



**TECHNISCHE
UNIVERSITÄT
DRESDEN**

Fakultät Elektrotechnik und Informationstechnik Lehrstuhl für Elektroenergieversorgung

Comparison of Static and Dynamic Simulation for Micro-CHP Units



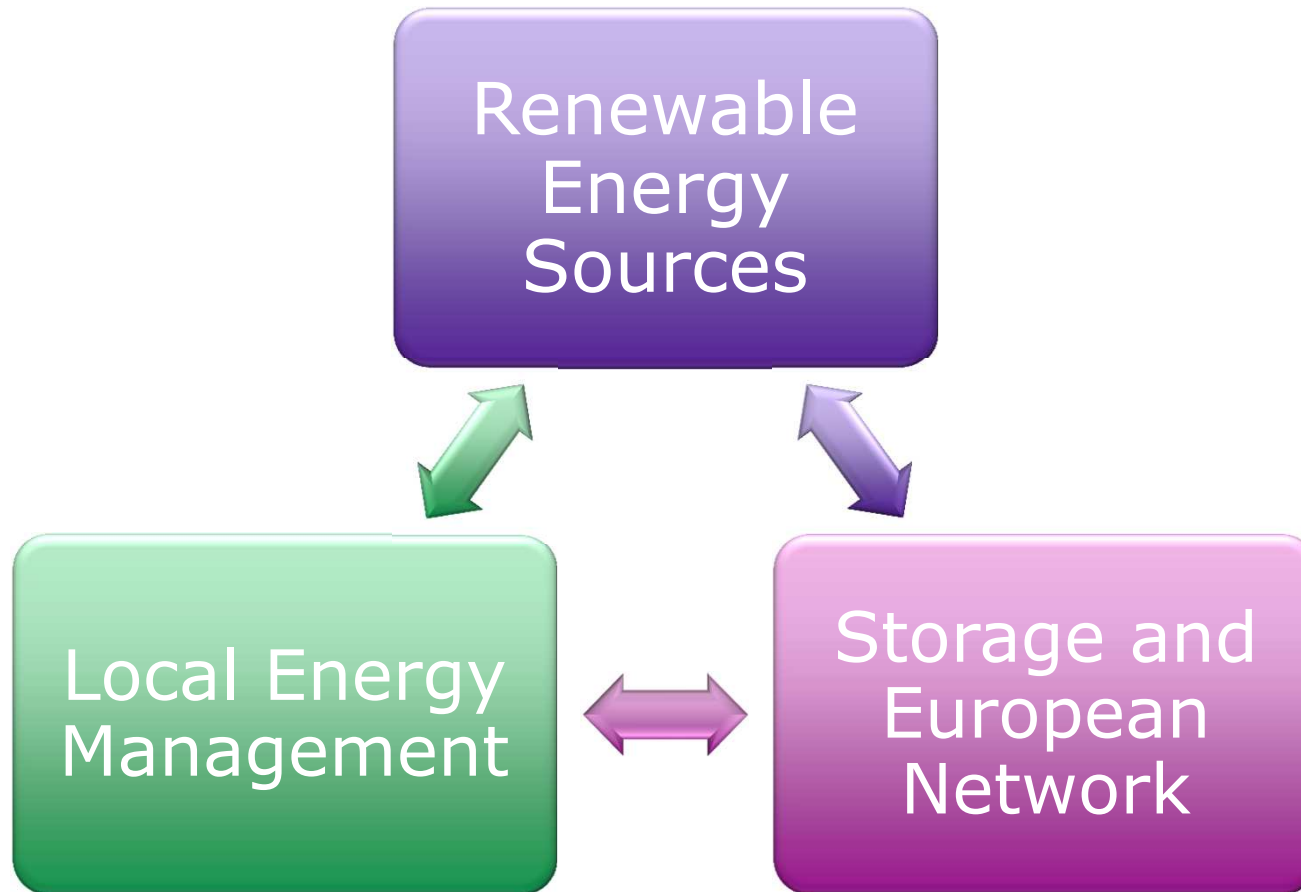
Tobias Heß



**DRESDEN
concept**
Exzellenz aus
Wissenschaft
und Kultur

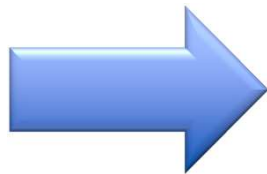
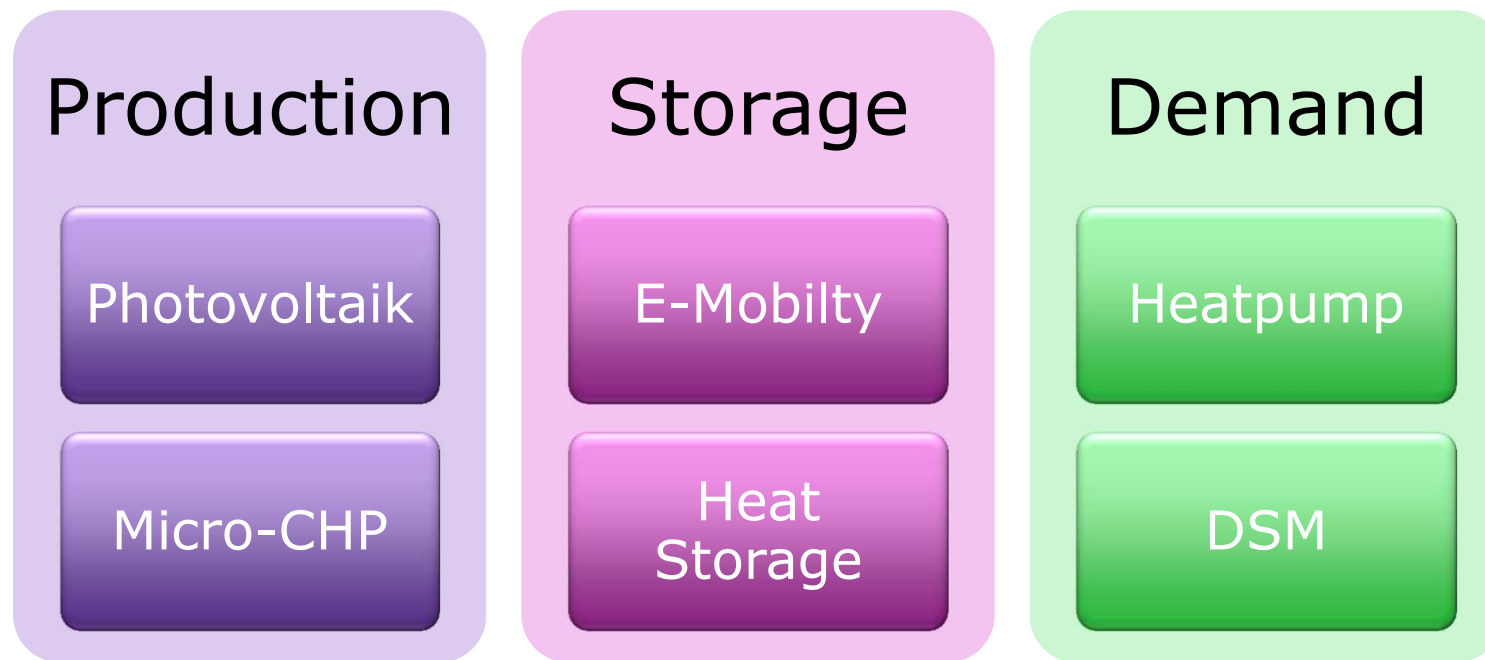
Introduction

Future Energy Framework



Introduction

Lokal Energy Management



- **Balance off local energy production and demand**
- **Integration of renewable resources**

Introduction

Local Energy Management with Micro-CHP

- **Always available and full controllable**
- **High total efficiency**
- **Fast startup time**
- **Flexible control**

Is the simulation accurate?

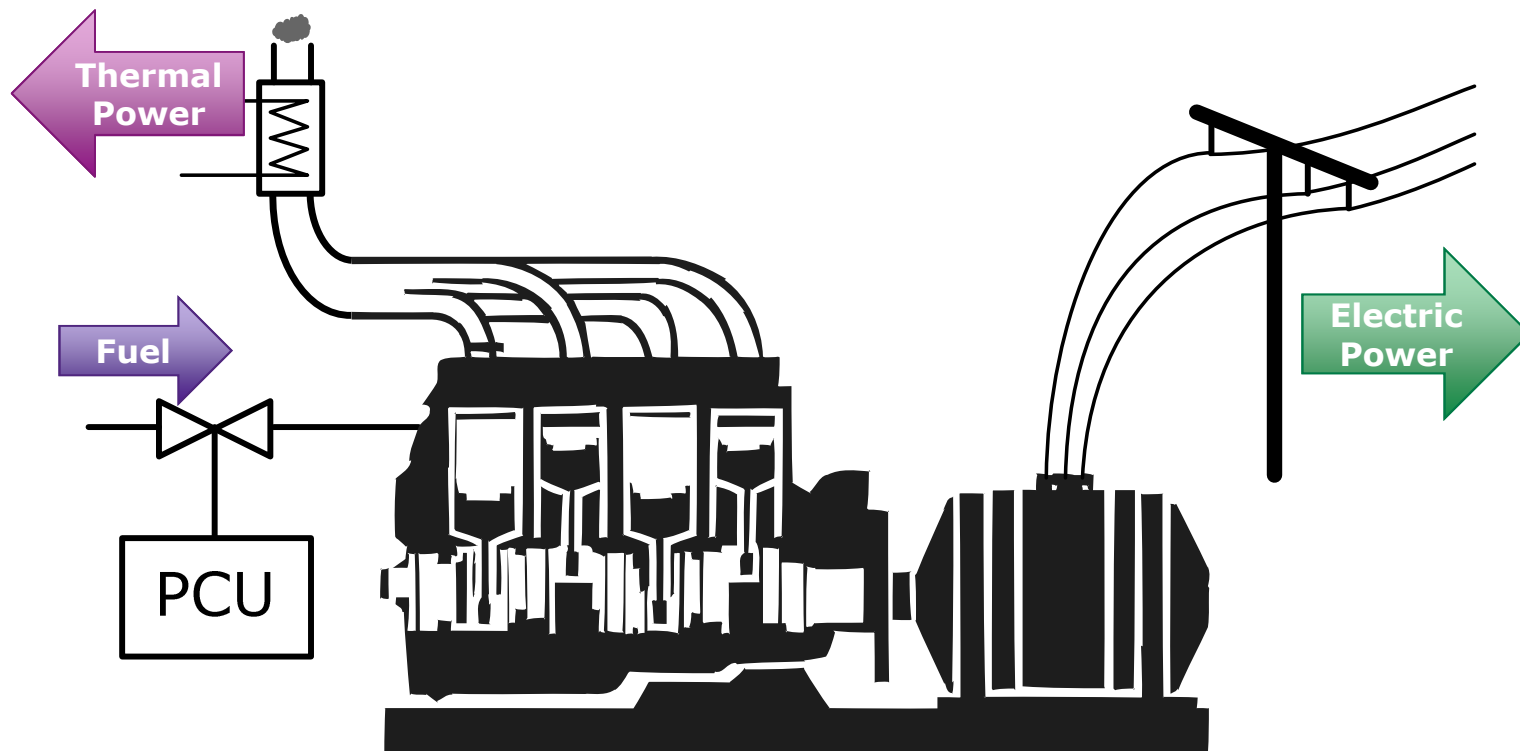


TECHNISCHE
UNIVERSITÄT
DRESDEN

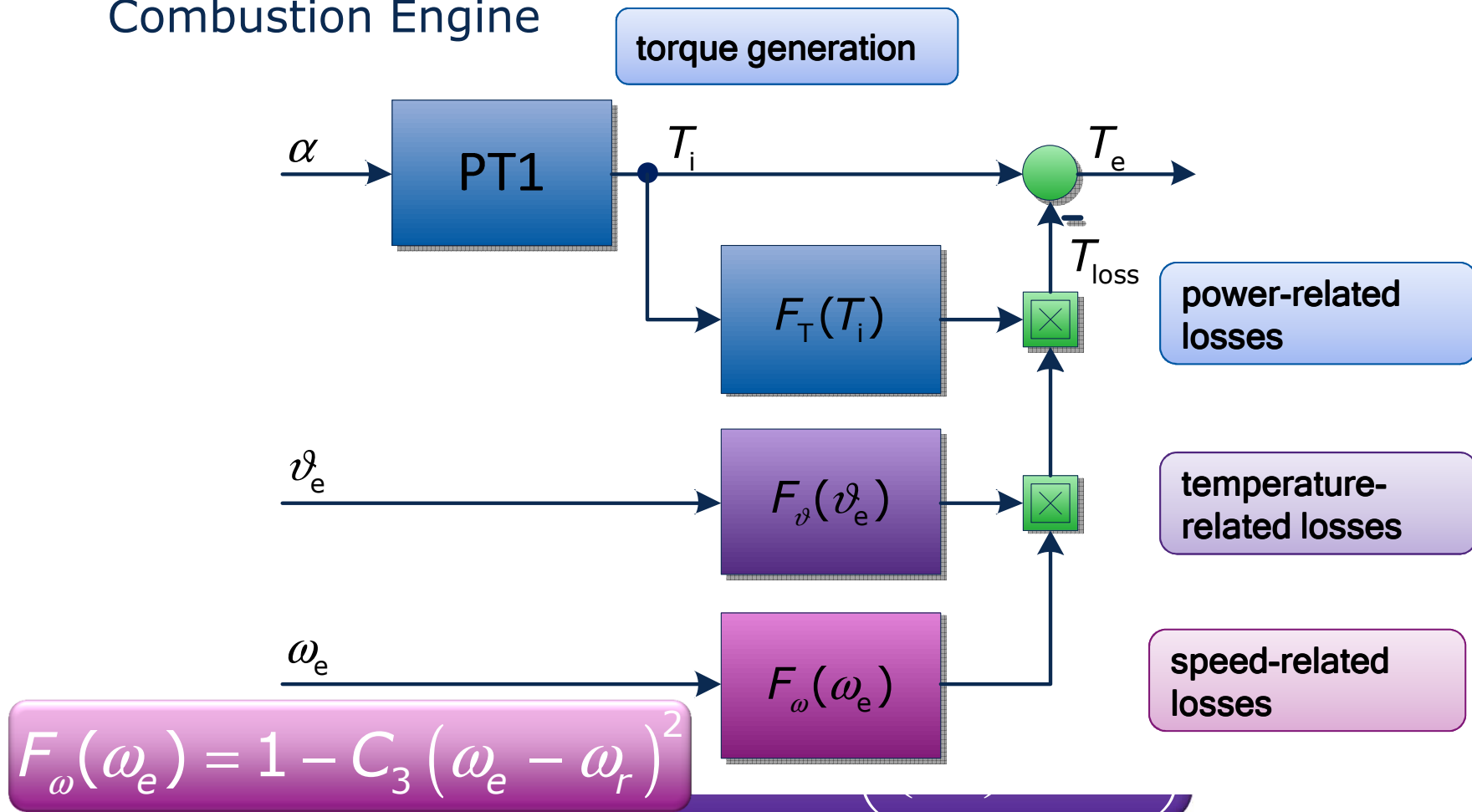
Model of Micro-CHP

Mirco-CHP Model

Overview



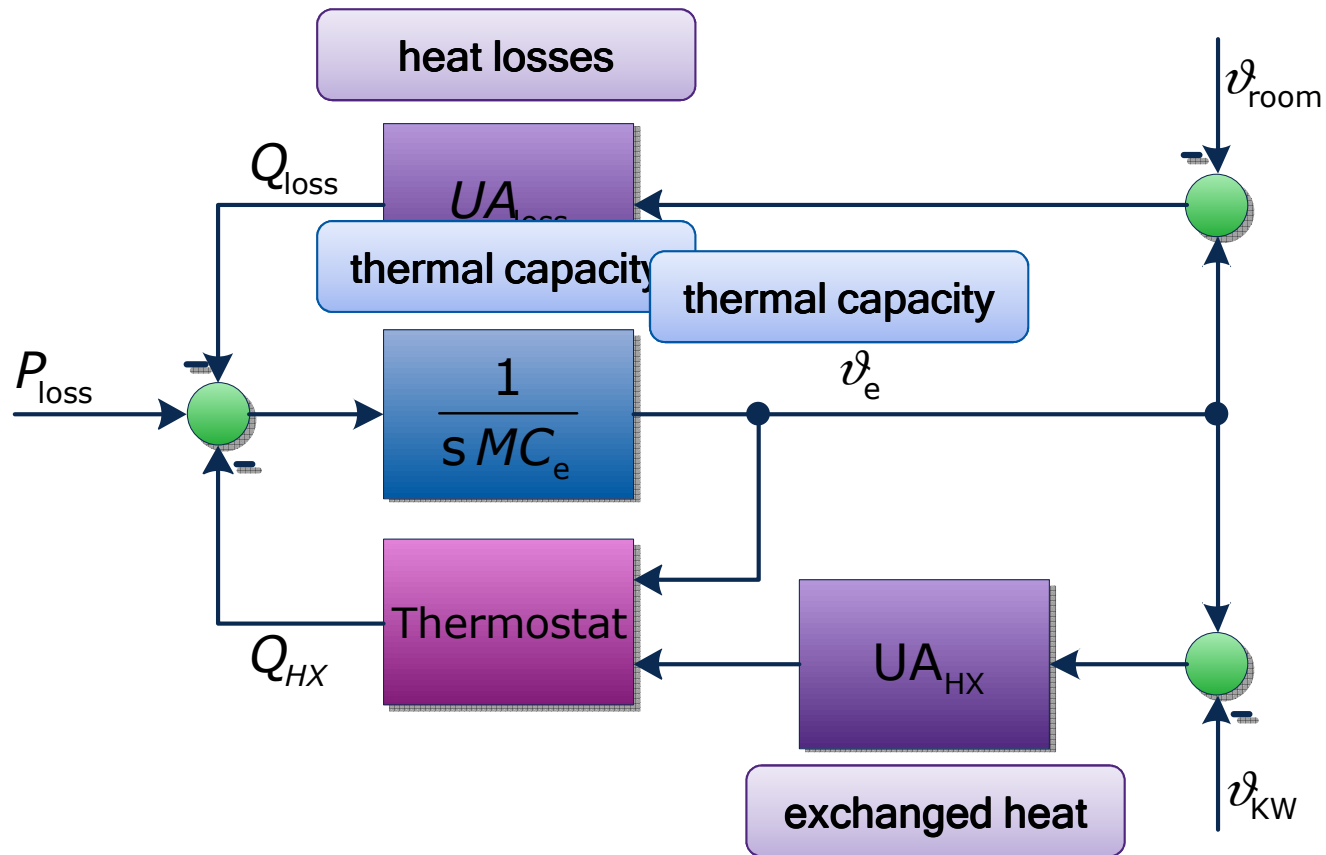
Mirco-CHP Model Combustion Engine



$$F_\omega(\omega_e) = 1 - C_3 (\omega_e - \omega_r)^2$$

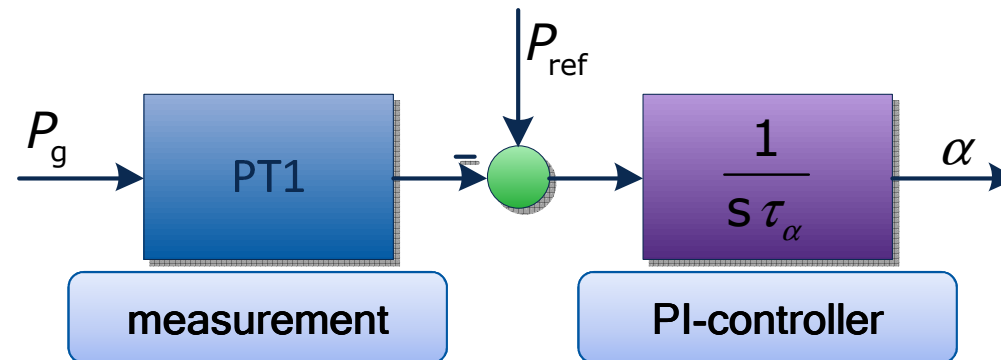
Mirco-CHP Model

Heat Exchanger



Mirco-CHP Model

Power Control Unit (PCU)





TECHNISCHE
UNIVERSITÄT
DRESDEN

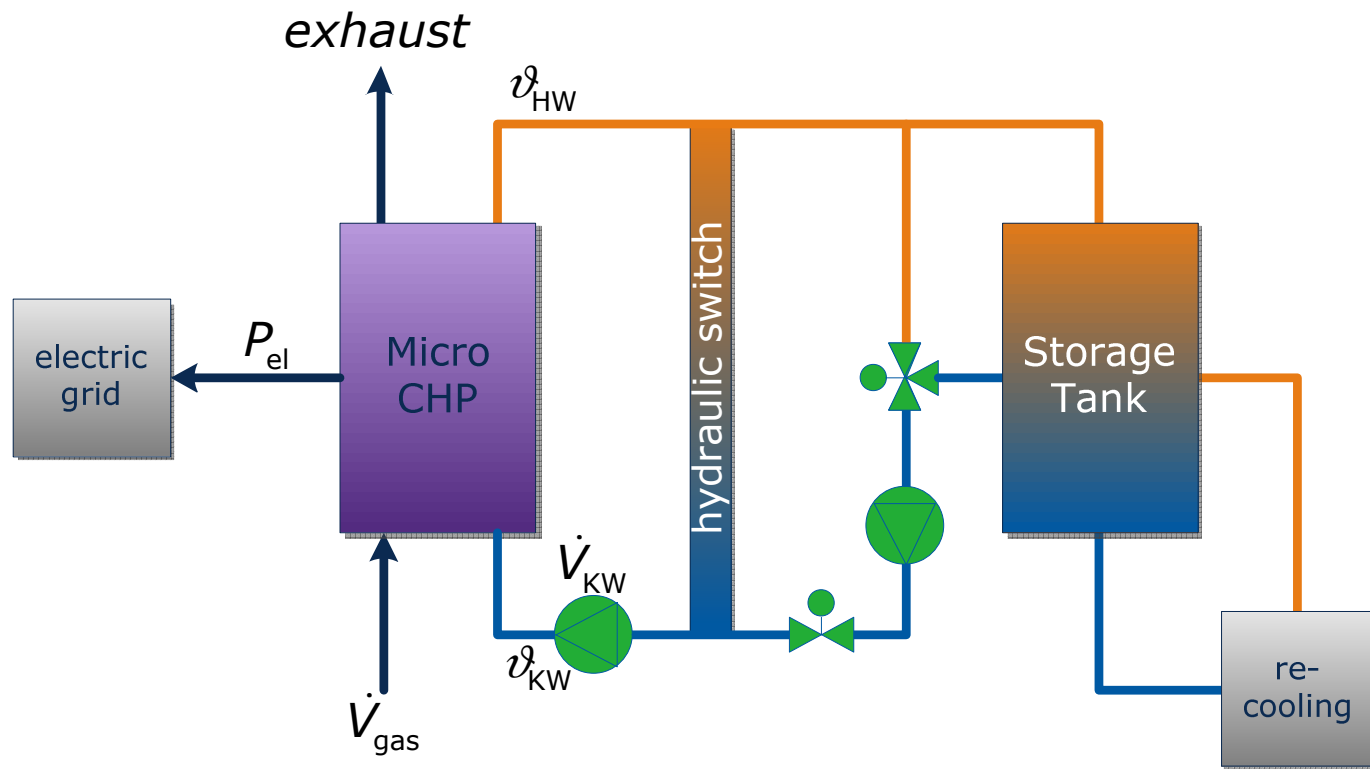
Parameter Estimation

Parameter Estimation Experimental facility



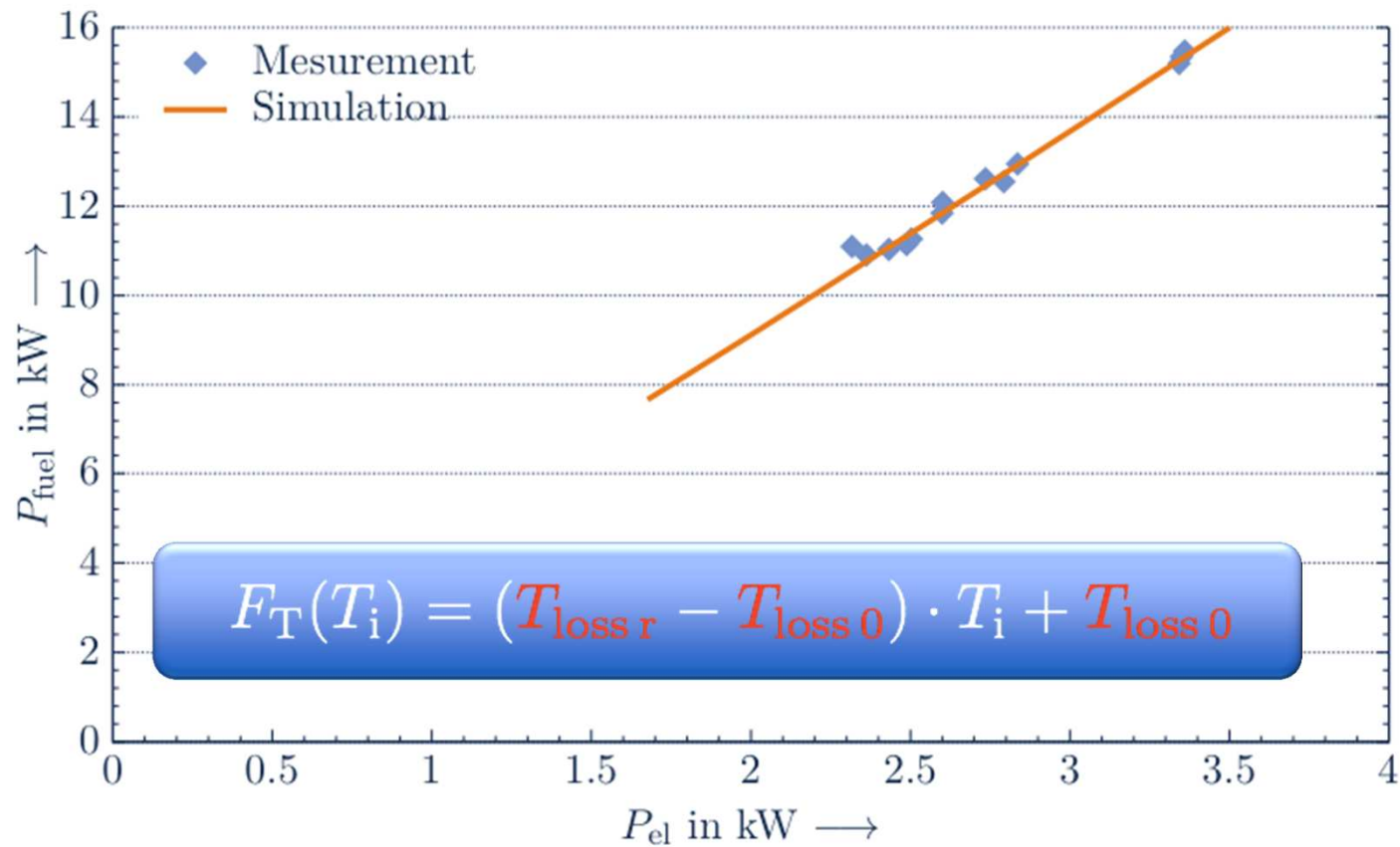
Parameter Estimation

Experimental facility



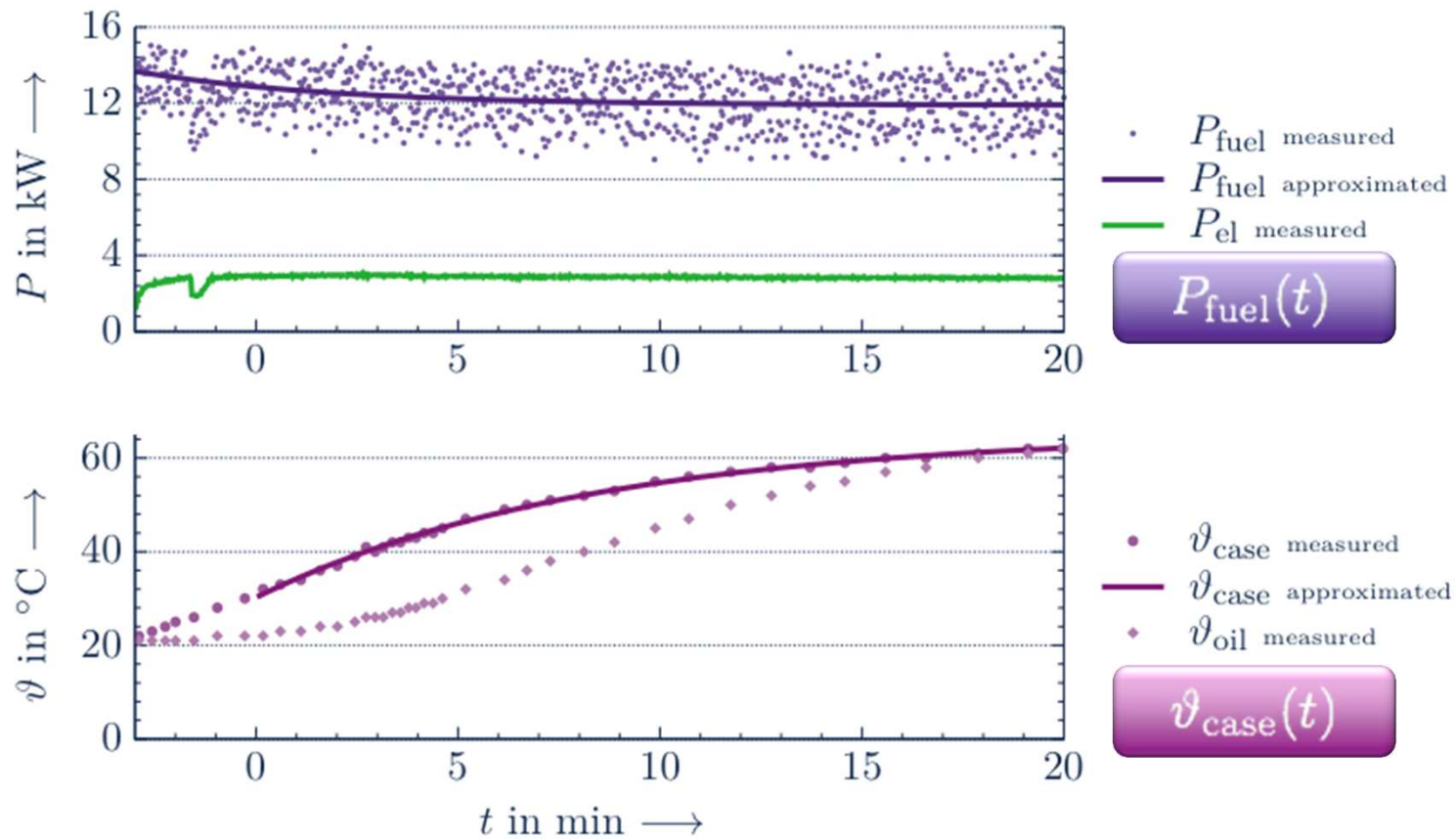
Parameter Estimation

Static Measurements



Parameter Estimation

Dynamic Measurement



Parameter Estimation

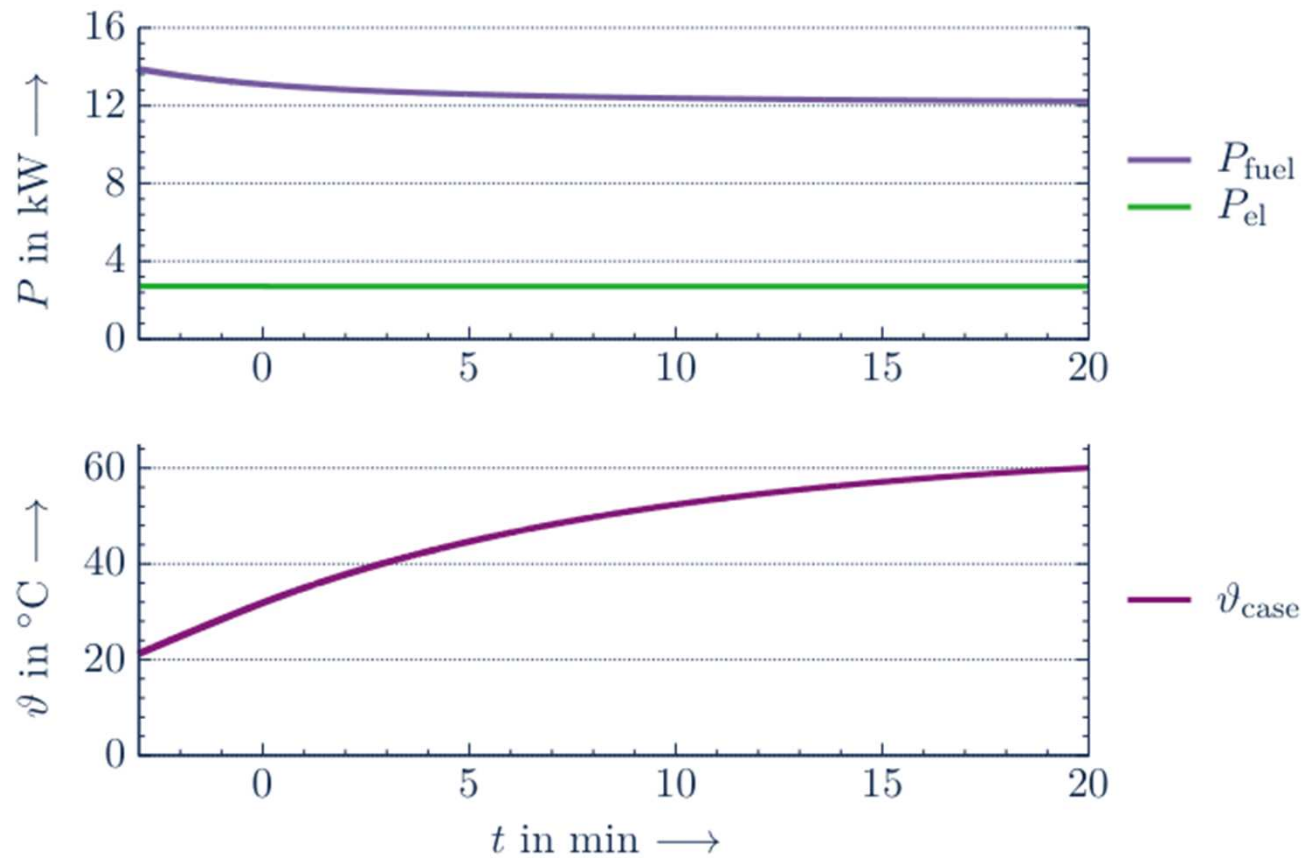
Dynamic Measurement

$$\begin{array}{c}
 P_{\text{loss}}(t) \\
 P_{\text{fuel}}(t) - P_{\text{el}}(t)
 \end{array}
 =
 \begin{array}{c}
 P_{\text{loss}}(t) \\
 F_T(P_{\text{fuel}}(t)) \cdot F_{\vartheta}(\vartheta_{\text{case}}(t))
 \end{array}$$

$$F_{\vartheta}(\vartheta_{\text{case}}) = 1 + C_1 \left(\left(\frac{\vartheta_r}{\vartheta_{\text{case}}} \right)^{C_2} - 1 \right)$$

Parameter Estimation

Dynamic Simulation



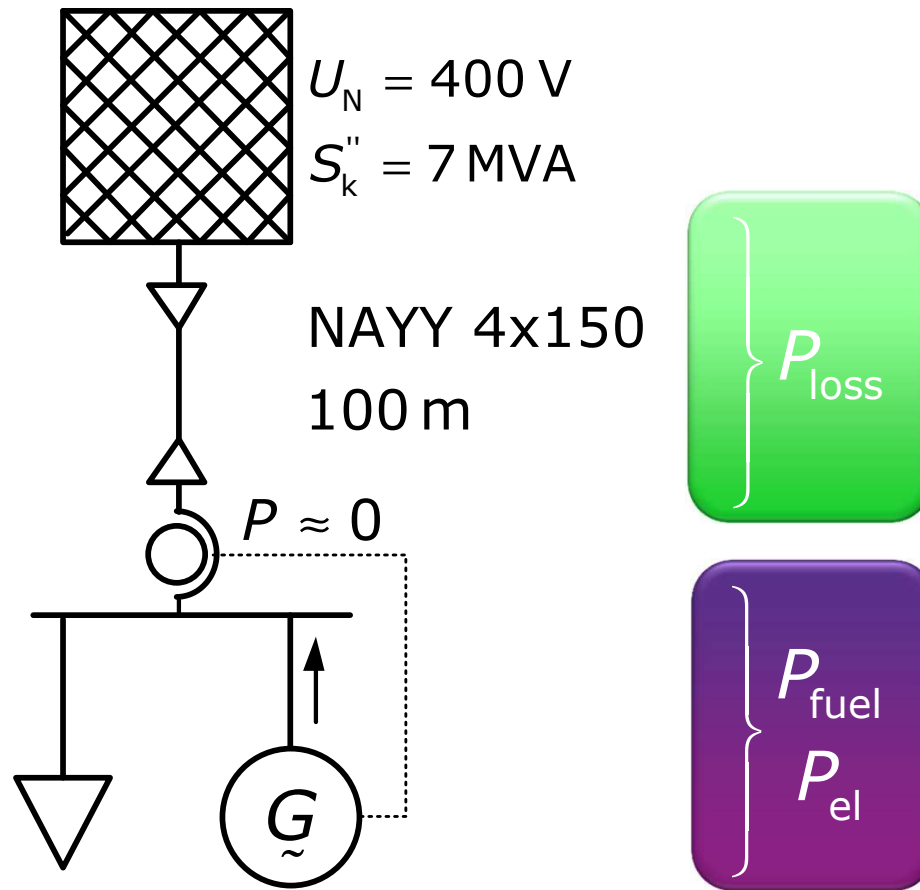


TECHNISCHE
UNIVERSITÄT
DRESDEN

Simulation Results

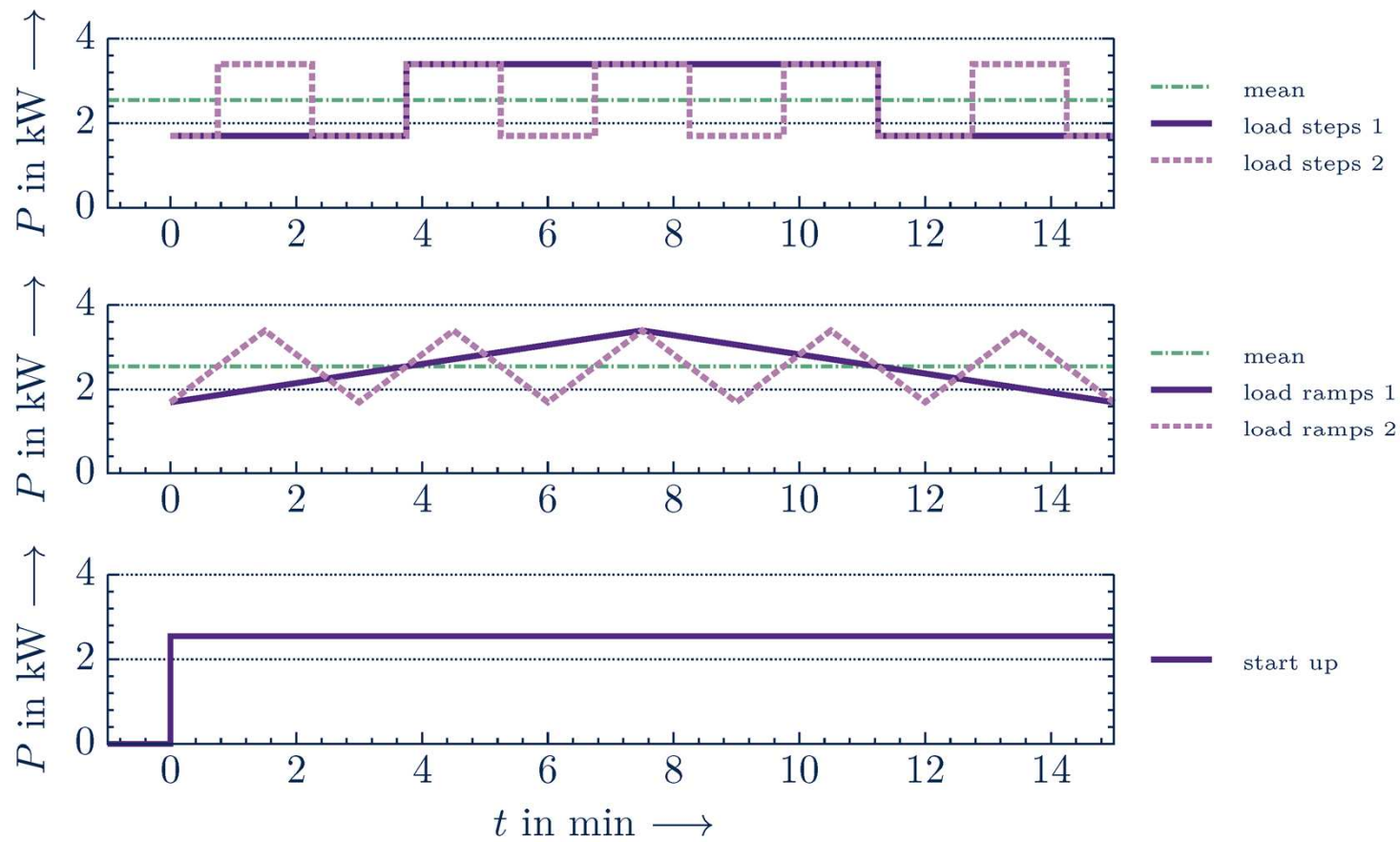
Simulation Results

Simple Simulation Network



Simulation Results

Load Szenarios



Simulation Results

Simulation

dynamic simulation:

- Time frame: 15 min
- Time step: 10 ms
- Initial conditions: mean value

static simulation:

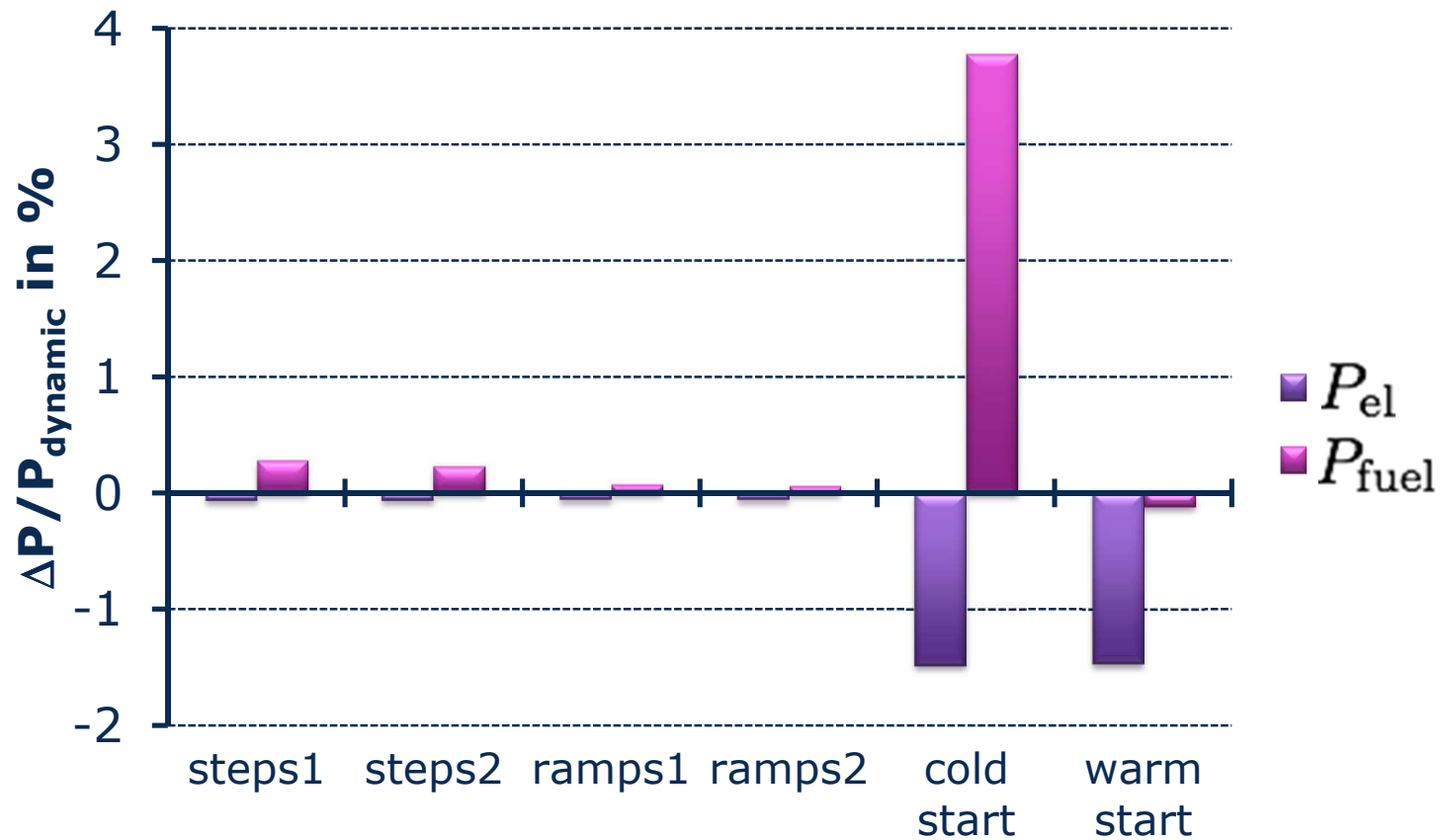
- load flow with mean values

differences between static and dynamic simulation:

$$\frac{\Delta P}{P_{dynamic}} = \frac{P_{dynamic} - P_{static}}{P_{dynamic}}$$

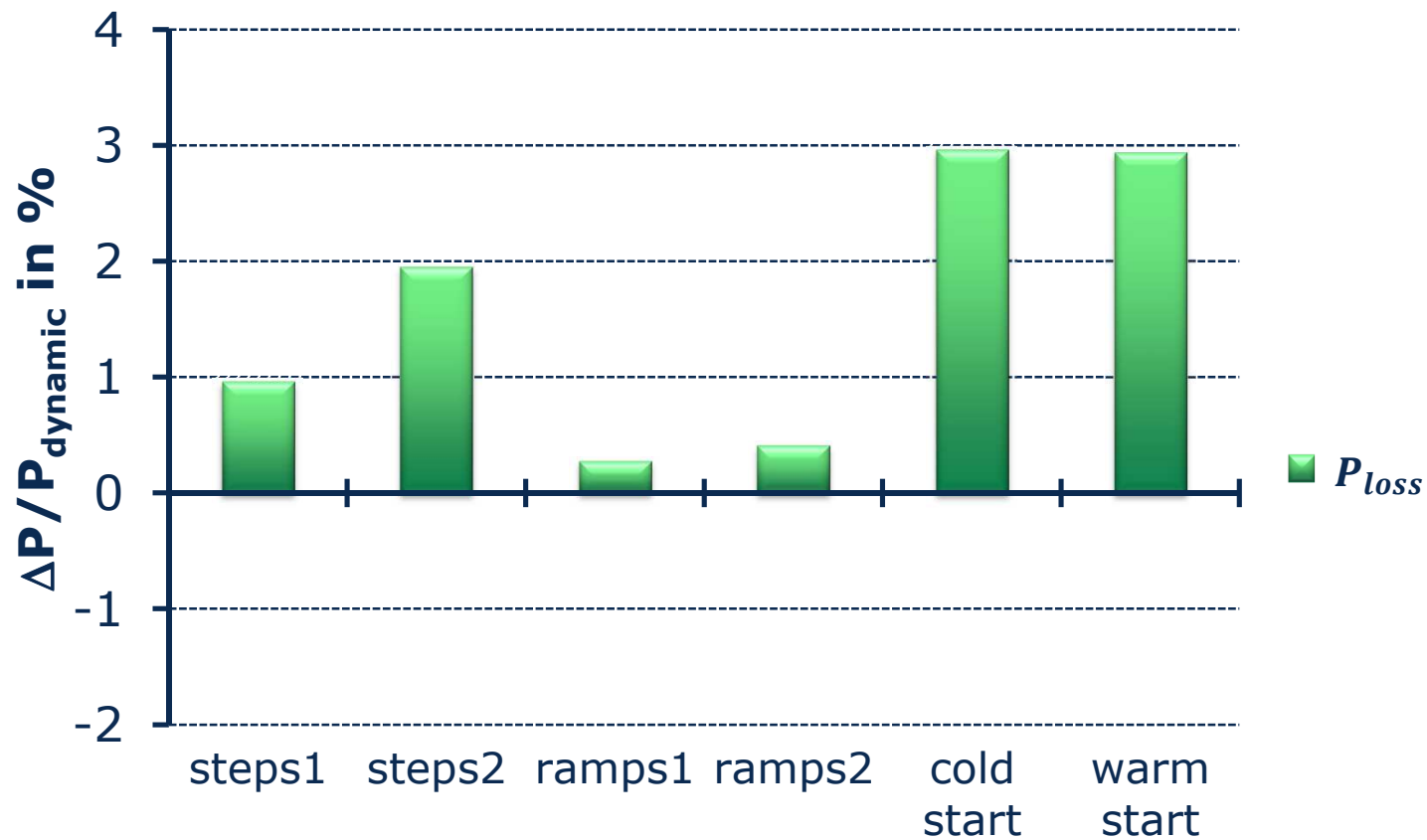
Simulation Results

Differenz between static and dynamic simulation



Simulation Results

Differenz between static and dynamic simulation



Conclusions

- Parameter estimation shows good results
- Load changes have small influence on CHP simulation results
- Start-Ups have to be considered in simulations

- Repeat measurements and simulation on different Micro-CHPs
- Verify simulation with measurements

Thank You!

**Tobias Heß
TU Dresden – IEEH**

+49 351 463 32941

tobias.hess@tu-dresden.de