Lucerne University of
Applied Sciences and Arts
HOCHSCHULE
LUZERN
Technik & Architektur
FH Zentralschweiz

MSE | MASTER OF SCIENCE IN ENGINEERING

Master-Thesis Engineering, Fachgebiet Energy and Environment

Predictive control of a building energy system

Figure 1: The Schwalbenhof residential building. (Source: src-architekten)

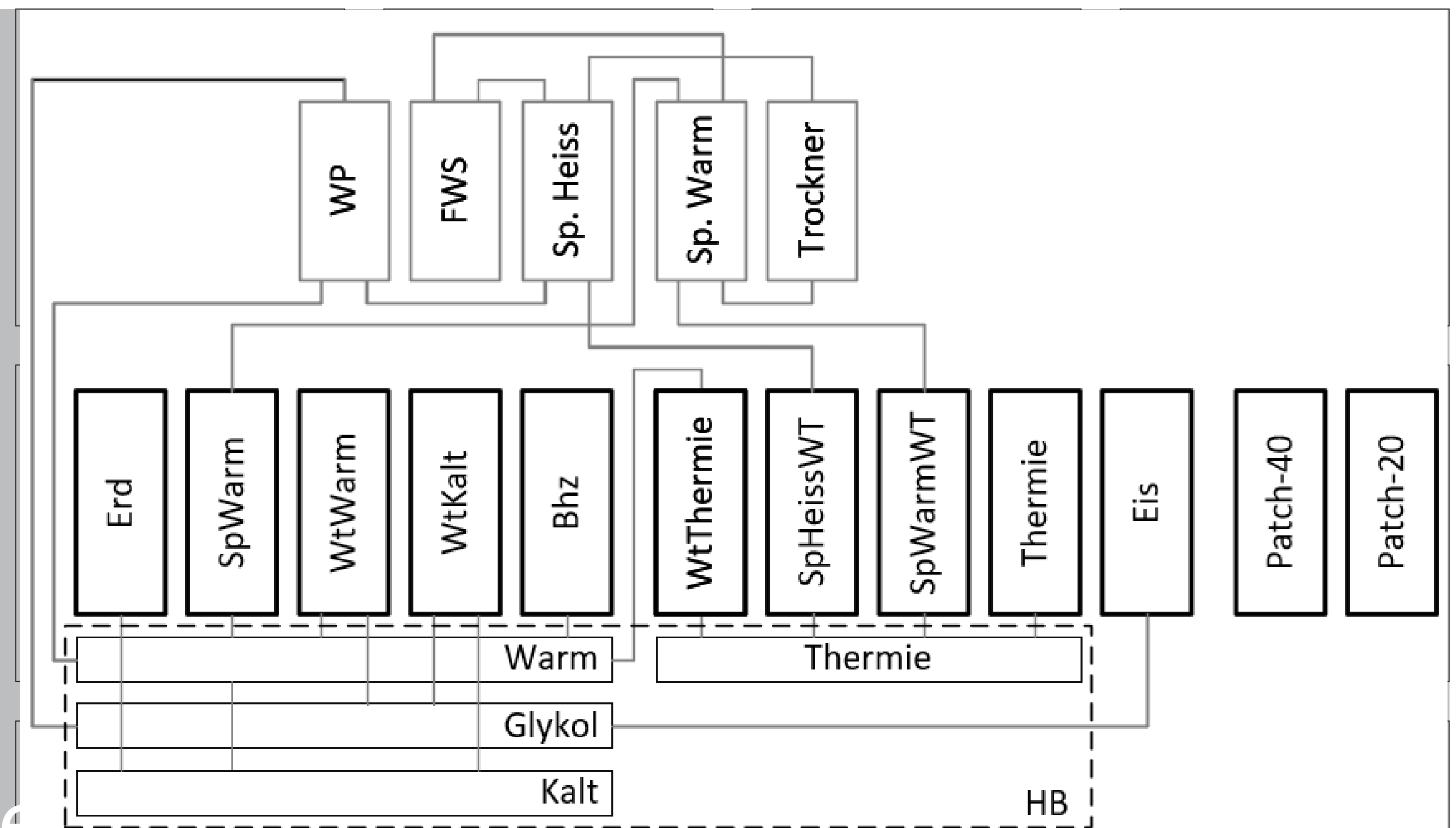
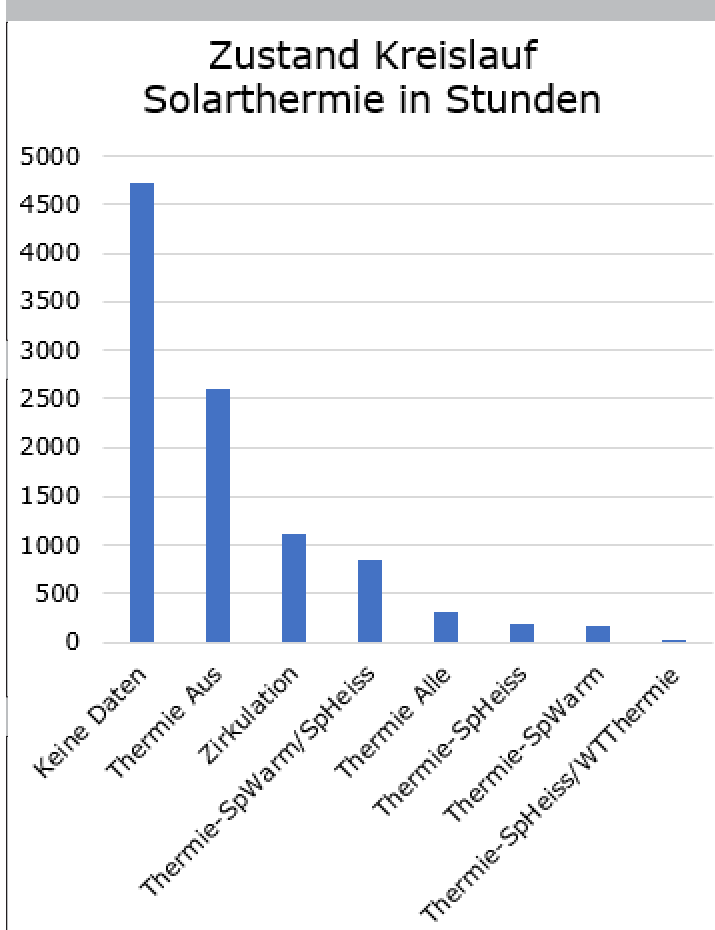


Figure 2: Structure diagram of the energy system. WP=Heat pump, FWS=Fresh water station of the domestic hot water, Bhz=Floor heating system, WT=Heat exchanger, Sp=Storage, HB=Rino Hydrobus system



Graphic 1: Measured operating state of the solar thermal circulation.

Kreislauf Thermie

Armatur / Sensor	Modul	Messung	Kommentar	Funktion	Kommunikation
Y-PWM-1	Thermie	Status	Hauptpumpe	Thermie An	Alle
V-Thermie	Thermie	Status	3W-Ventil Zirkulation		
f7d	Thermie	°C	Solarkollektor VL	T<95°C	Alle
V-Thermie	Thermie	Status	3W-Ventil Zirkulation		
F-Flow-1	Thermie	Volumenstrom	Solarkollektor	Ertrag Solarkollektor	Heiss / Warm / Kalt / Glykol
f7d	Thermie	°C	Solarkollektor VL		
fb2	Thermie	°C	Solarkollektor RL		
V-SpHeissWT	SpHeissWT	Status	Ventil Speicher Heiss	Regeneration Speicher Heiss	Heiss / Warm / Kalt / Glykol
f7d	Thermie	°C	Solarkollektor VL		
V-SpWarmWT	SpWarmWT	Status	Ventil Speicher Warm	Regeneration Speicher Warm	Heiss / Warm / Kalt / Glykol
f7d	Thermie	°C	Solarkollektor VL		

Chart 2: Sensors and Valves needed for the MPC of the solar thermal circulation.

Kommunikation	MPC Elektrizität	eMobilität
		Patch20
		Patch40
	MPC Heiss	Trockner
		FWS
		HUB
		WTKalt
		WTWarm
		SpWarm
		WTThermie
	MPC Kalt	Erd
	MPC Glykol	Eis
	MPC Warm	BHZ
	MPC Thermie	Thermie
		SpWarmWT
		SpHeissWT

Chart 1: One example of the structure of the MPC Schwalbenhof. Colour represent the different circuits. Light grey: Electricity, Dark red: Hot domestic water, Blue: Geothermal probe, Purple: Ice storage, Light red: Floor heating system, Yellow: solar thermal.

Situation and Challenge

The Schwalbenhof residential building has an innovative building energy system that uses solar thermal, photovoltaics and seasonal storage systems. The system is modular and the control tries to optimally couple the temperatures of the energy sources with the required temperatures of the energy sinks.

The controller of the energy system is a rule-based control (RBC) and currently works with the current temperatures and valve positions. This control should be gradually rewritten into a model predictive control (MPC). The goal of the MPC is to reduce the operating costs of the energy system based on a production and consumption forecast using the given Data.

Solution

In a first step, the existing data sets of the energy system were evaluated via the valve positions and assigned on the basis of the possible operating states. Then the physical processes were described on the basis of the floor heating and the sensors and valves involved were summarized in tables.

The next step was to conduct a literature review of MPCs that contain determining components that are also present in the Schwalbenhof building. Based on the research, possible structures of the MPC Schwalbenhof were developed with the specific characteristics of the energy system in mind.

Results

The measured data sets can be used as a basis for training for the MPC. However, it must be considered that the spring of 2021 was cooler than the standard meteorological year and may have corresponding influences.

The structure of the MPC Schwalbenhof can be divided into three categories with corresponding advantages and disadvantages. If possible, the structure should represent the circuits or the modules.

Markus Lacher

Betreuer:
Prof. Dr. Mirko Kleingries
Prof. Dr. Matthias Berger

Kooperationspartner:
Rino Electronics AG
Oberwilerstrasse 83
8309 Nürensdorf

Genossenschaft Wohnen, Arbeiten und Kultur Elgg und Umgebung (WAK)
Vordergasse 21
8353 Elgg