Validation of a new heat pump model for Carnot library

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Abstract

Validation of a new heat pump model for Carnot library with data from two sites :

- installation "L"
- installation “S“

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1 Introduction

The heat pump model was improved by adding a dissipation scheme. The resulting block must be validated with measurement data.

Two sources of data are used :

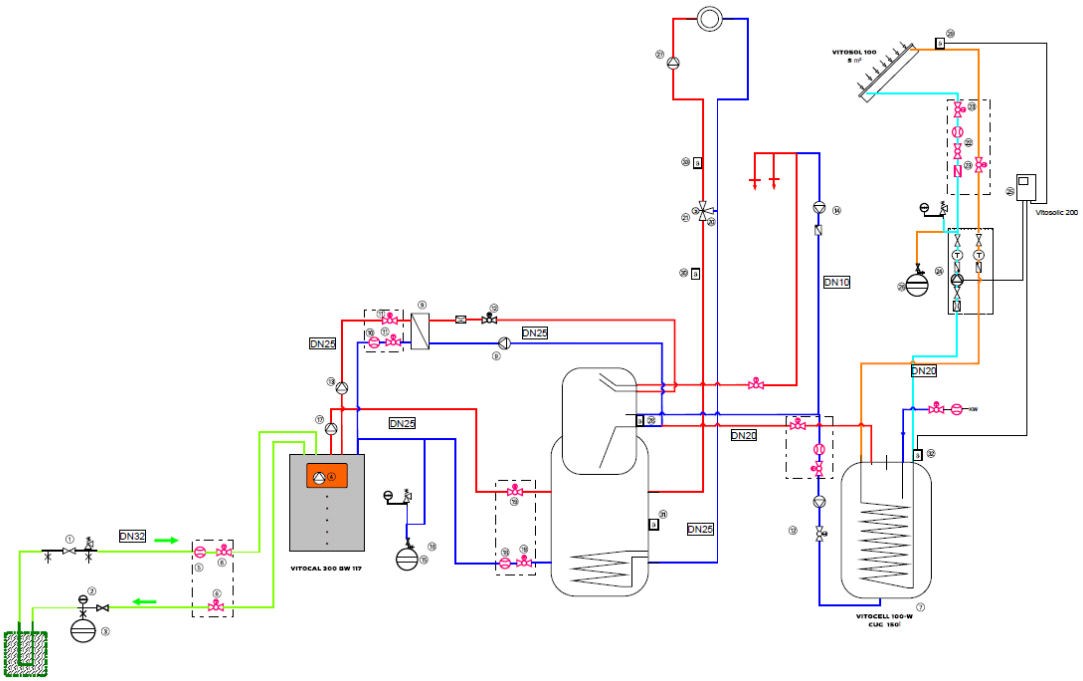
- installation "L"
- installation “S”

2 Description of data sources

2.1 Installation „L“

2.1.1 General description

DHW and heating production with a heat pump and solar panels. Solar energy is used as primar energy for DHW production. The heat pump is used as primar energy for heating and additionnal heating for DHW.



Installation scheme

2.1.2 Heat pump description

The heat pump is a VITOCAL 300-G BW 121. It is a water-glycol mix/water heat pump with a nominal heat power of 21.2 kW.

Typ BW/BWS

BW/BWS		**121**
Leistungsdaten nach DIN EN 14511 (0/35 °C, 5 K Spreizung)		
Nenn-Wärmeleistung	kW	21,2
Kälteleistung	kW	17,0
Elektr. Leistungsaufnahme	kW	4,48
Leistungszahl ε (COP)		4,73
Leistungsdaten nach DIN EN 255 (0/35 °C, 10 K Spreizung)		
Nenn-Wärmeleistung	kW	21,5
Kälteleistung	kW	17,5
Elektr. Leistungsaufnahme	kW	4,33
Leistungszahl ε (COP)		4,97
Sole (Primärkreis)		
Inhalt	l	7,3
Min. Volumenstrom (Δt = 5 K)	l/h	3300
Durchflusswiderstand	mbar	90
Max. Vorlauftemperatur	°C	25
Min. Vorlauftemperatur	°C	–5
Heizwasser (Sekundärkreis)		
Inhalt	l	7,3
Min. Volumenstrom (Δt = 10 K)	l/h	1900
Durchflusswiderstand	mbar	30
Max. Vorlauftemperatur	°C	60

Technical information about the heat pump.

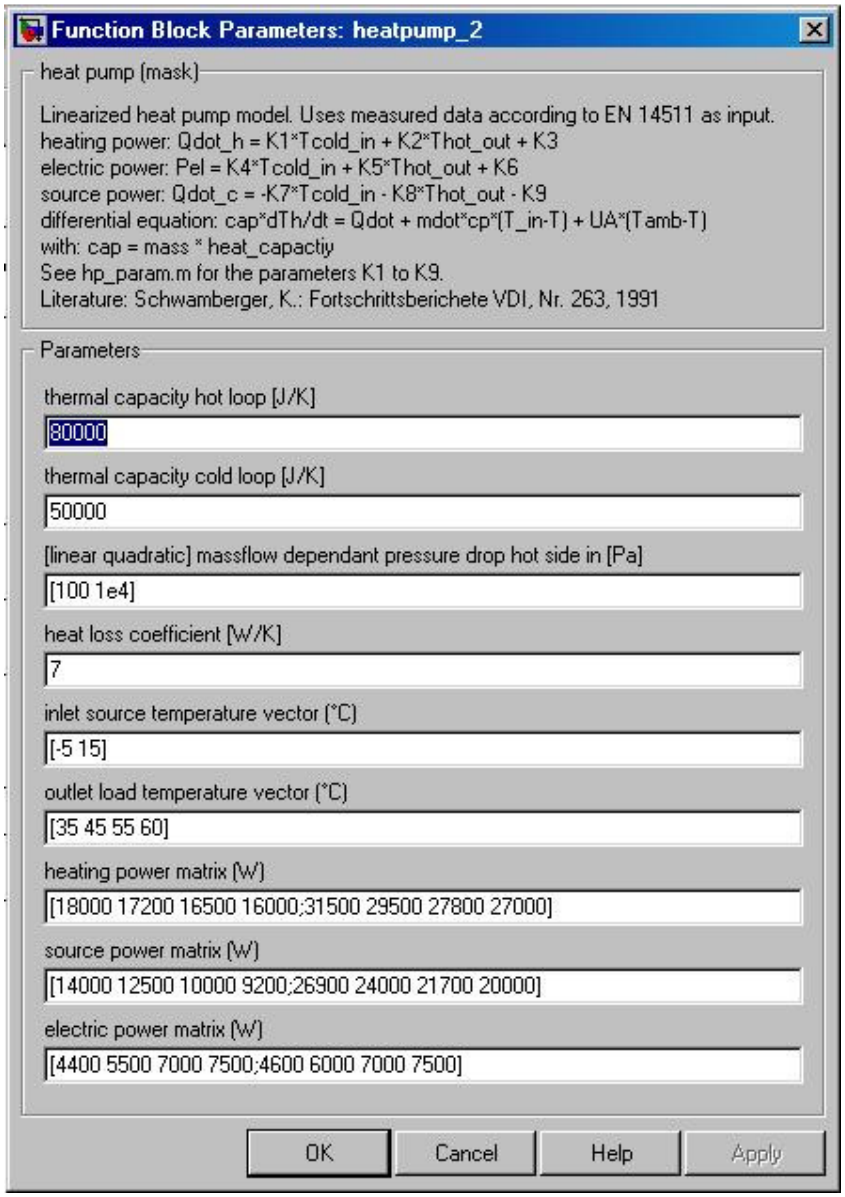


Figure 1 : Adjusted parameters for validation with VITOCAL300-G BW 121

2.1.3 Data

I use the data of one day : 17th october 2009.

The following data are used (original name is in brackets) :

- Compressor power in W (*Verdichterleistung in W*)
- Heating power in kW (*Leistung_Ladekreis_Puffer*)
- Inlet temperature of antifreeze loop in °C (*VL_Solekreis*)
- Outlet temperature of antifreeze loop in °C (*RL_Solekreis*)
- Volume flow of antifreeze loop in l/h (*Vol_Solekreis*)
- Inlet temperature of hot loop in °C (*RL_Ladekreis_Puffer*)
- Outlet temperature of hot loop in °C (*VL_Ladekreis_Puffer*)
- Volume flow of heating loop in l/h (*Vol_Ladekreis_Puffer*)

Command is calculated with compressor power data :

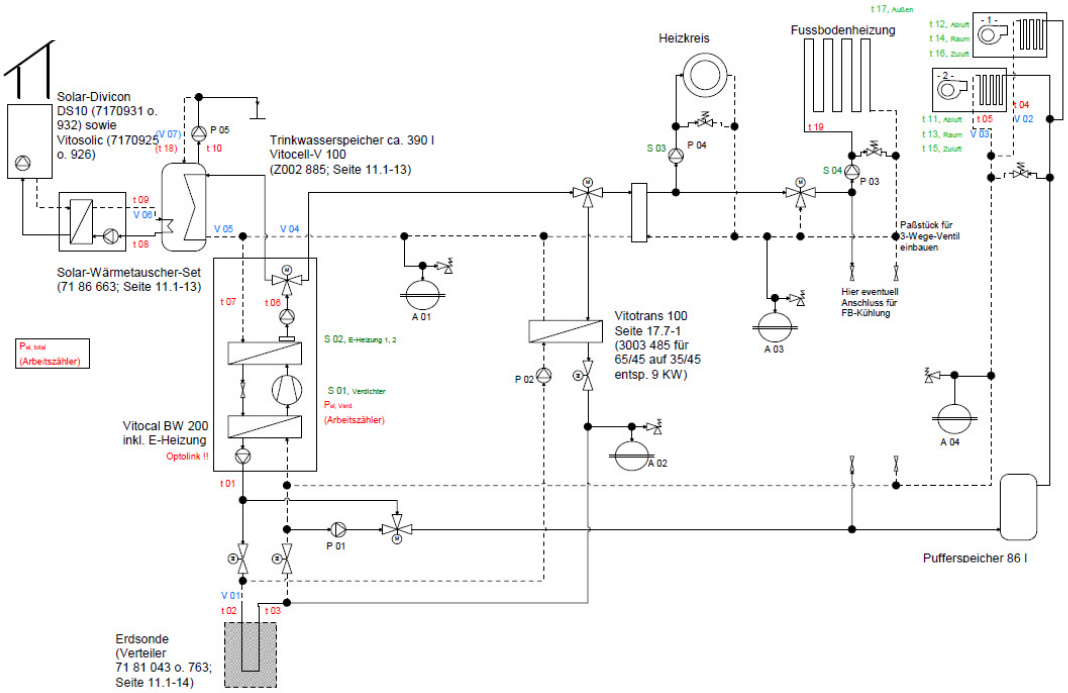
command = (if Pel>0 then 1 else 0)

I choose to use only data about the heating loop (and not about the DHW loop) because there are few requests for DHW : only once at the beginning and once at the end, both during a short time. I make my calculus with the data between these two events.

2.2 Installation „S“

2.2.1 General description

DHW production, heating, natural cooling and air-conditioning with a heat pump and solar panels. Solar energy is used as primary energy for DHW production. The heat pump is used as primary energy for heating, natural cooling and air-conditioning and as additional heating for DHW.



Installation scheme.

2.2.2 Heat pump description

The heat pump is a VITOCAL 200 BWP 108. It is a water-glycol mix/water heat pump with a nominal heat power of 7.7 kW.

Vitocal 200	Typ	BWP 106	BWP 108
Leistungsdaten Wärmepumpe[*1]			
Heizleistung	kW	6,1	7,7
Kälteleistung	kW	4,7	5,9
Elektr. Leistungsaufnahme	kW	1,4	1,8
Leistungszahl ε (COP) bei Heizbetrieb		4,3	4,3
Leistungsdaten Heizwasser-Durchlauferhitzer (Zubehör)			
Wärmeleistung	kW		stufig 3/6/9
Heizleistung mit Heizwasser-Durchlauferhitzer	kW	15,1	16,7
Sole (primär)			
Inhalt	Liter	1,6	2,1
min. Durchsatz[*2]	Liter/h	1200	1400
max. externer Durchflusswiderstand	mbar	400	480
max. Eintrittstemperatur	°C	25	25
min. Eintrittstemperatur	°C	–5	–5
Heizwasser (sekundär)			
Inhalt, Wärmepumpe	Liter	1,6	1,8
Inhalt, gesamt	Liter	7,0	7,2
min. Durchsatz[*2]	Liter/h	800	800
max. externer Durchflusswiderstand	mbar	450	450
max. Vorlauftemperatur	°C	60	60
Elektrische Werte			
Nennspannung (Wärmepumpe komplett)			3/N/PE 400 V~/50 Hz
Nennspannung (Steuerstromkreis)			230 V~/50 Hz
Nennstrom (Verdichter)	A	5,5	6,0
Anlaufstrom (Verdichter)	A	25,0	14,0[*3]
Anlaufstrom (Verdichter bei blockiertem Rotor)	A	32,0	35,0
Elektr. Leistungsaufnahme			
– Umwälzpumpe Solekreis bei Stufe 1/2/3	W	62/92/132	195/175/120
– Umwälzpumpe Heizkreis bei Stufe 1/2/3	W		62/92/132
Absicherung (träge)	A	3 × 16	3 × 16[*4]
Schutzart			IP 20
Absicherung (intern)			T 6,3 A H
Kältekreis			
Arbeitsmittel			R 410 A
Füllmenge	kg	1,050	1,200
Verdichter	Typ		Scroll Vollhermetik

Technical information about the heat pump.

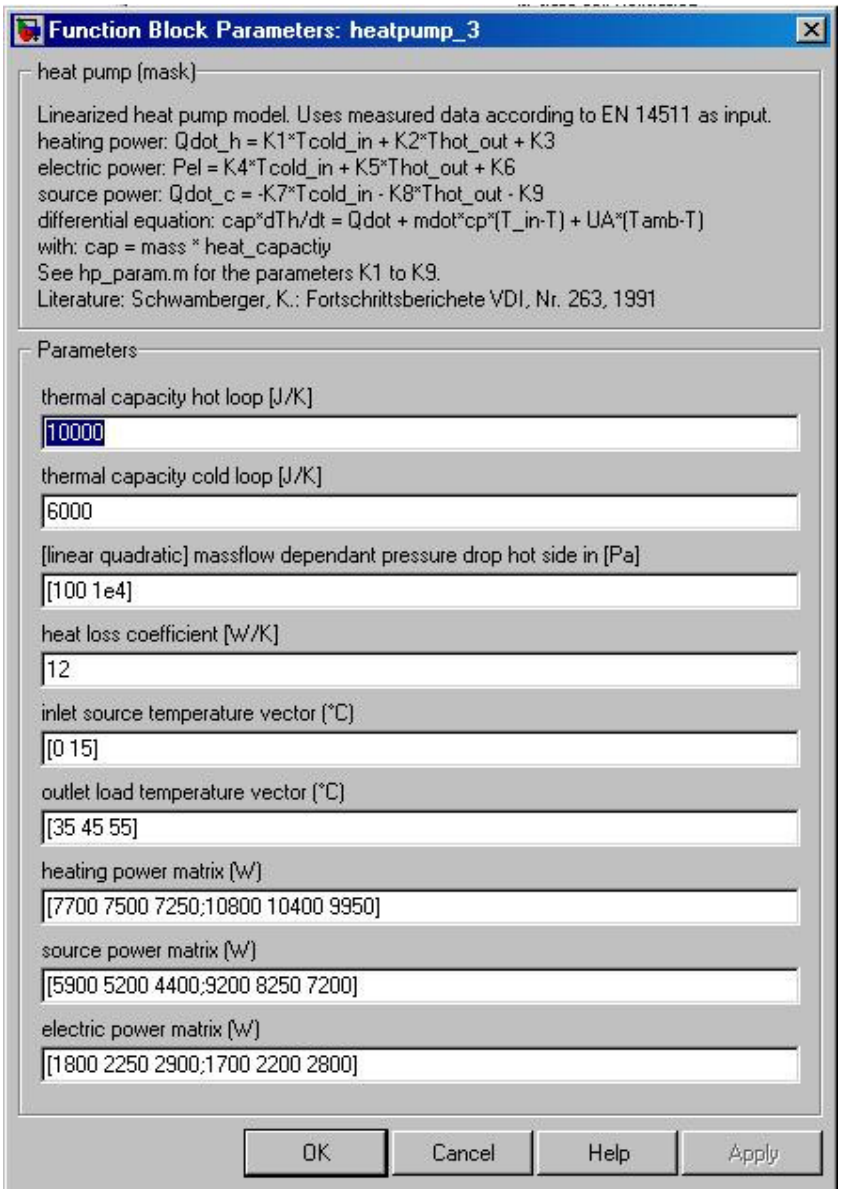


Figure 2 : Ajusted parameters for validation with VITOCAL200 BWP 108

2.2.3 Data

I use the data of three days :

- 22th April 2006 ;
- 5th October 2006 ;
- 7th October 2006.

These days are chosen in order to **study heating capacity of the heat pump** (there are no request for natural cooling or air-conditioning).

The following data are used (original name is in brackets) :

- Compressor power in W (*Reserve5* or *Leistung_el in W*)
- Heating power in kW (*Leistung _Puffer*)

- DHW heating power in kW (*Leistung_Speicher*)
- Inlet temperature of antifreeze loop in °C (*RL_Primär WP*)
- Outlet temperature of antifreeze loop in °C (*RL_Primär WP*)
- Volume flow of antifreeze loop in l/h (*RL_Erdsonde*)
- Inlet temperature of heating loop in °C (*RL_ Puffer_Speicher*)
- Outlet temperature of the part of the hot loop used for heating in °C (*VL_ Puffer*)
- Outlet temperature of the part of the hot loop used for DHW heating in °C (*VL_Speicher*)
- Volume flow of the part of the hot loop used for heating in l/h (*RL_Puffer*)
- Volume flow of the part of the hot loop used for DHW heating in l/h (*RL_Speicher*)
- Command of the heatpump (0 ou 5) (*Verdichter*)

3 Results

3.1 Installation „L“

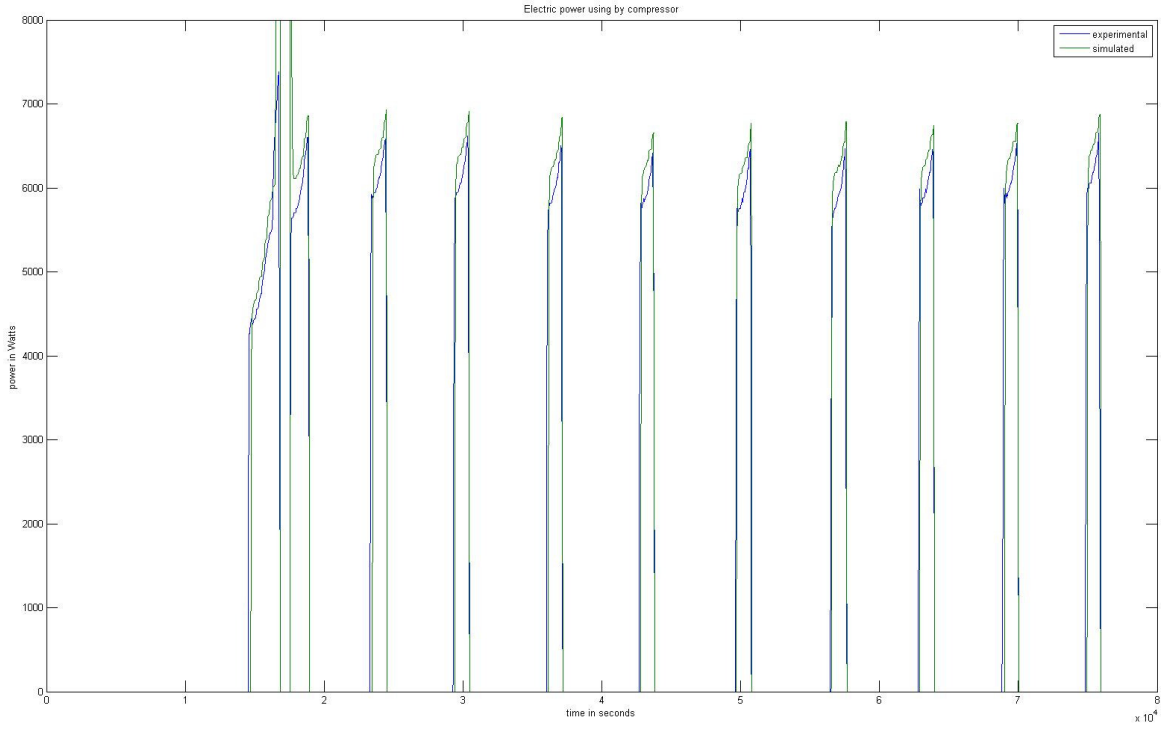


Figure 3 : Electric power used by the compressor

The instantaneous errors of electric power are less than 5%, which is the commonly maximum error between theorical technical data and practical values.

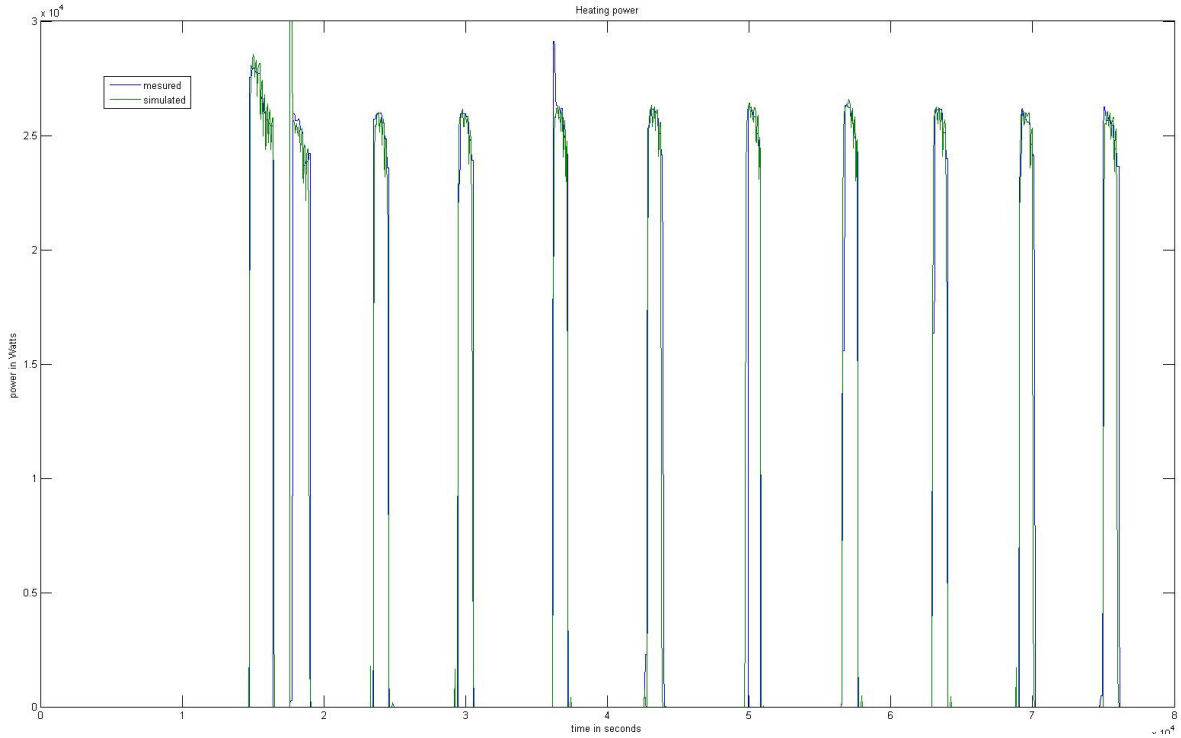


Figure 3 : Heating power

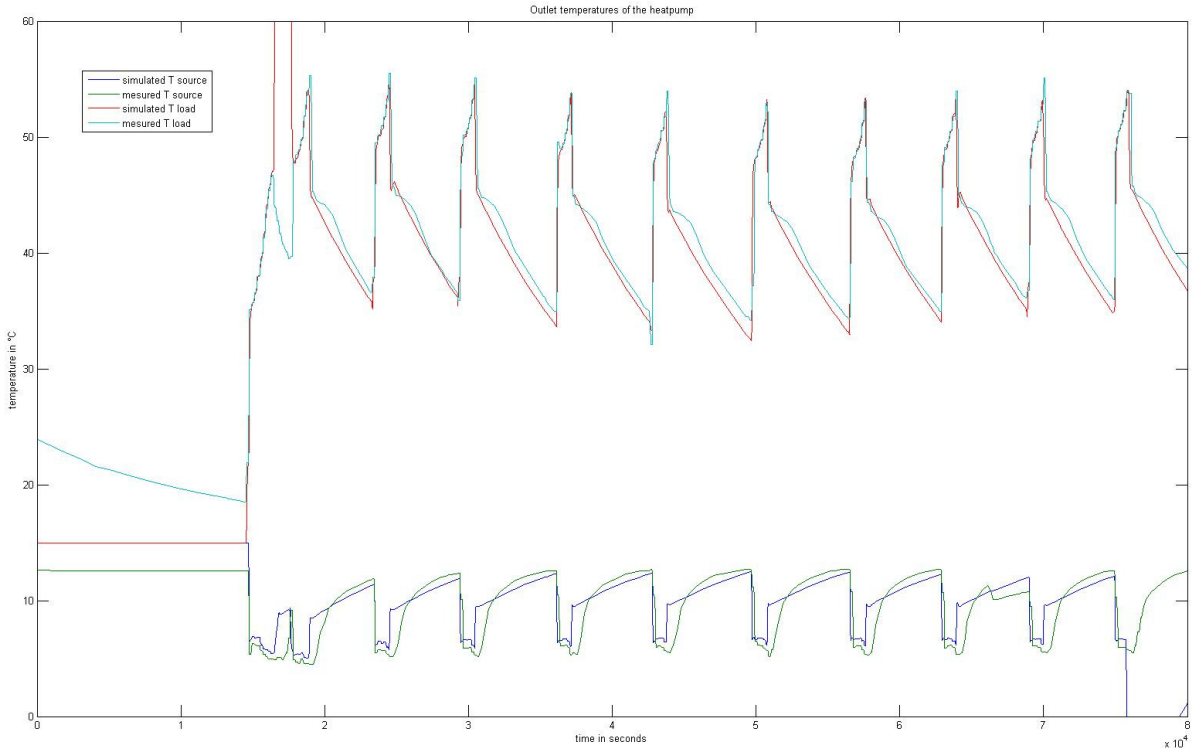


Figure 4 : Outlet temperatures of the heatpump

3.2 Installation “S”

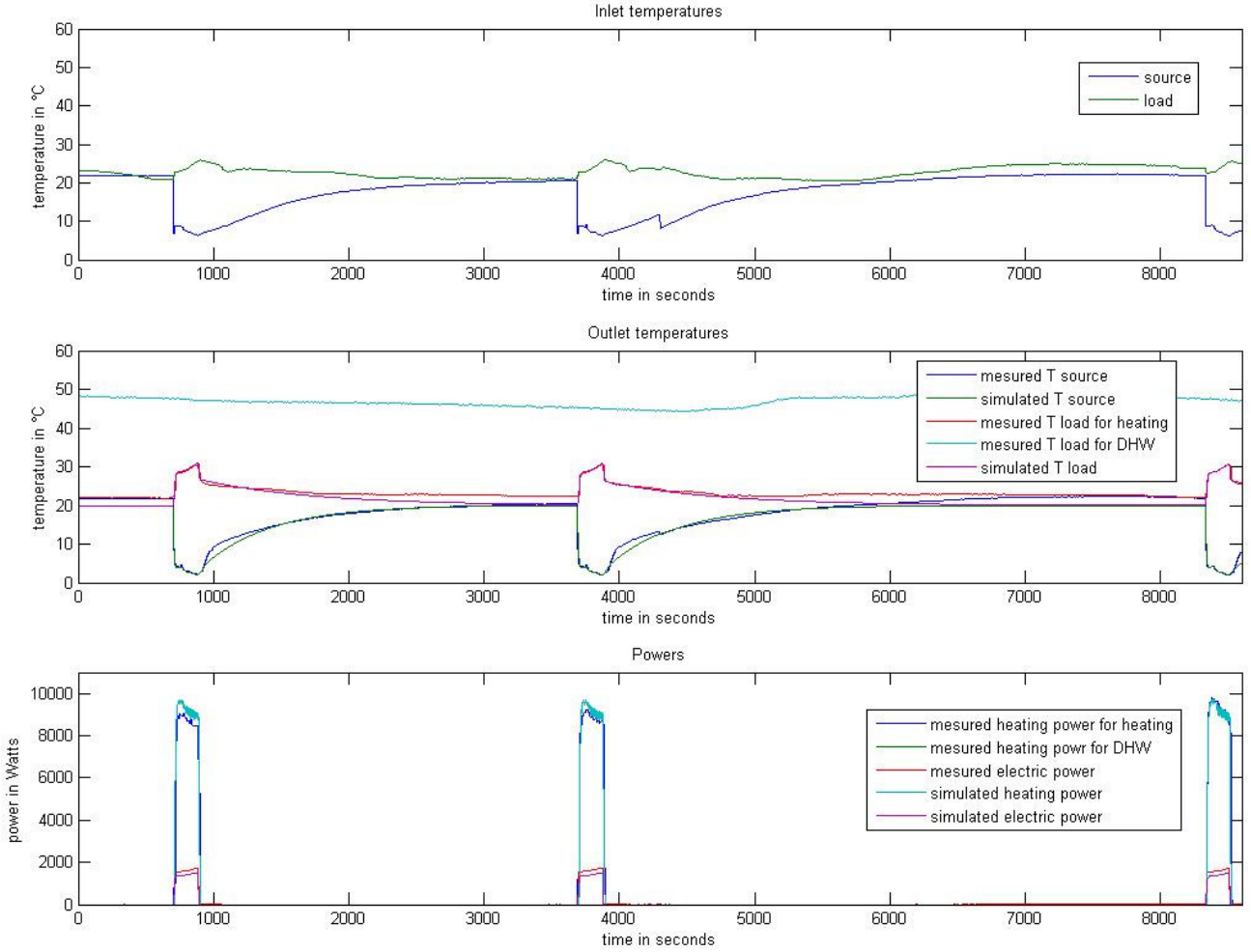


Figure 5 : Results for 22.04.2006

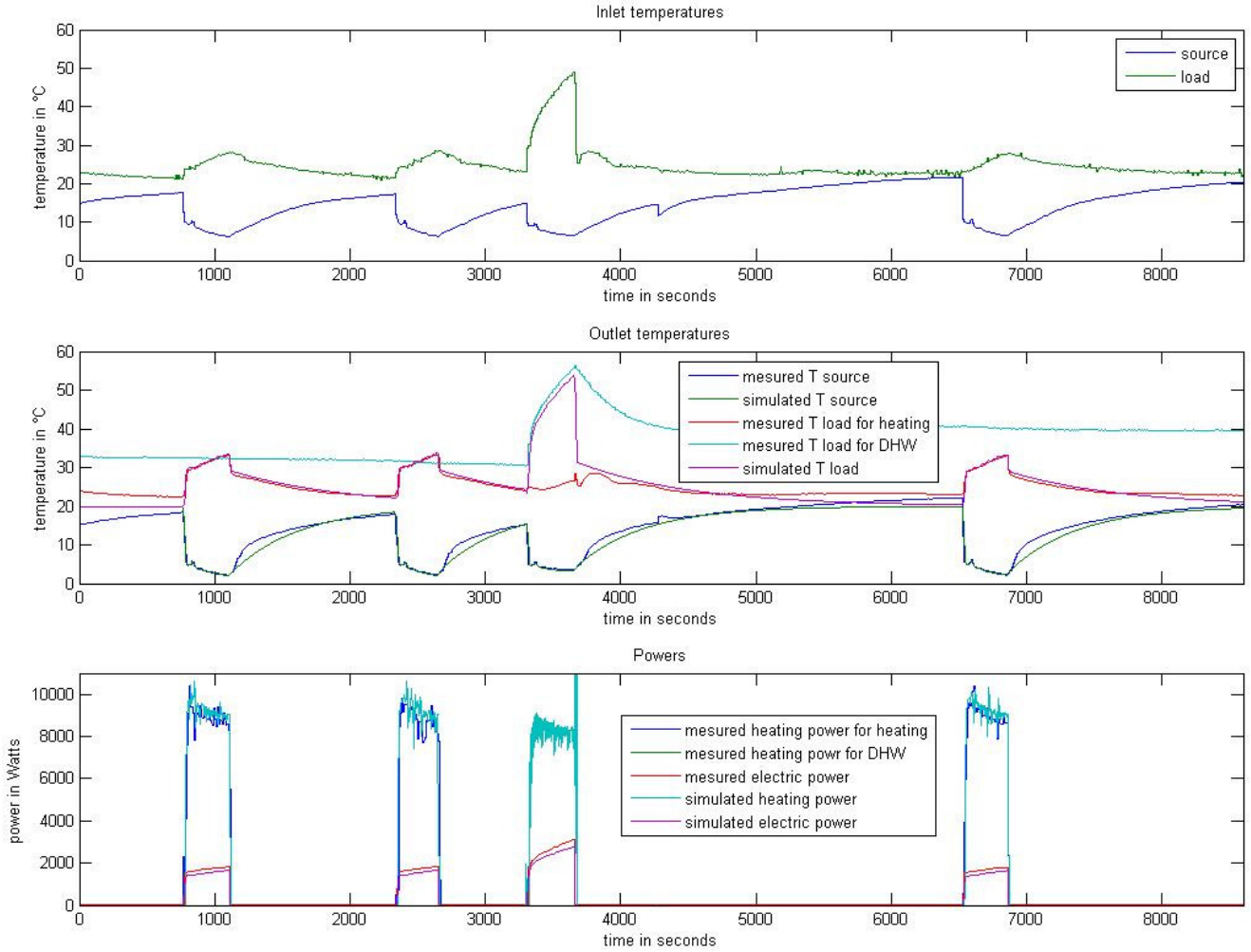


Figure 6 : Results for 05.10.2006

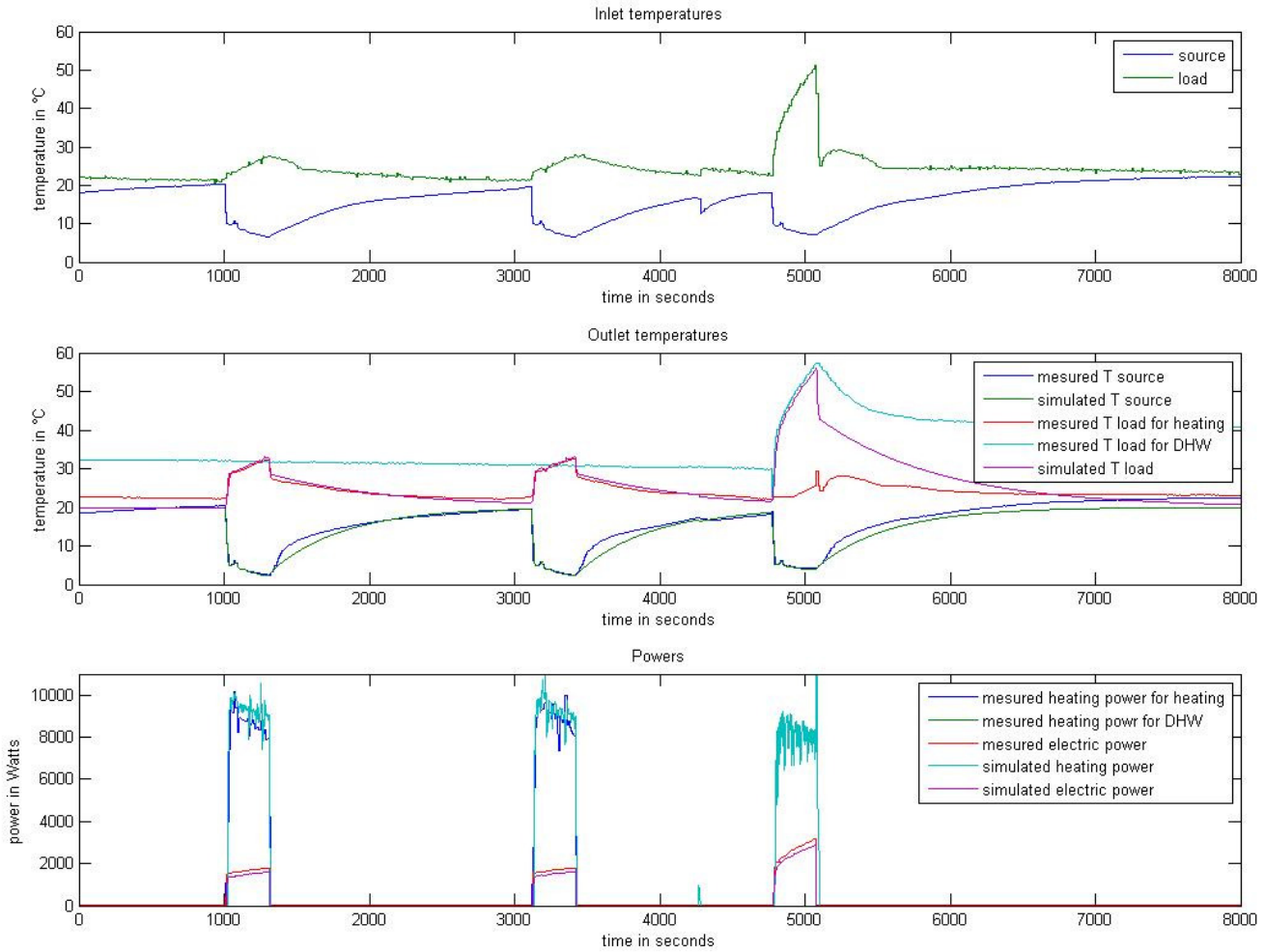


Figure 7 : Results for 07.10.2006

3.3 Conclusion

Validation is completed.