Peer to Peer activity
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Planning and operating Net-Zero Energy Factory

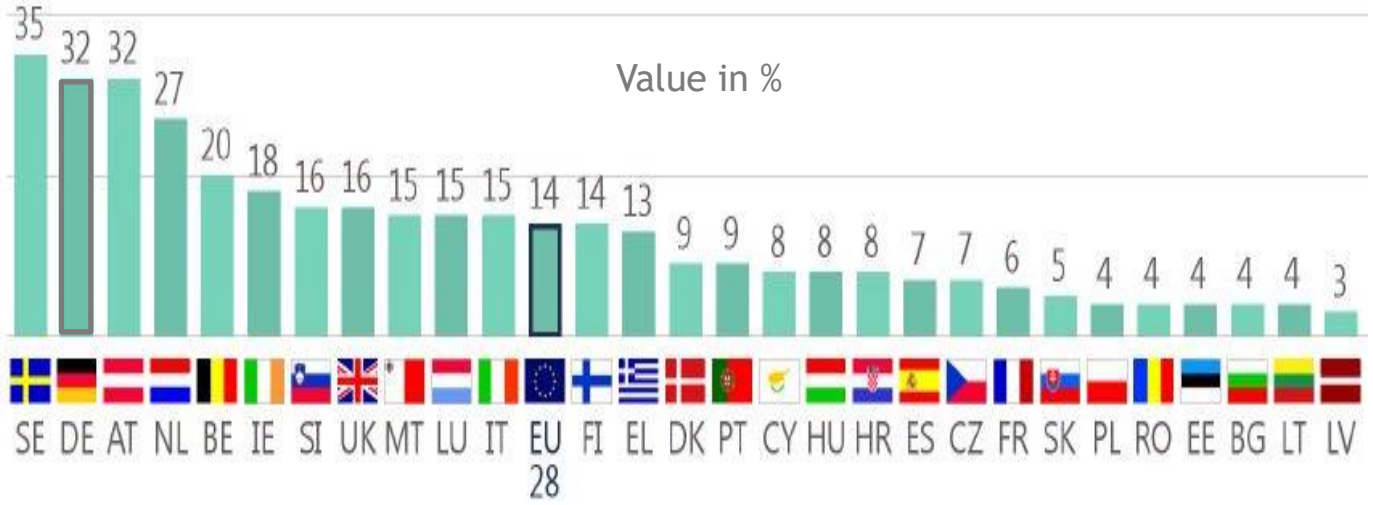
PROSPECT2030 | HSMD | Prof. P. Komarnicki, Dr. P. Lombardi, Dr. B. Arendarski

AGENDA

- Motivation
- Aim of the Project
- Net-Zero Energy Factory
- First results

MOTIVATION

- Integration of volatile RES in EU SMEs



Quelle: European Commission „Flash Eurobarometer 456“

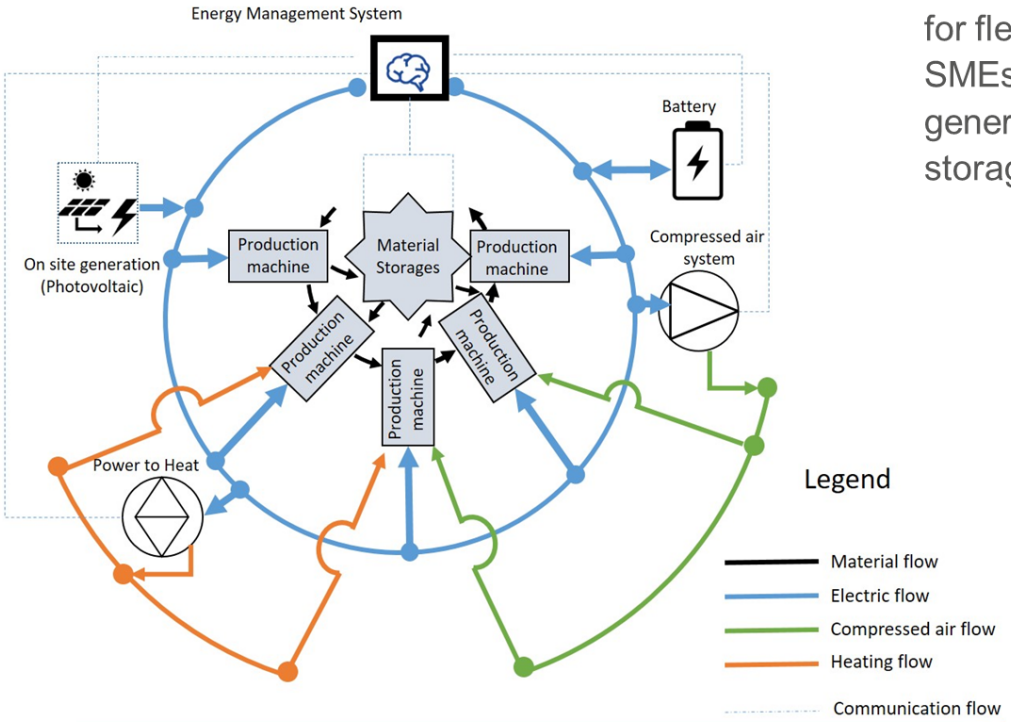
- Needed flexibility capacities to buffer the volatility of RES

Storage Systems

DSM/ DSR

Power-to-X

AIM OF THE PROJECT
NET ZERO ENERGY FACTORY CONCEPT



- Develop, test and evaluate new solutions and applications for flexibility of energy-relevant industry processes at SMEs through dynamic management of controllable loads, generation of renewable energies as well as energy storages.

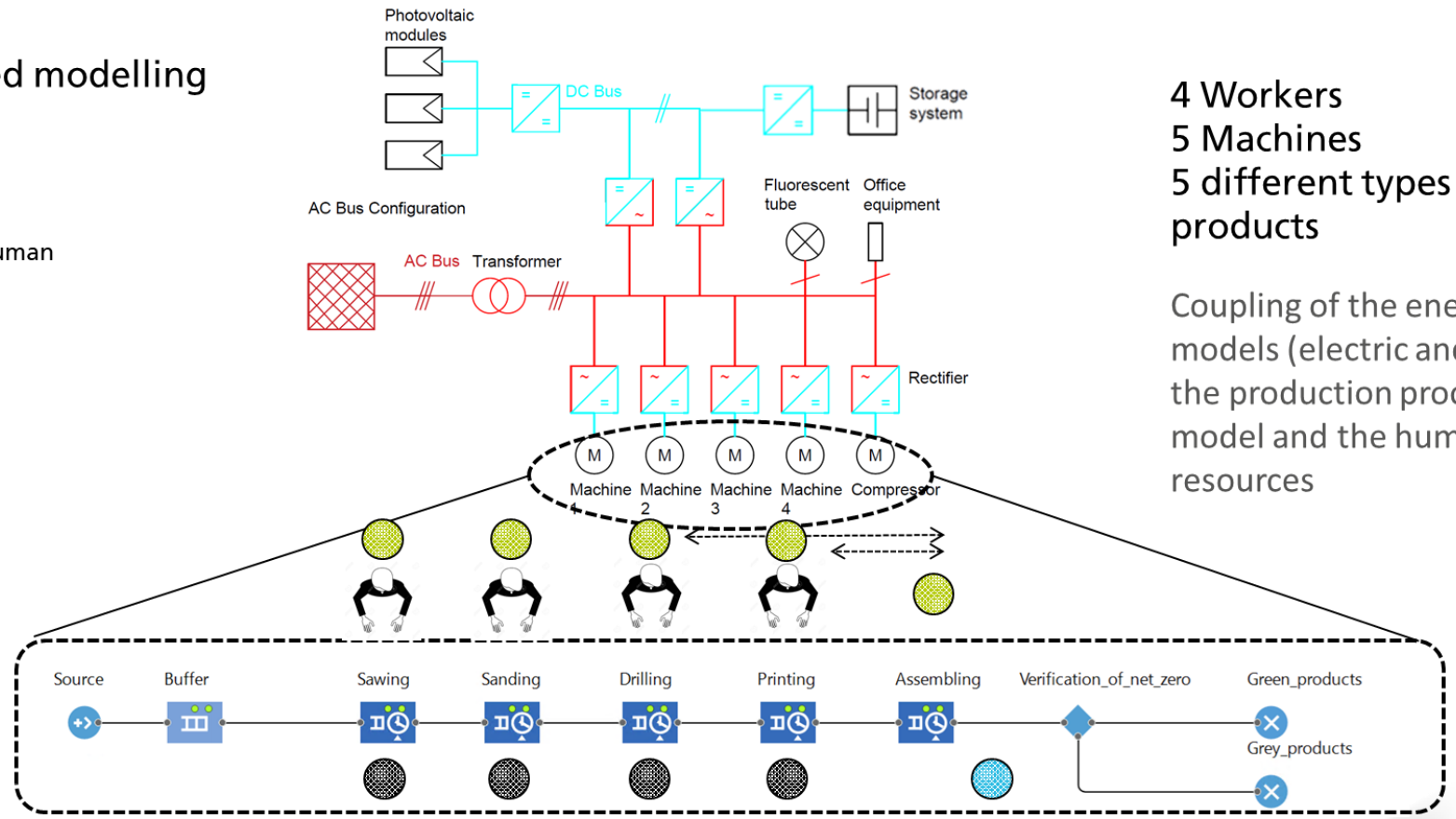
Exploitation of Flexibility through:

- Control of energy converters (i.e. P2H; P2G)
- Control of manufacturing process (i.e. speeding up and down, switching on and off)
- Material Storages
- Energy Storage systems
- Voltage Control of some loads - ST

IDENTIFICATION AND EVALUATION OF FLEXIBILITY WITHIN A NZEF

Agent based modelling

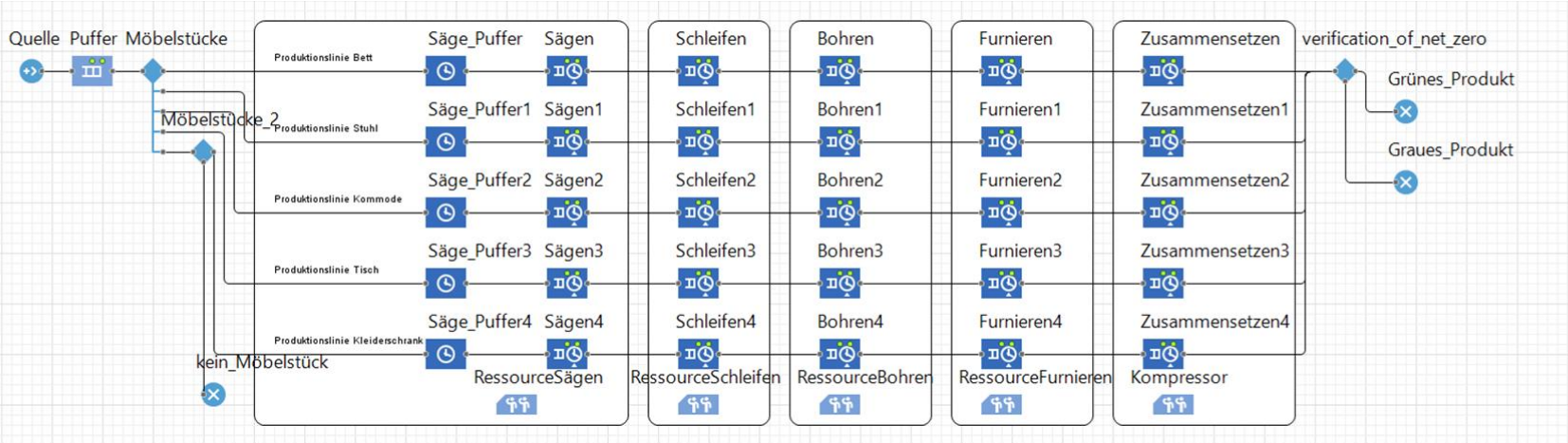
- Agent for production machines
- Agent for human resources
- Agent for compressed air system



4 Workers
5 Machines
5 different types of products

Coupling of the energy models (electric and heat), the production process model and the human resources

PRODUCTION PROCESS SIMULATION



$$O.F. = min \int_{t_1}^{t_2} \left(G_{RES}(t) - L_E(t) \right) \, dt$$

Constraints:

$$n_k \geq m_k \,, \qquad k = 1, \ldots, N$$

$$\sum_{k=1}^{N} n_k \geq m_{\text{tot}}$$

$$I_3(t) + I_4(t) + J_5(t) \leq 2$$

$N = 5$	Types of furniture
$G_{\text{RES}}(t)$	Power generated by PV
$L_{\text{E}}(t)$	Load for production
$T = [t_1, t_2]$	working period from t_1 to t_2,
m_k	minimum number of furniture of type k
m_{tot}	minimum total number of furniture types
n_k	number of furniture type k
t_5	time a worker needs to go from machine M_3 or M_4 to machine M_5

index function for machines M_3, M_4, M_5

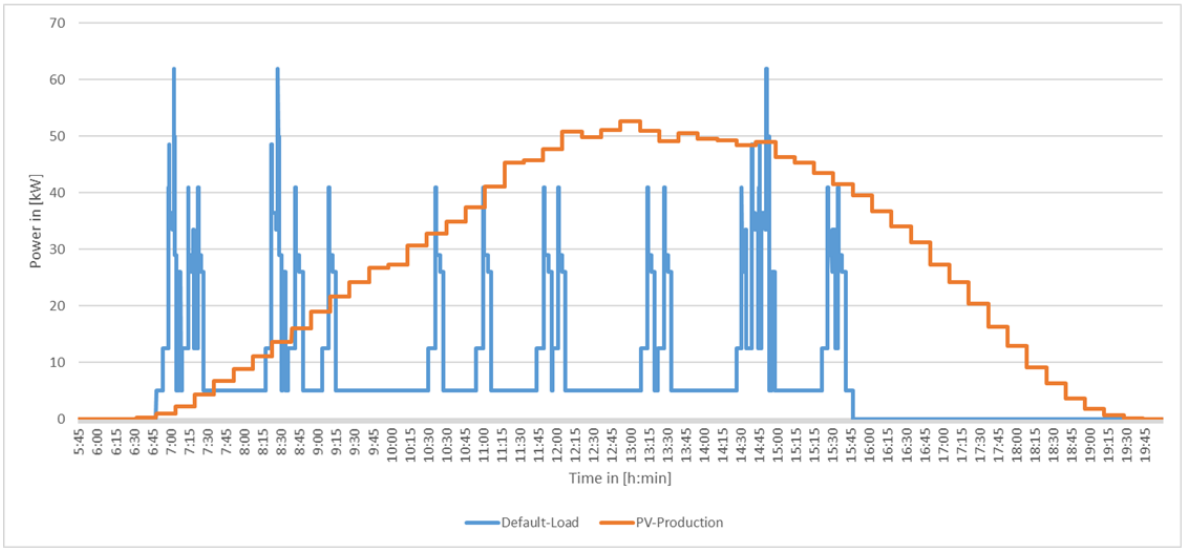
$$I_i(t) = \begin{cases} 1, & \text{if machine } M_i \text{ is working at time } t \\ 0, & \text{if machine } M_i \text{ is not working at time } t \end{cases}$$

extended index function for machine M_5 that includes the time a worker needs to move between machines M_3 and M_5 or M_4 and M_5

$$J_5(t) = \begin{cases} 1, & \text{if } I_i(t+\tau) = 1 \text{ for any } \tau \in [-t_5, t_5] \\ 0, & \text{elsewhere} \end{cases}$$

IDENTIFICATION AND EVALUATION OF FLEXIBILITY WITHIN A NZEF

- Default Scenario

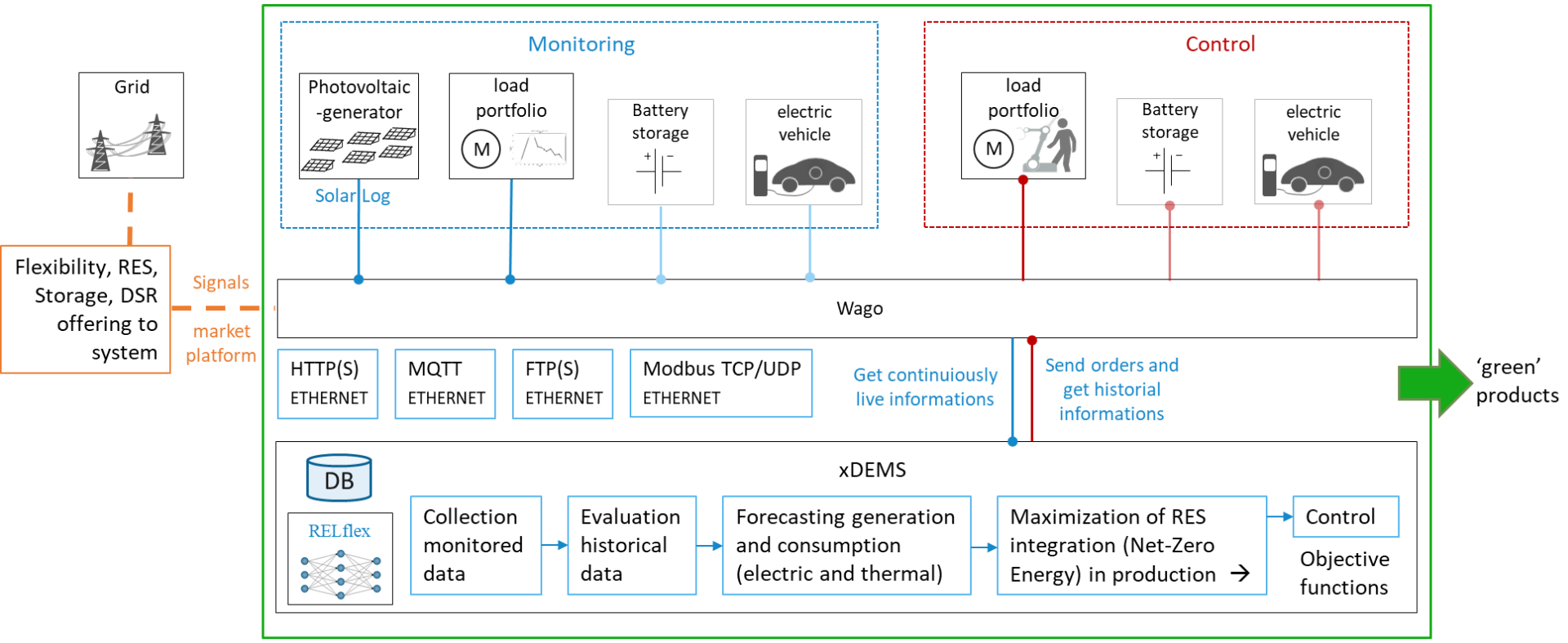


Production condition
- 7 green products
- 13 grey products

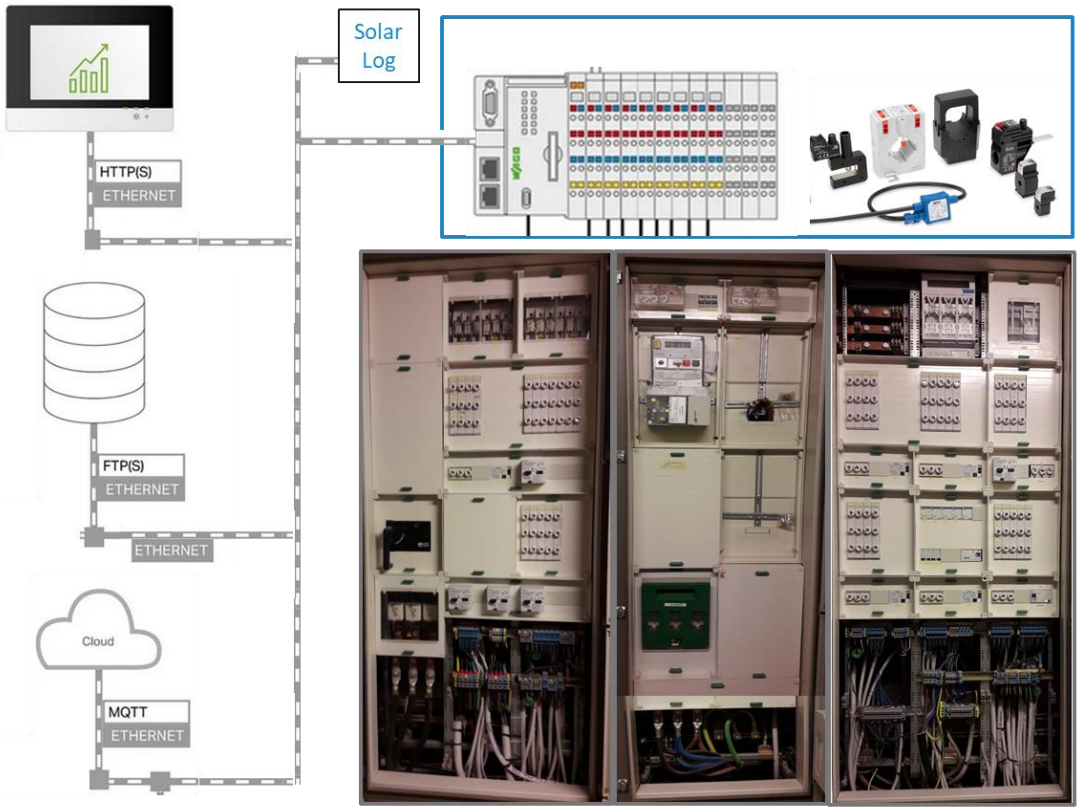
Furniture type
- 3x Bed
- 3x Chair
- 5x Chest of drawers
- 4x Table
- 5x Wardrobe

- Maximum power of the four machines and compressor is 81,5 kW
- Including of 5 kW flow fans (8h load over the operation time)
- Average product consumption is 5 kWh
- Electricity daily consumption 100,6 kWh
- To complete the production process 17,2 kWh energy was drawn from the grid

DEMO ICT ARCHITECTURE

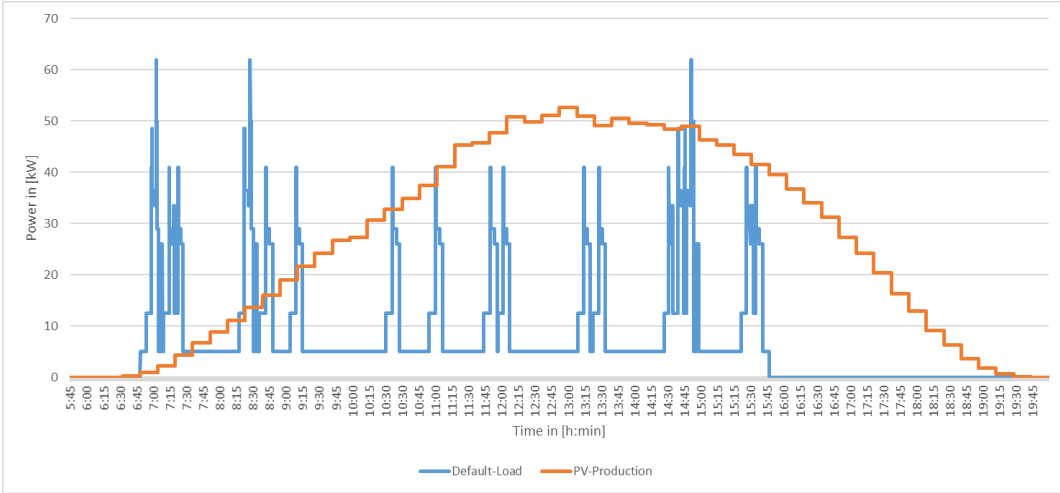


EXPANSION OF THE EXISTING INFRASTRUCTURE

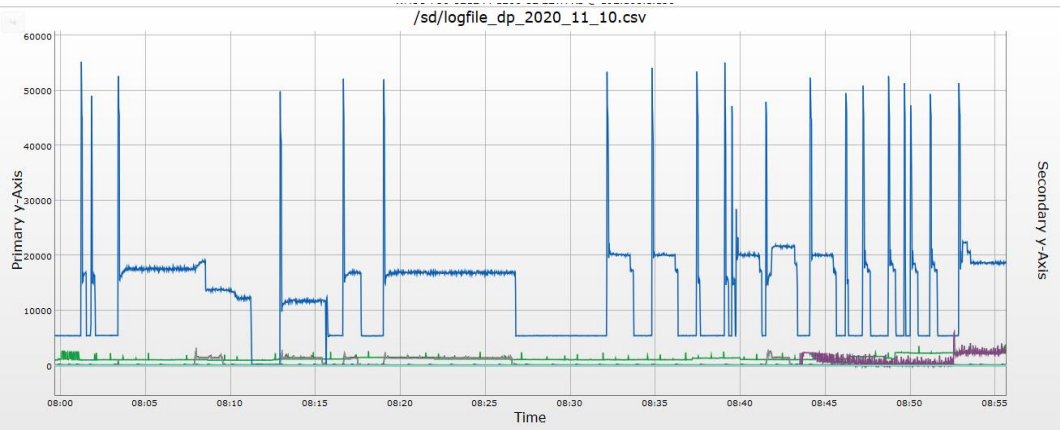


SIMULATION MODEL VS. REAL MEASUREMENTS

- Simulation model profile



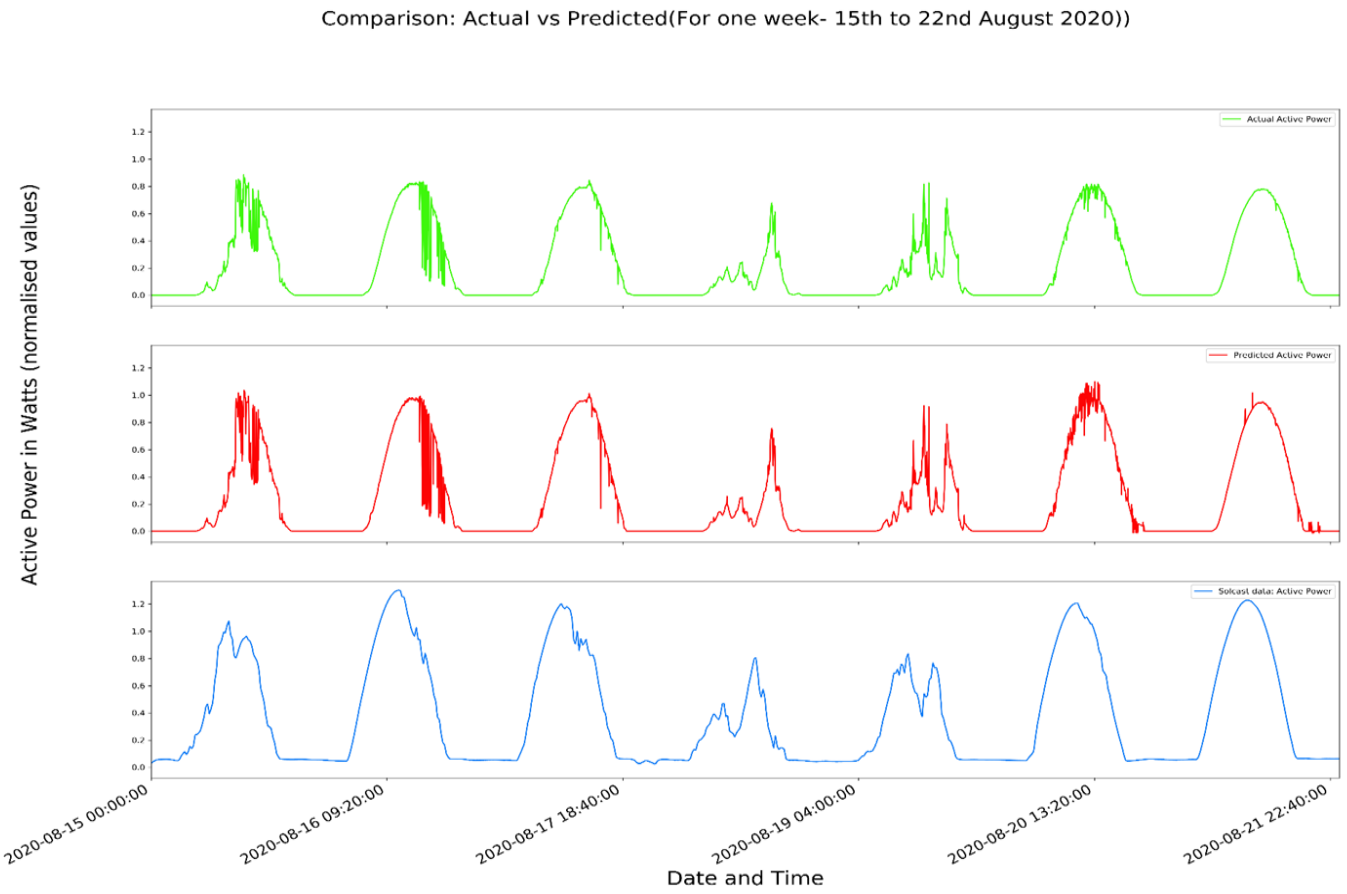
- Real measurement load profiles



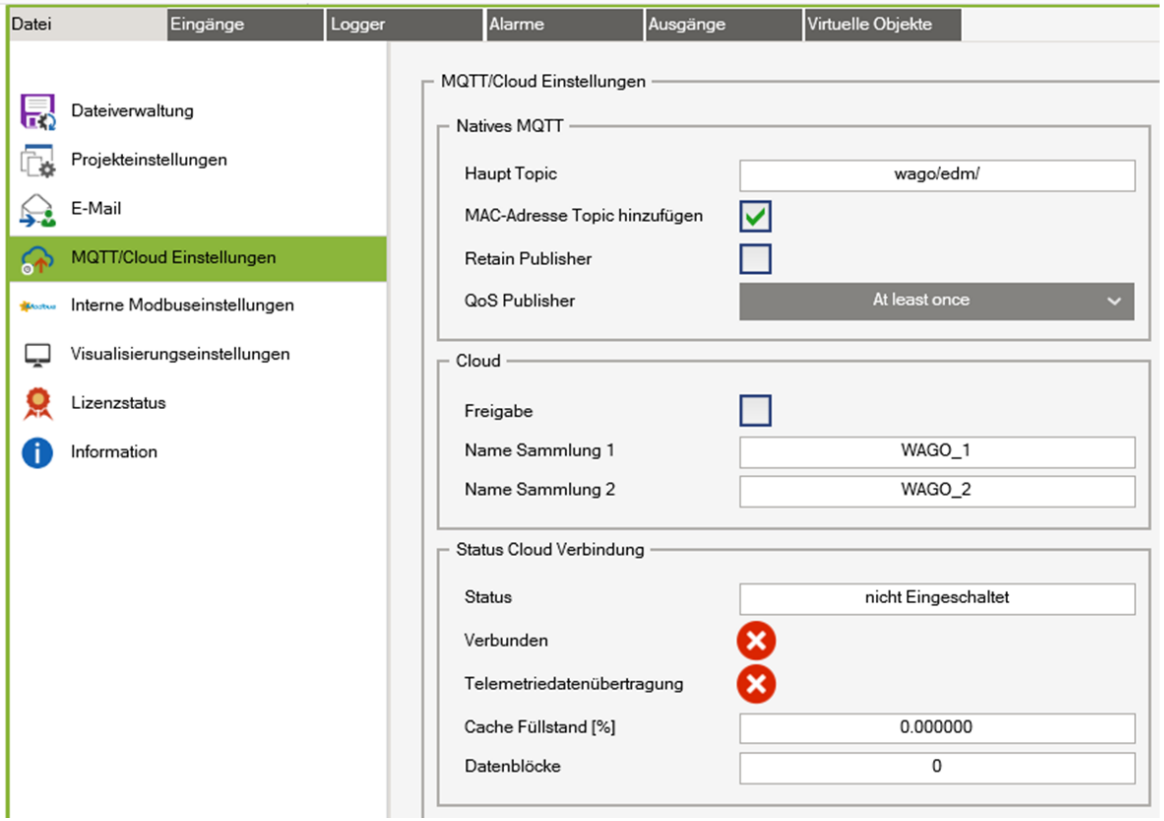
→ good matching of the simulation model with real load profiles in terms of characteristics and amplitude

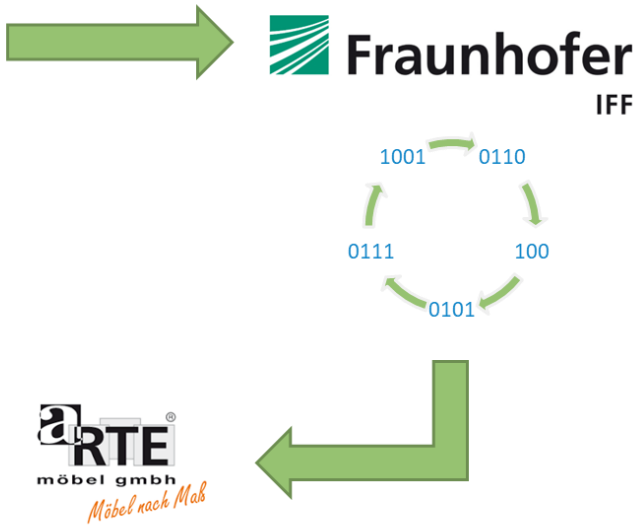
PV FORECAST

- Neural network for prediction (Python/ Jupyter) with Solcast weather forecast
- LSTM (Long Short Term Memory) algorithm
- ARIMA (Auto Regressive Integrated Moving Average) algorithm



TO DO
ONLINE MONITORING, FORECAST AND ‘CONTROL’





THANK YOU FOR YOUR ATTENTION