S C I E N C E ▪ P A S S I O N ▪ T E C H N O L O G Y

powered by klima+ energie fonds

CREATION OF HYBRID SIMULATION MODEL

Institute of Electrical Power Systems

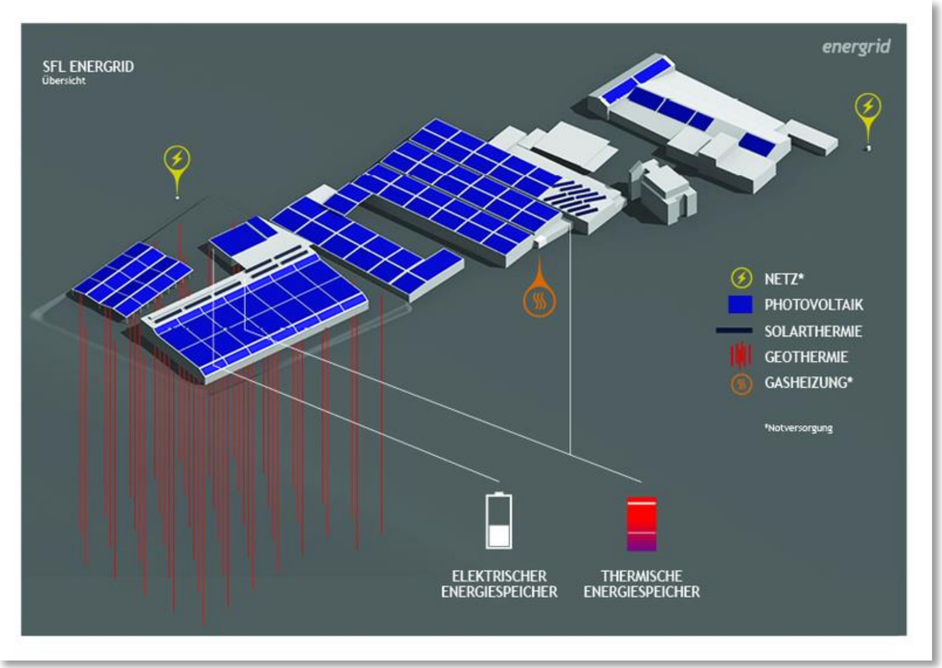
Institute of Thermal Engineering

M. Lagler, W. Lerch, E. Schmautzer, R. Schürhuber, R. Heimrath, T. Mach

Thursday, 04.10.2018

Content

- Motivation
- Challenges / Goals
- Hybrid Energy System – Industrial Company
- Method Interface
- Optimization
- Results
- Summary / Conclusion



Institut of Thermal Engineering
ELECTRICAL POWER SYSTEMS TU GRAZ

Motivation

„Regelungsstrategien zur Effizienzsteigerung komplexer hybrider Energiesysteme (REsys)“

REsys

Hybrid energy systems are systems that combine different energy sources (e.g. thermal and electrical systems), energy distribution and storage in a compact system

- Resources can be spared
- Energy costs can be saved
- The perceived comfort can be increased

Project „REsys“

- Hybrid energy systems are modelled by the combination of both thermal and electrical
- Measured data are used to validate the simulation models (thermal and electrical)
- Smart control strategies are developed
  - first step are integrated into the simulation models
  - second step are tested on a real hybrid energy system (SFL technologies Stallhofen (Styria))
- Optimization calculations with the hybrid simulation models
- Integration of the new control strategy in the real hybrid energy system

Challenges / Goals

Development of a hybrid simulation model

- for economic and ecologic optimization of an industrial company
- and the transferability to other hybrid energy systems is investigated

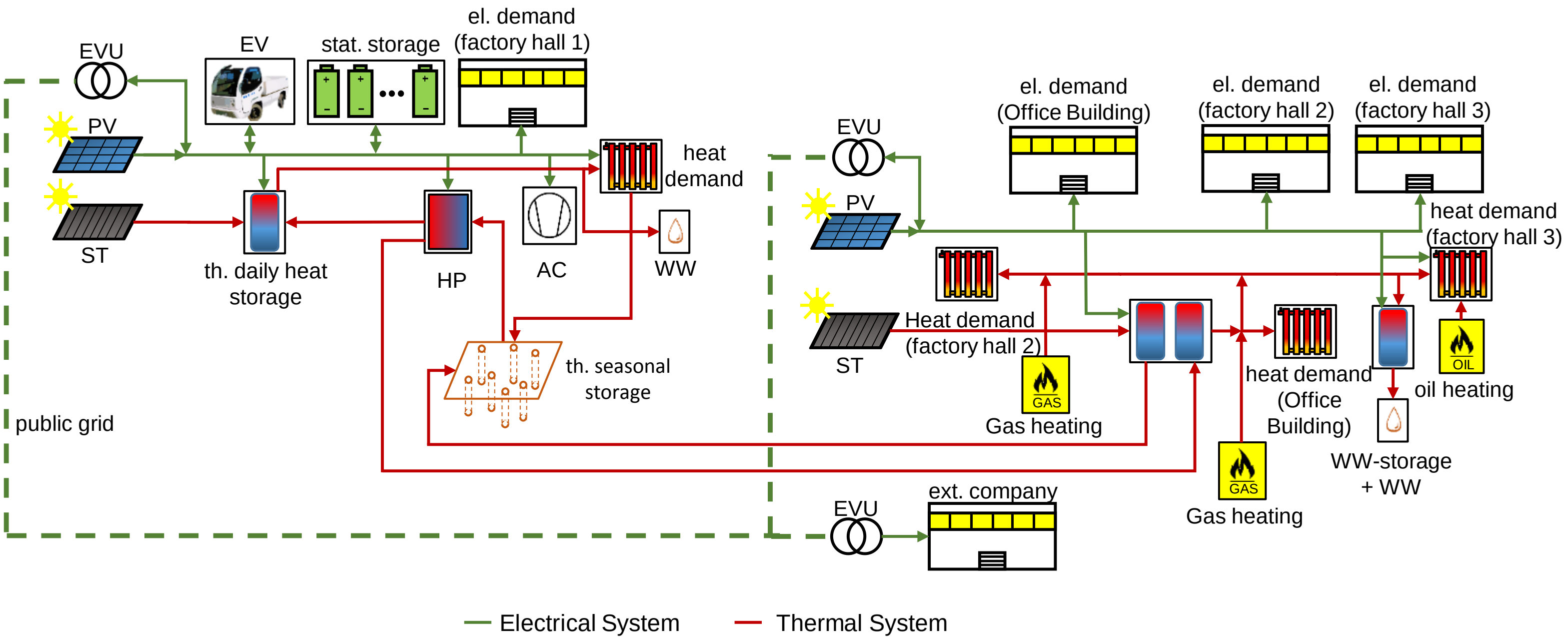
Modelling of a detailed

- thermal system in TRNSYS
- electrical system in MATLAB

Coupling of both systems via an interface

Hybrid Energy System – Industrial Company

Coupling via Heat Pumps (HP), thermal daily heat storages and ventilation systems



Method Interface (1)

Model coupling (TRNSYS and MATLAB)

- via TRNSYS Type 155
- Component Object Model (COM) interface
- different Calling Models e.g. iterative component or real-time controller
- no specific limits on the number of inputs, outputs, or instances of Type 155
- universally applicable

Two ways to implement the interface:

- serial and the parallel interface

Method Interface (2)

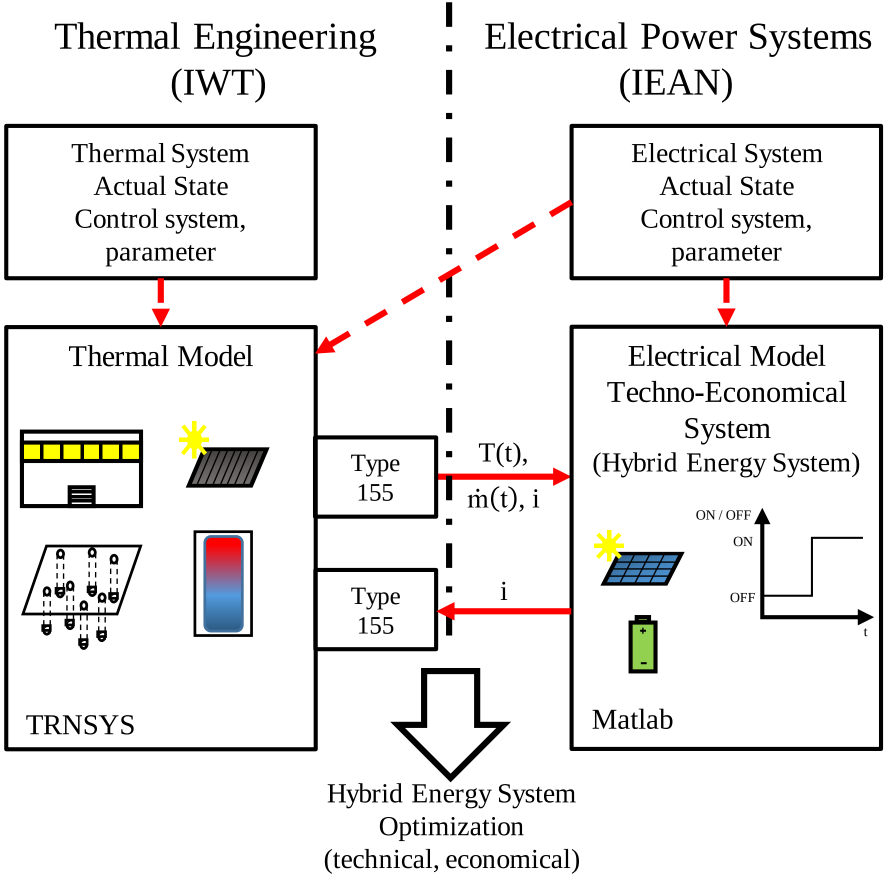
Parallel Interface

Advantages:

- Intense collaboration between the two institutes
- creating mutual dependencies on the creation of the models

Disadvantages:

- simulation time increases
- Collaboration have an temporal and organizational impact



Optimization

Optimization Algorithm (MILP – Mixed Integer Linear Programming)

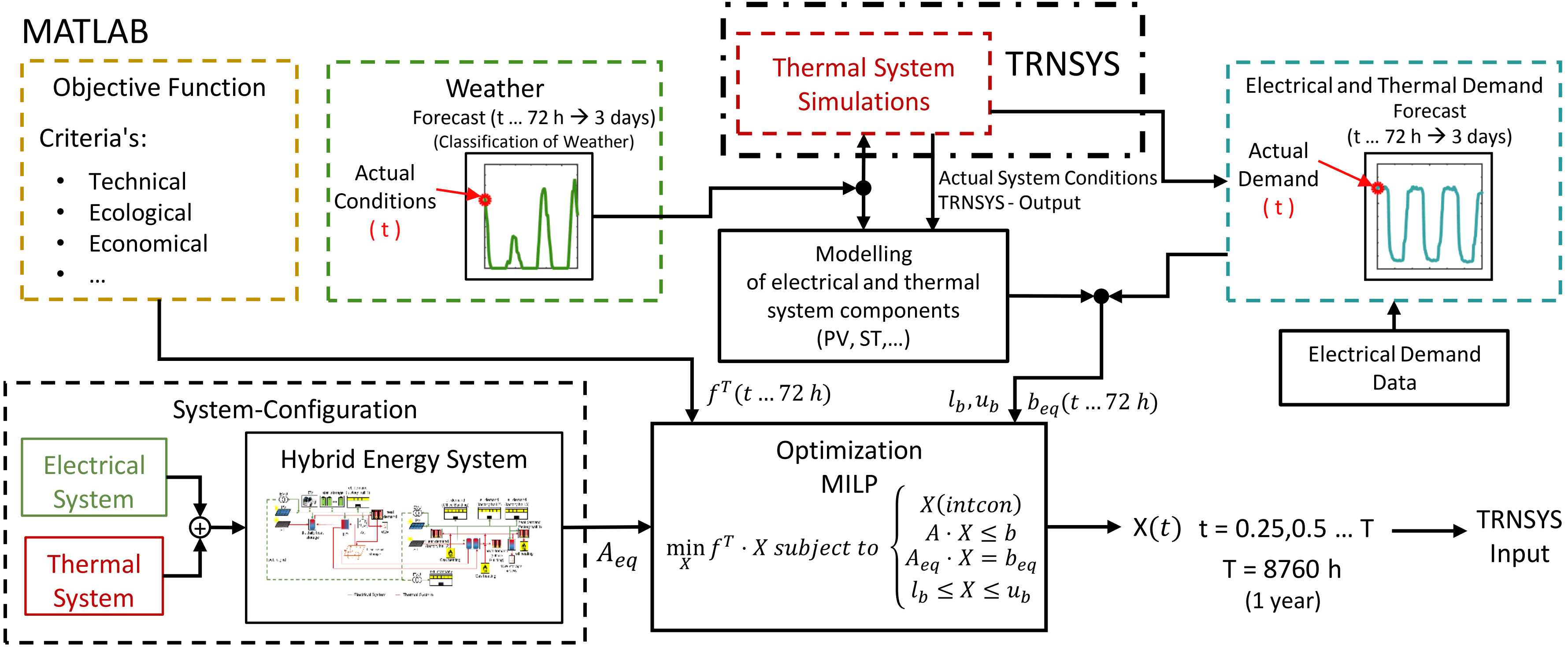
$$\min_x f^T \cdot x \; subject\ to \begin{cases} x(intcon) \\ A \cdot x \leq b \\ A_{eq} \cdot x = b_{eq} \\ l_b \leq x \leq u_b \end{cases}$$

x	… system variables (energy flow)
A_{eq}	… coefficient matrix
b_{eq}	… load, state of charge
l_b, u_b	… lower and upper boundary of system variables
f^T	… objective function

- temporal time resolution: 15-minutes or hours
- Time period: at least one year

Institut of Thermal Engineering
ELECTRICAL POWER SYSTEMS TU GRAZ

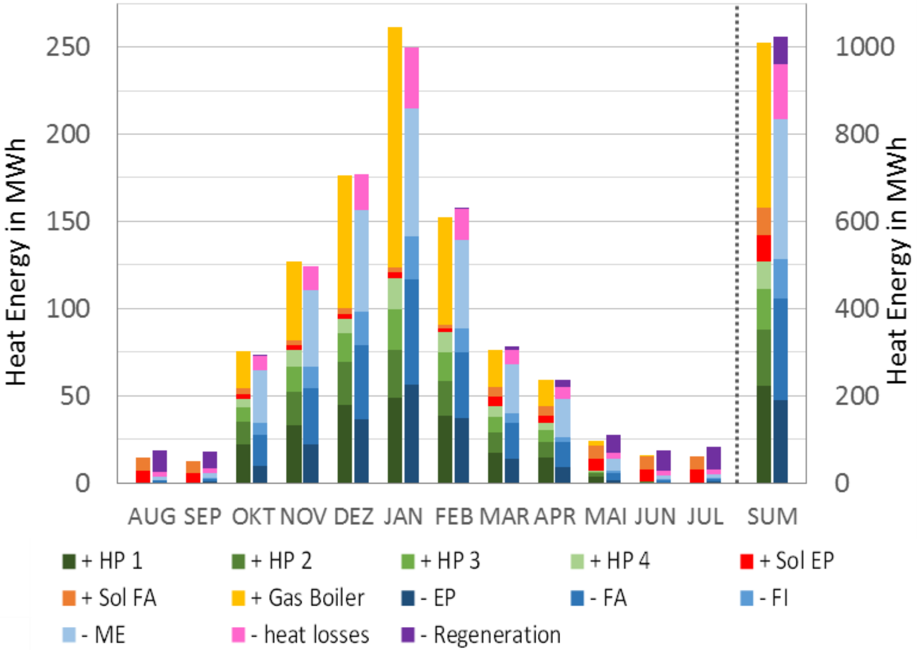
Methodology of Optimization



Results (1) – Thermal System

Balance for the heat sources and consumers

- Time Period: 01.08.2016 – 31.07.2017
- January
  Gas Boiler
  → heat quantity of 137.5 MWh
  → total demand of 261.4 MWh
- May to September
  Regeneration of Borholes
  → amount of heat regenerated 63.8 MWh
  → total yield of solar systems of 121.0 MWh



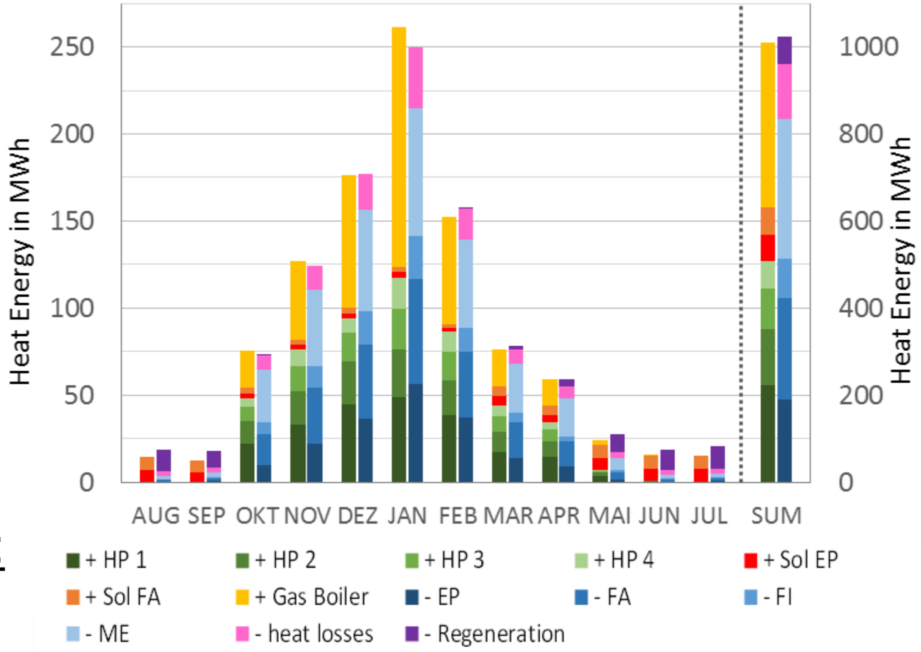
Institut of Thermal Engineering

ELECTRICAL POWER SYSTEMS TU GRAZ

Results (2) – Thermal System

Balance for the heat sources and consumers

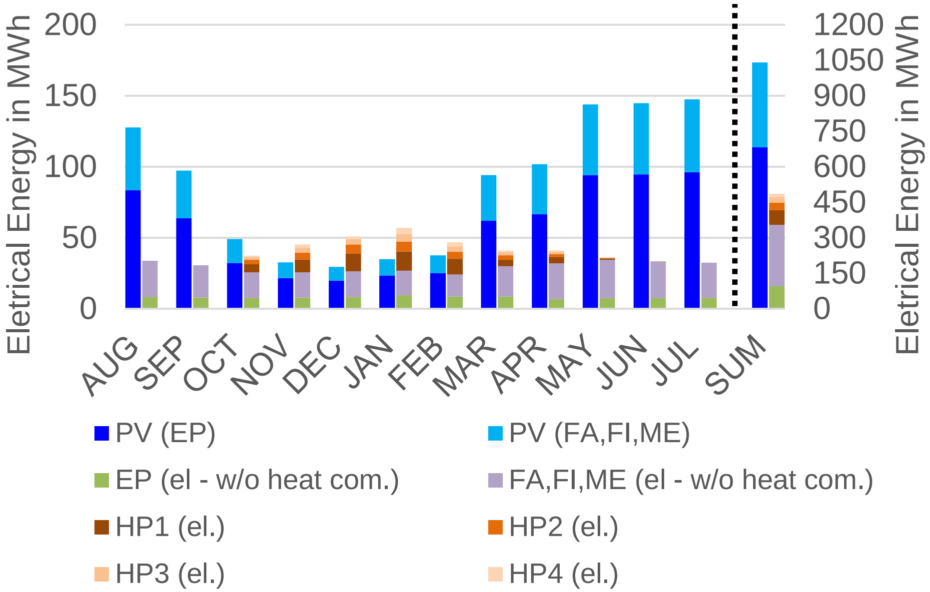
- Amount of heat generated:
  → 1010.8 MWh (sources)
- Amount of heat consumed:
  → 1023.9 MWh (sinks)
- Deviation between sources and sinks:
  → about 1.3 %



Results (3) – Electrical System

- PV-System:
  → installed power about 1 MWp
  → separated into two systems
  → balance via the public grid

- Electrical Demand:
  → 29 MWh/mth. (average demand)
  → varies significally of the current production



Summary / Conclusion (1)

- Data for system components are collected with the associated integrated control strategy on the thermal and on the electrical side
- For detailed information's, measuring instruments are installed and a monitoring was started
- The system is modeled and tested by simulation models in TRNSYS (Thermal System) and MATLAB (Electrical System)
  → Simulation models are validated for a complete measurement year

Institut of Thermal Engineering
ELECTRICAL POWER SYSTEMS TU GRAZ

Summary / Conclusion (2)

- Coupling of separately validated models (thermal and electrical):
  → Parallel Interface - increased simulation time against a high degree of detail
  → Coupling of TRNSYS and MATLAB has been implemented and tested by Type 155
- Optimization:
  → Algorithm implemented in Matlab
  → Thermal Control handed over to Matlab (th. component is activated or deactivated)
  → objective function: e.g. economic (€/kWh) and ecological (CO_2 emissions)

Summary / Conclusion (2)

- Coupling of separately validated models (thermal and electrical):
  → Parallel Interface - increased simulation time against a high degree of detail
  → Coupling of TRNSYS and MATLAB has been implemented and tested by Type 155
- Optimization:
  → Algorithm implemented in Matlab
  → Thermal Control handed over to Matlab (th. component is activated or deactivated)
  → objective function: e.g. economic (€/kWh) and ecological (CO_2 emissions)

This research was supported by the "Klima- und Energiefonds" (KLIEN) and is associated with the project "Regelungsstrategien zur Effizienzsteigerung komplexer hybrider Energiesysteme (REsys)" (Project No. 848936)

SCIENCE ▪ PASSION ▪ TECHNOLOGY

powered by klima+ energie fonds

CREATION OF HYBRID SIMULATION MODEL

Institute of Electrical Power Systems

Institute of Thermal Engineering

M. Lagler, W. Lerch, E. Schmautzer, R. Schürhuber, R. Heimrath, T. Mach

Thursday, 04.10.2018