

Device under Test

LV Control System

Micro Grid Manager

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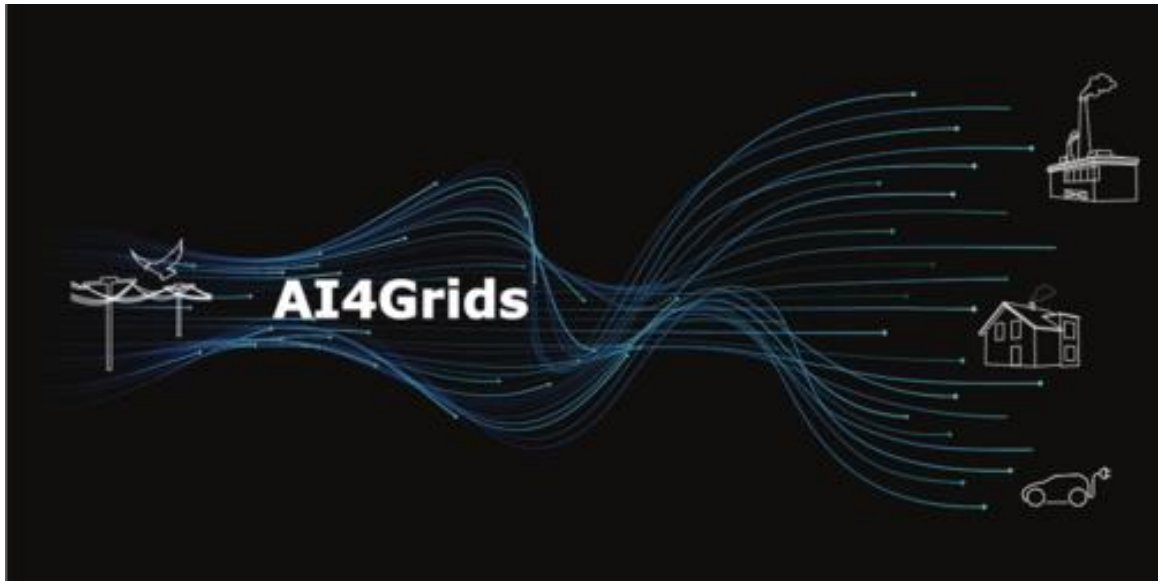


# AI4Grids Test Environment

 

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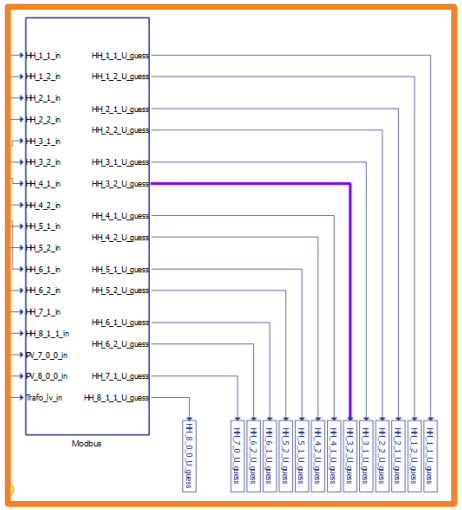
# AI4Grids Test Environment

## Real Time Model Allensbach

Modbus Interface

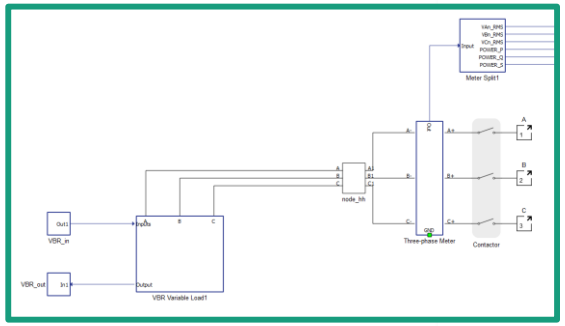


measurement

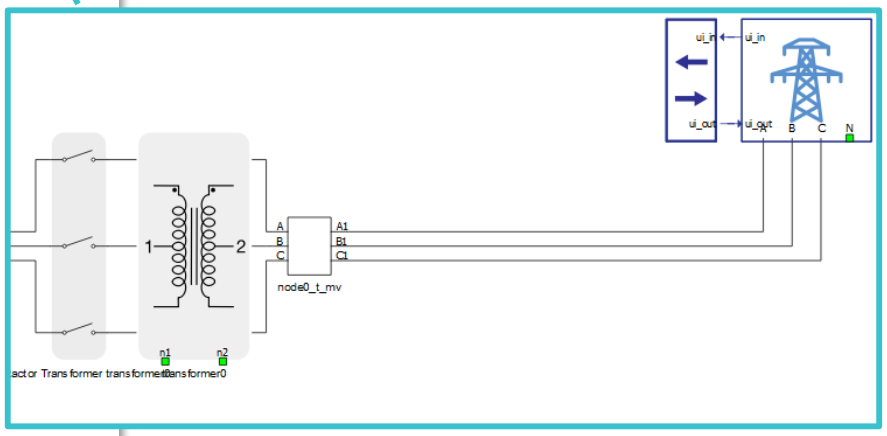
AI4Grids

Set points

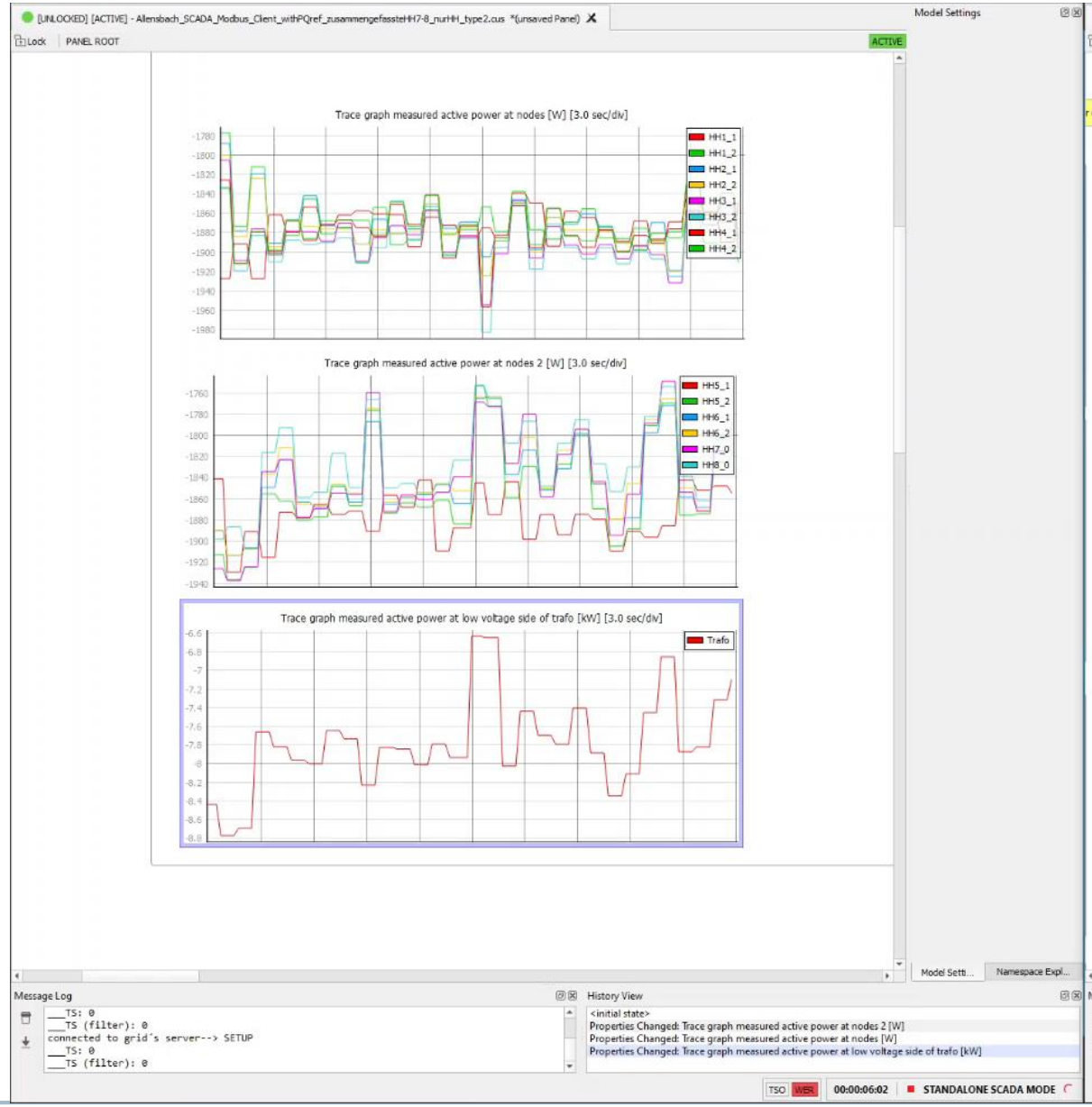
House with PV



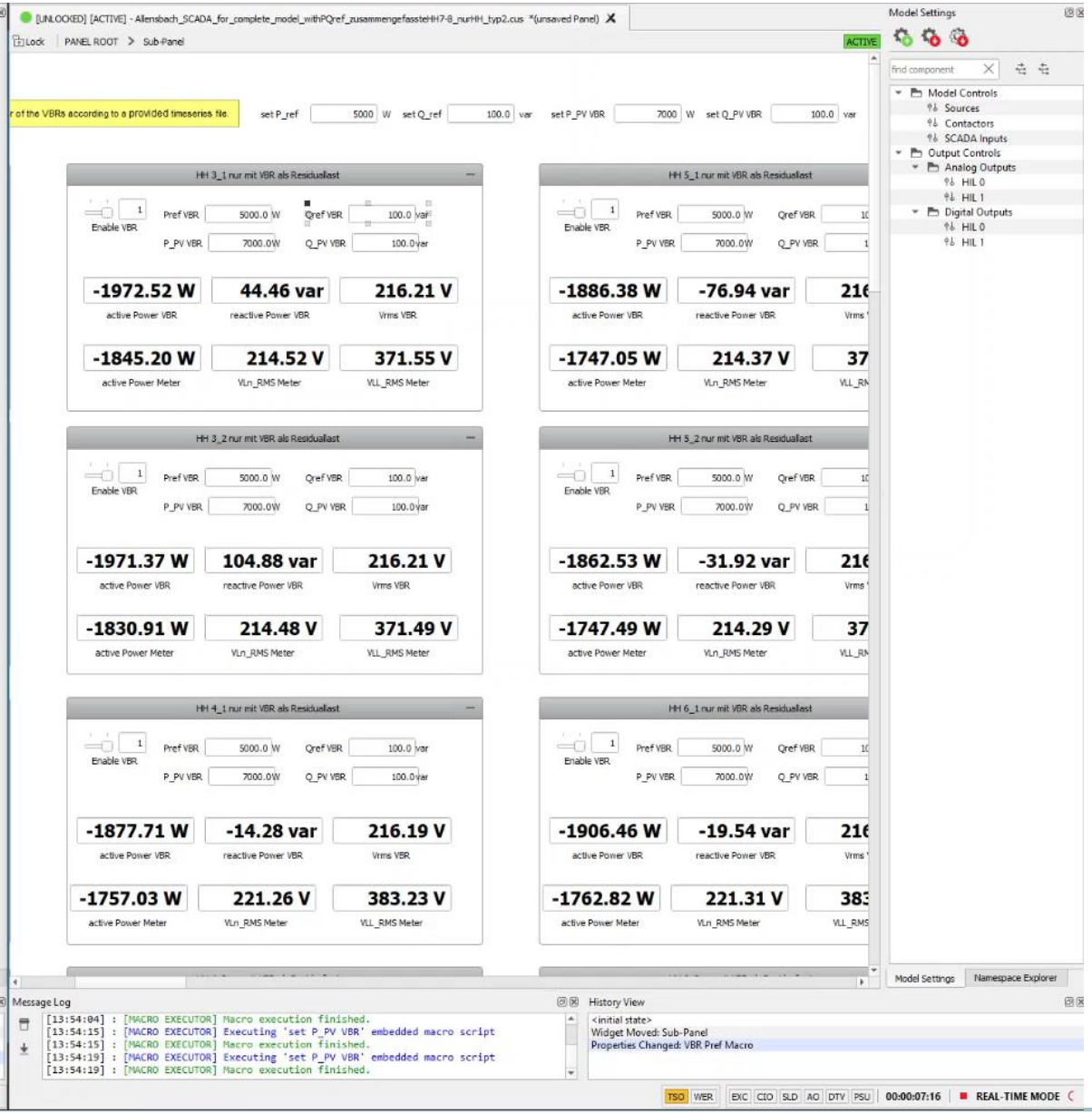
Grid Connection



# Interface Modbus Control




# Interface Realtime Model

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