

Practical examples for optimization measures



Full member of:

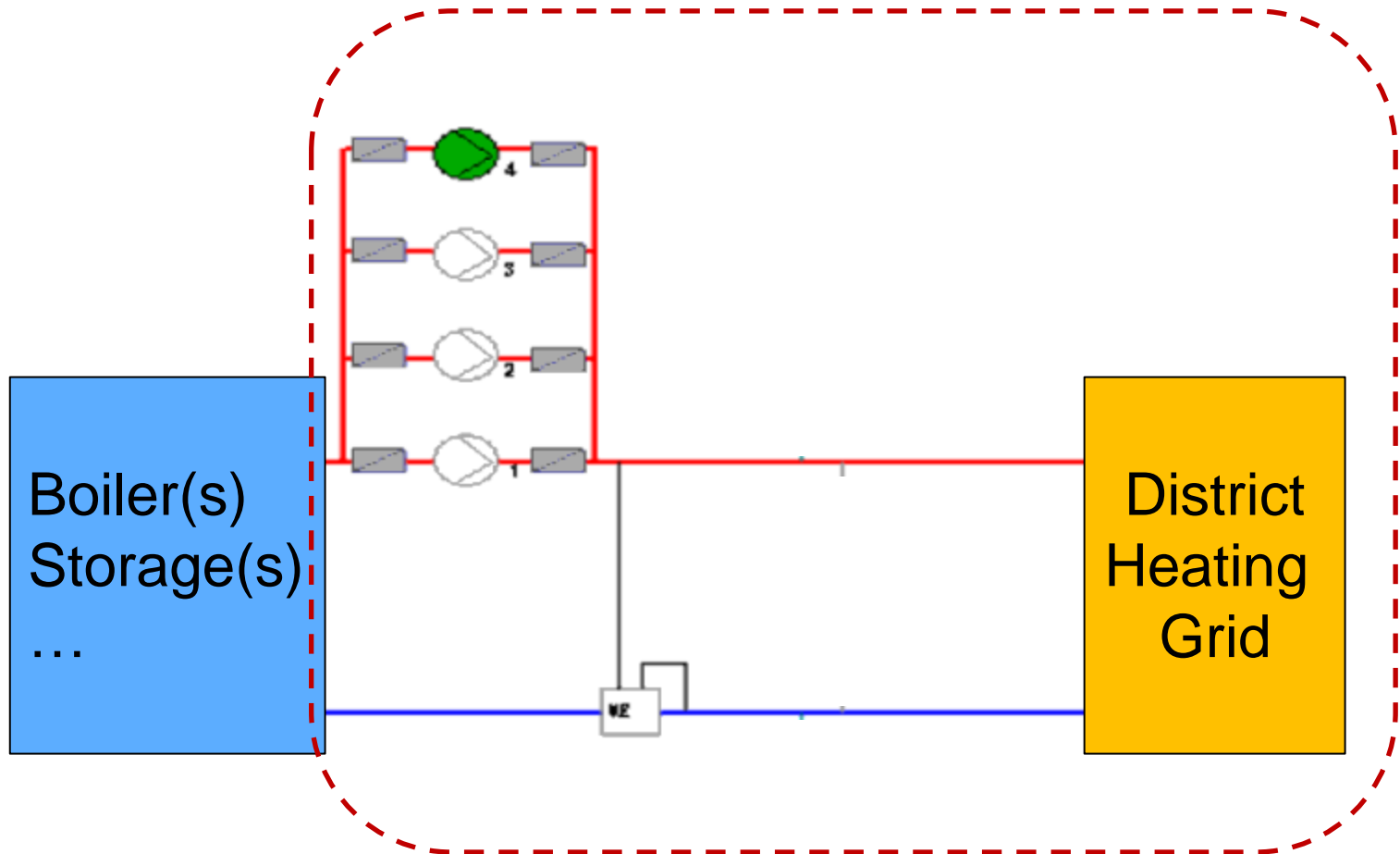


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From the heating central to the customer



Basics for DH grids

- ◆ Minimize pipe network losses
- ◆ Minimize pump energy

**Minimize return
flow temperature!**

Basics: Minimize return flow temperature

Betriebszeit:	8760 h
Temperatur Vorlauf:	85 °C
Temperatur Rücklauf:	55 °C
Temperatur Erdreich:	10 °C
Verkaufte Wärmemenge:	3.224 MWh

Betriebszeit:	8760 h
Temperatur Vorlauf:	85 °C
Temperatur Rücklauf:	40 °C
Temperatur Erdreich:	10 °C
Verkaufte Wärmemenge:	3.224 MWh

Rohrdimension	Rohrlänge	Wärmedurchgangskoeff. T-abhängig	Verlust-Leistung	Fiktiver Jahreswärmeverlust
[Text]	[m]	[W/mK]	[kW]	[kWh/a]
10	11	13	14	15
DN 20	1.543	0,1261	11,7	102.245
DN 25	3.988	0,1130	27,0	236.875
DN 32	3.997	0,1340	32,1	281.527
DN 40	2.194	0,1450	19,1	167.229
DN 50	1.298	0,1840	14,3	125.538
DN 65	1.961	0,2070	24,4	213.308
DN 80	736	0,2160	9,5	83.613
DN 100	1.077	0,2499	16,1	141.464
DN 125	681	0,2851	11,7	102.094
Summe:	17.476		165,97	1.453.893

Rohrdimension	Rohrlänge	Wärmedurchgangskoeff. T-abhängig	Verlust-Leistung	Fiktiver Jahreswärmeverlust
[Text]	[m]	[W/mK]	[kW]	[kWh/a]
10	11	13	14	15
DN 20	1.543	0,1261	10,2	89.464
DN 25	3.988	0,1130	23,7	207.266
DN 32	3.997	0,1340	28,1	246.336
DN 40	2.194	0,1450	16,7	146.325
DN 50	1.298	0,1840	12,5	109.846
DN 65	1.961	0,2070	21,3	186.645
DN 80	736	0,2160	8,4	73.161
DN 100	1.077	0,2499	14,1	123.781
DN 125	681	0,2851	10,2	89.332
Summe:	17.476		145,22	1.272.156

Ergebnis:

Netzlänge-Trasse :	8.738 trm
Netzlänge Rohrleitungsnetz :	17.476 m
Spreizung im Auslegungsfall :	30 °C
Wärmeverlustleistung Netz :	165,97 kW
Jahreswärmeverlust (auf Basis der derzeit angenommenen Betriebsweise) :	1.454 MWh
Maximalwärmeverlust - Referenzwert :	1.454 MWh
Verk. Jahreswärmemenge inkl. Netzverlust :	4.678 MWh
Prozentueller Referenzwert Netzverlust :	31,08 %

Ergebnis:

Netzlänge-Trasse :	8.738 trm
Netzlänge Rohrleitungsnetz :	17.476 m
Spreizung im Auslegungsfall :	45 °C
Wärmeverlustleistung Netz :	145,22 kW
Jahreswärmeverlust (auf Basis der derzeit angenommenen Betriebsweise) :	1.272 MWh
Maximalwärmeverlust - Referenzwert :	1.272 MWh
Verk. Jahreswärmemenge inkl. Netzverlust :	4.496 MWh
Prozentueller Referenzwert Netzverlust :	28,29 %

Example of pipe network losses calculation

	85 / 55 °C	85 / 40 °C	Difference
Energy sold to customers [MWh/a]:	3.224	3.224	0
Ø ΔT supply/return flow [°C]:	30	45	15
Capacity of losses [kW]:	166,0	145,2	20,7
Annual pipe network losses:	1.454	1.272	182
Energy delivered to pipe network:	4.678	4.496	182
Annual water volume for pumps:	137.083	87.838	49.245
Elect. energy for pumps:	27.965	9.470	18.495

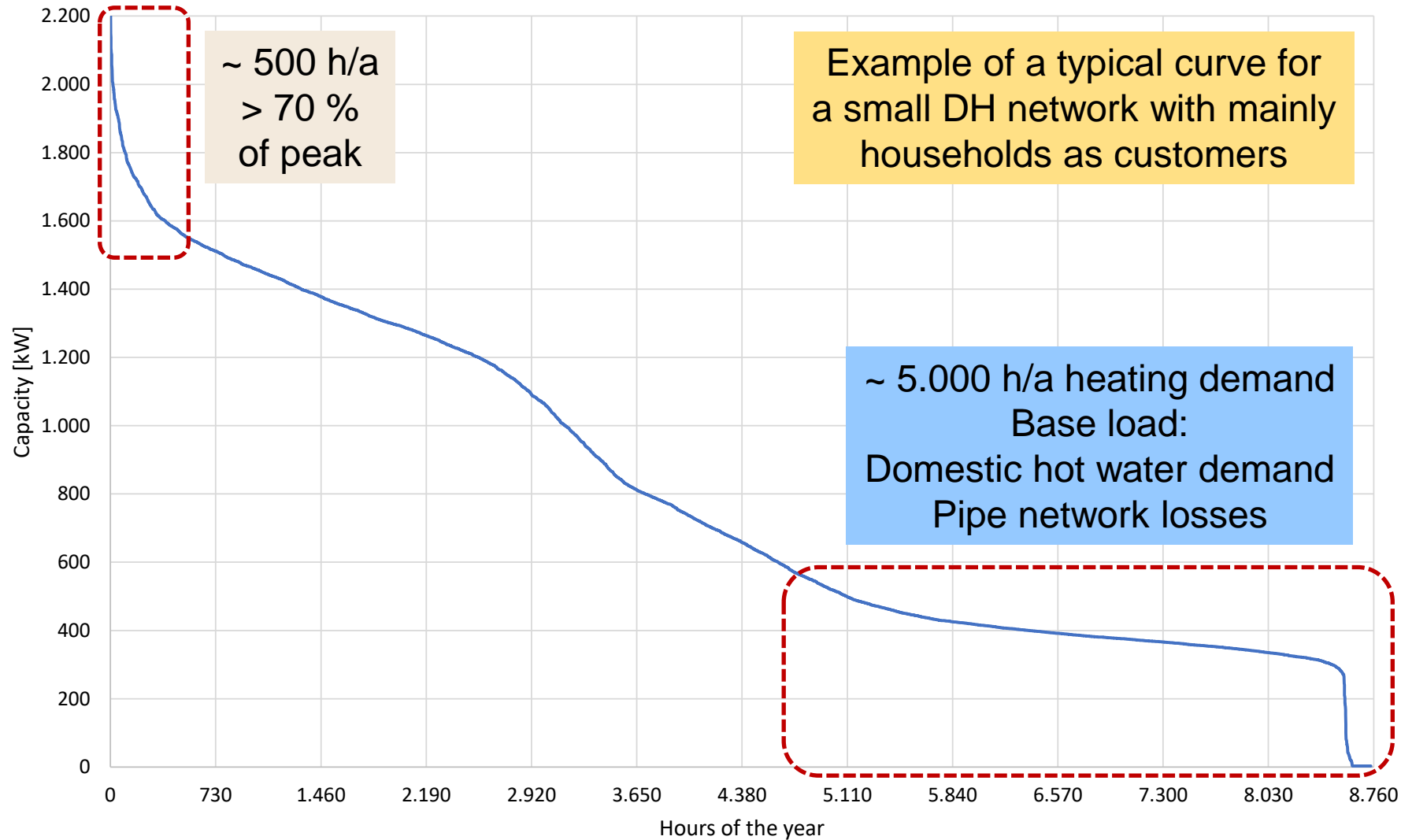
Biomass savings - 12,5 %

Elect. energy pumps savings - 66,1 %

Importance of data

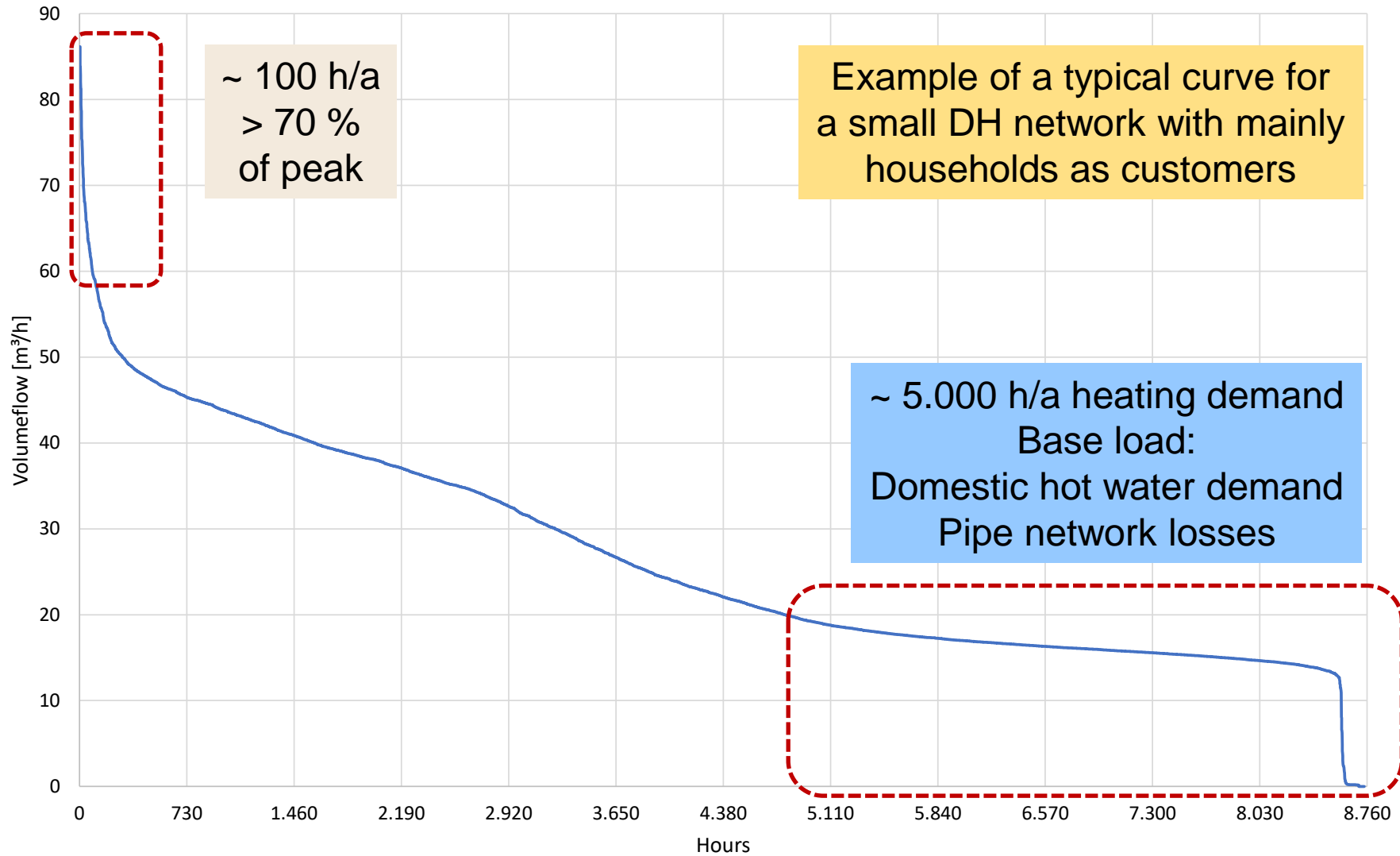
- ◆ Heat meter input district heating grid
- ◆ Hourly values over one year
 - Volume Flow [m³/h]
 - Supply temperature [°C]
 - Return temperature [°C]
- ◆ Annual heat capacity duration curve
- ◆ Annual volume flow duration curve

Example of an annual heat capacity duration curve

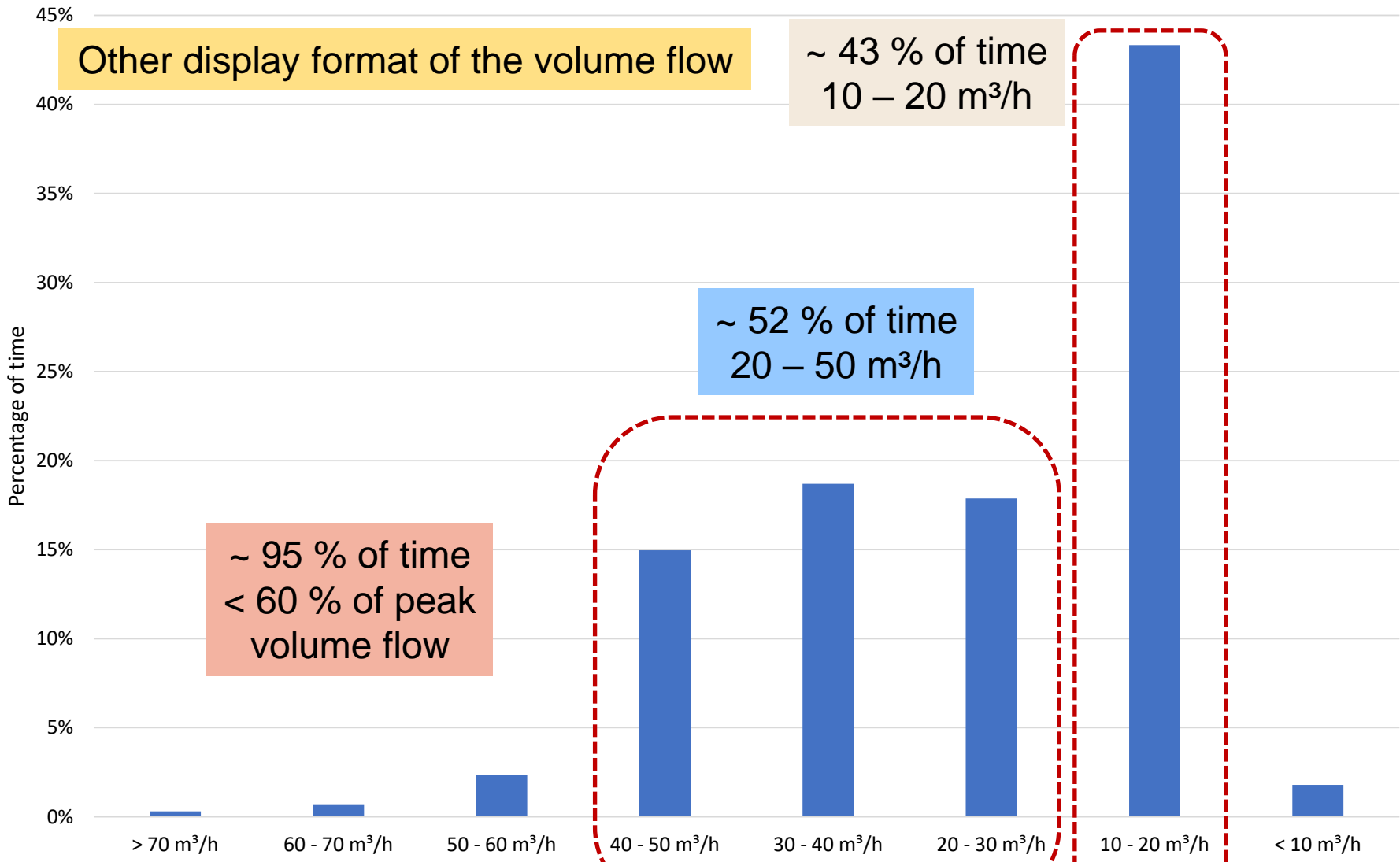


Annual volume flow duration curve

Example of an annual volume flow duration curve



Example of a statistical evaluation of volume flow groups



Important information for pump dimensioning

- ◆ Grid pumps design point => maximum volume flow
- ◆ ~ 95 % of time - < 60 % of peak volume flow
- ◆ ~ 43 % of time - < 25 % of peak volume flow
- ◆ full range => often more than 1 grid pump necessary
- ◆ keep an eye on “summer operation” => 43 % of time between 10 – 20 m³/h

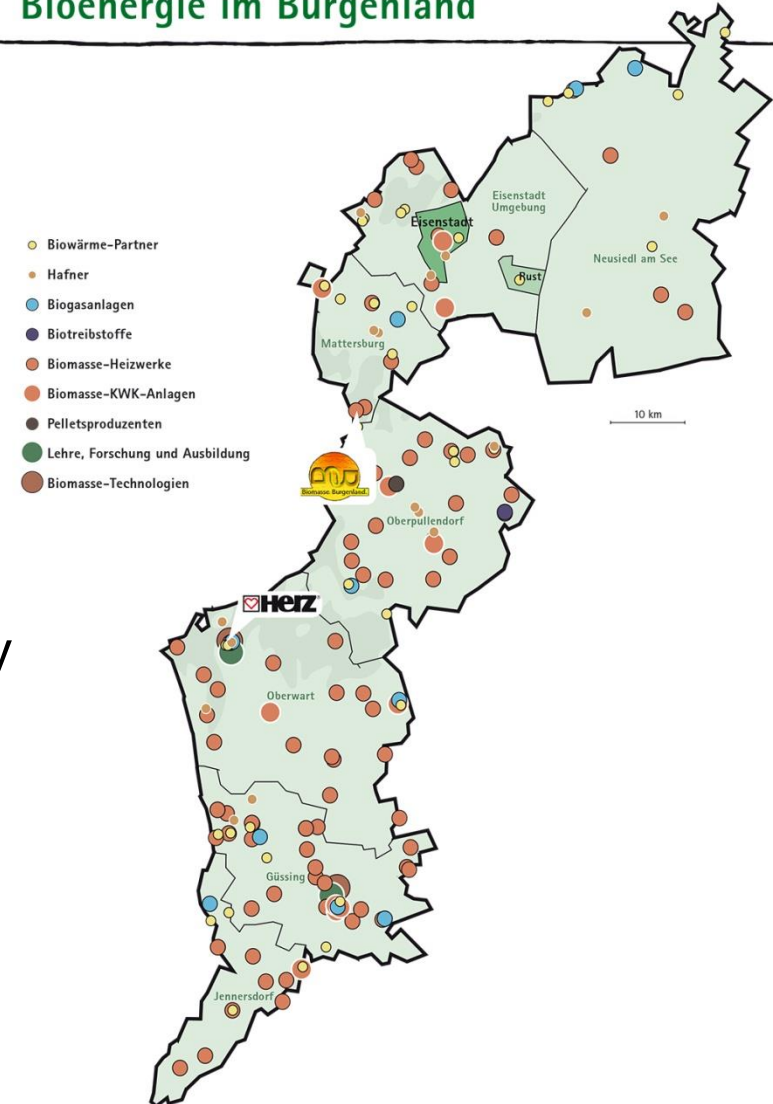
Burgenland

- ◆ 80 heating plants
- ◆ power of 74 MW
- ◆ 2016: 511 TJ heat

Quelle: Bioenergie im Burgenland, Biomasseverband

- ◆ Small DH systems with similar problems:
 - grid with low linear heat density
 - customer mainly households
 - High grid losses

Bioenergie im Burgenland

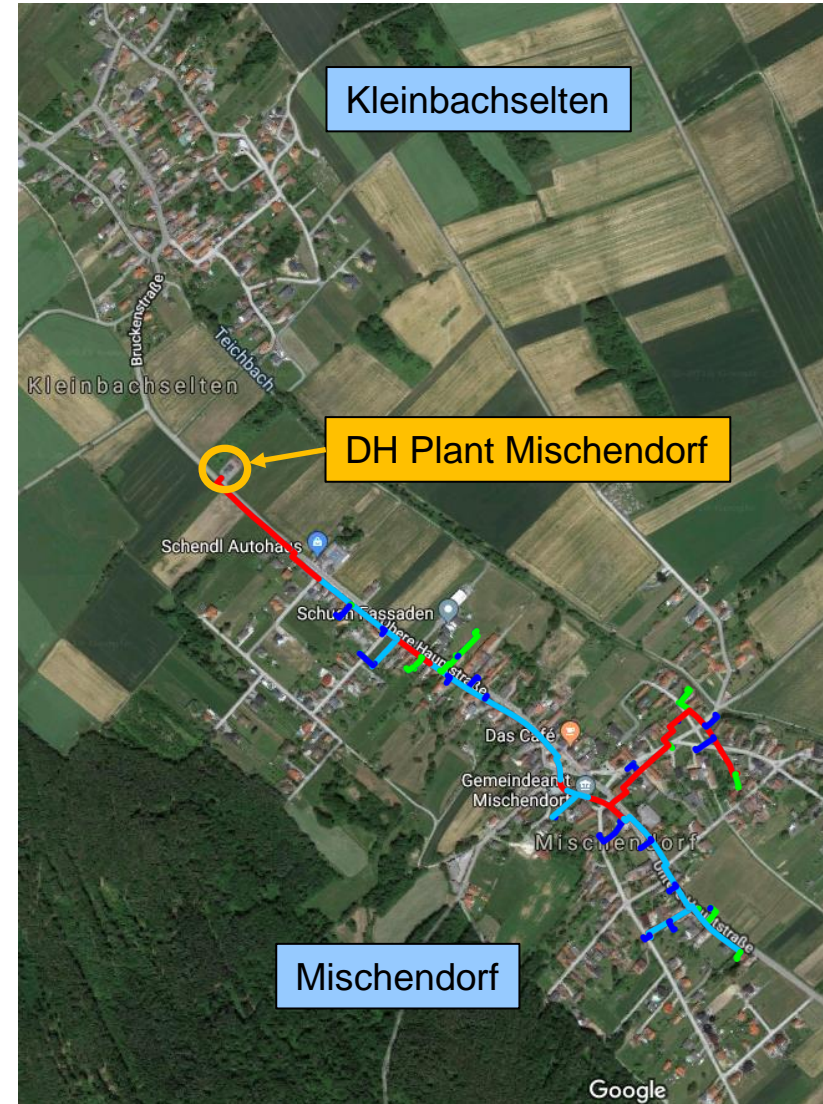


DH Mischendorf

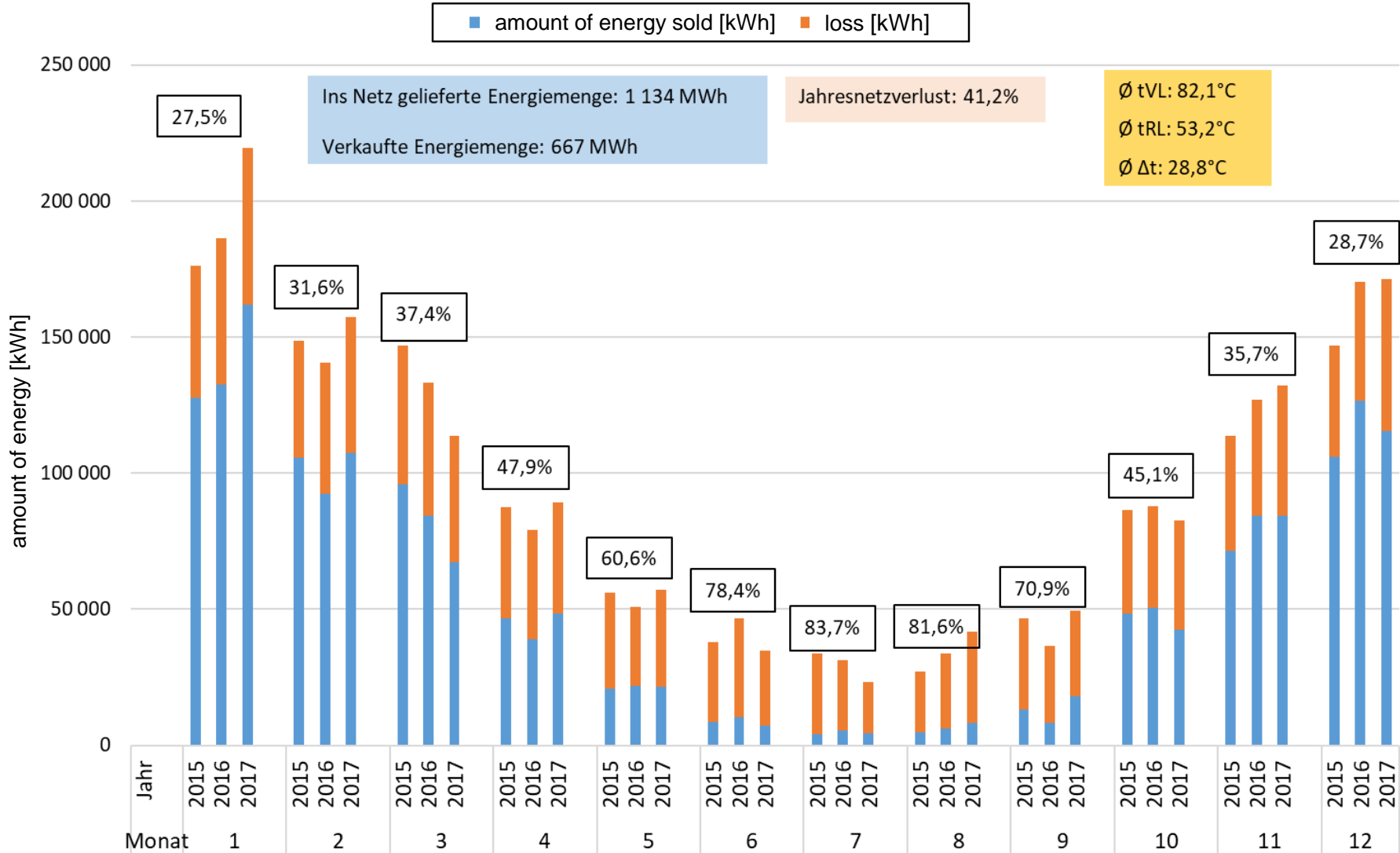
- ◆ Construction year 2007
- ◆ Biomass boiler: 320 kW
- ◆ Oil peak boiler: 400 kW
- ◆ Storage: 15 m³
- ◆ District heating grid: ~ 2.800 trm trench length
- ◆ 26 heat consumer
- ◆ ~ 700 MWh/a sold to customers

- ◆ Basic idea: One DH plant to supply Mischendorf and Kleinbachselten
- ◆ Only the DH grid Mischendorf was built
- ◆ 26 customer
- ◆ 2.800 trm
- ◆ Linear heat density: 248 kWh/(a.trm)

**Pipe network losses!
Pump energy!**

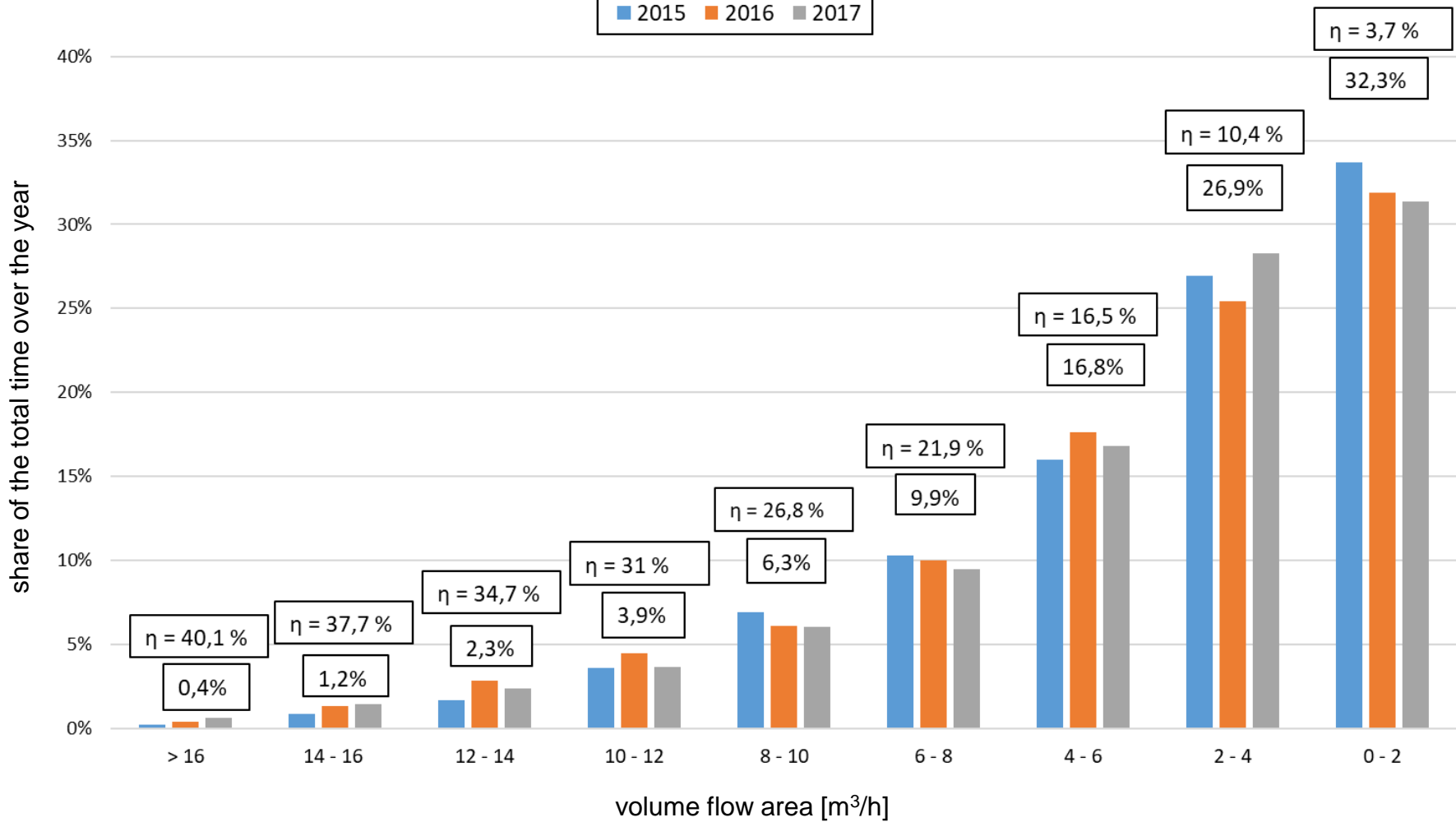


District heating Mischendorf grid losses 2015-2017



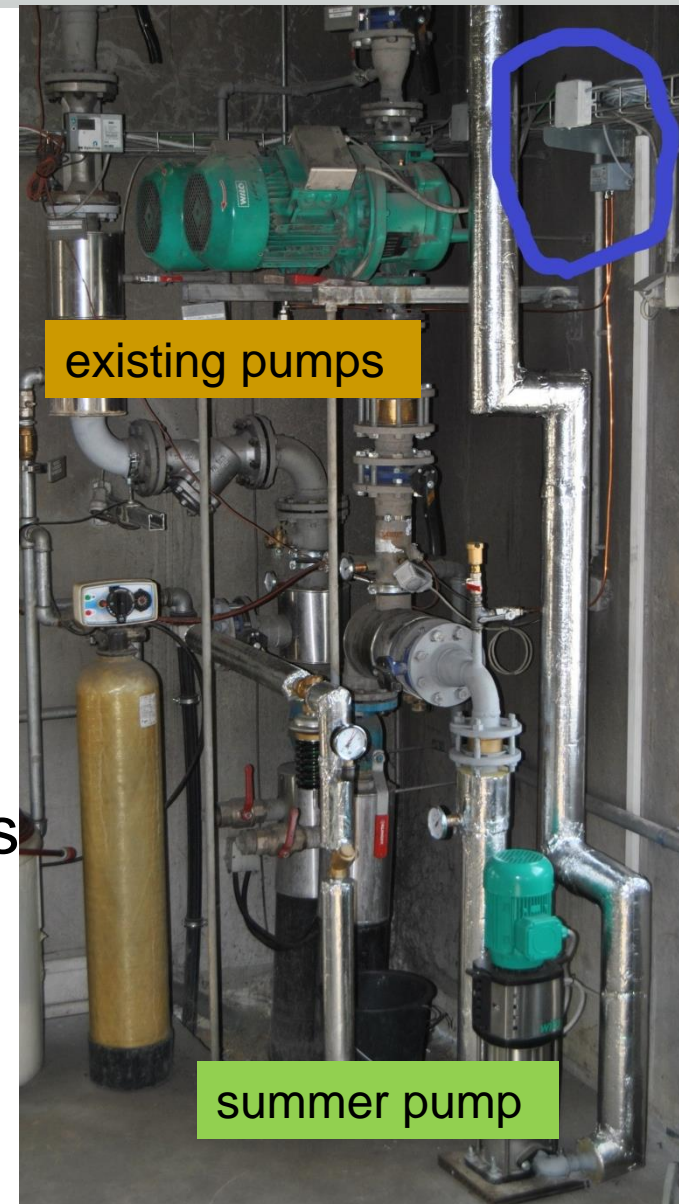
Statistic distribution volume flow groups grid pump FW Mischendorf 2015 - 2017

■ 2015 ■ 2016 ■ 2017



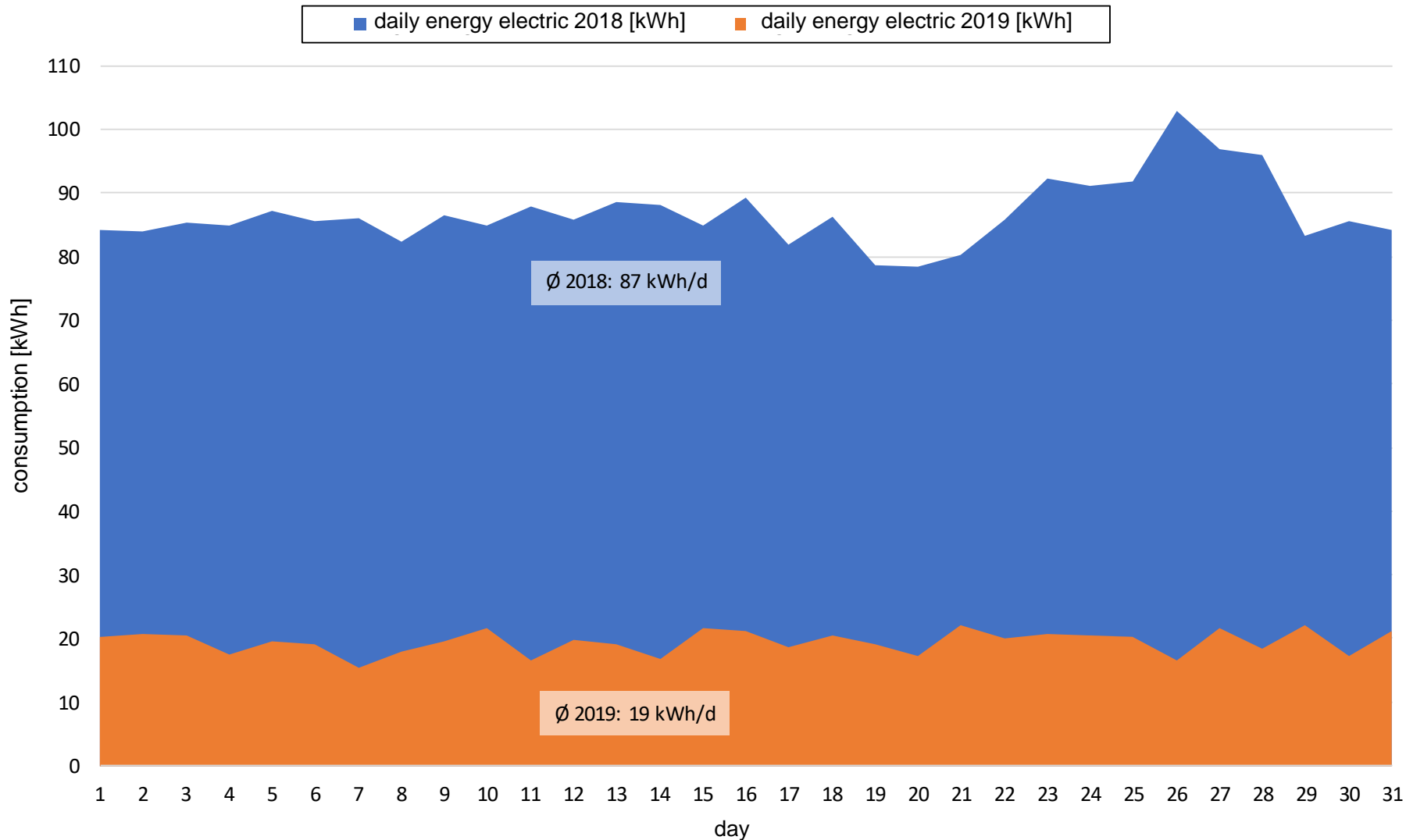
Optimization grid pumps

- ◆ Installation of an additional summer pump
- ◆ Volumerange: 0 – 6 m³/h
- ◆ Differential pressure measurement at the end of DH grid for speed control of pumps
- ◆ automatic switchover with hysteresis
- ◆ existing pumps: 6 – 20 m³/h



Electrical energy consumption boiler house

Comparison of electrical energy boiler house Mischendorf August 2018 to August 2019

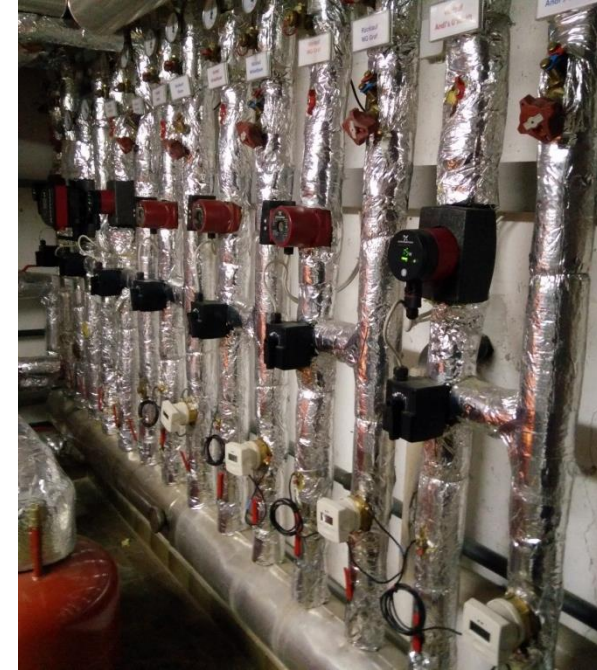
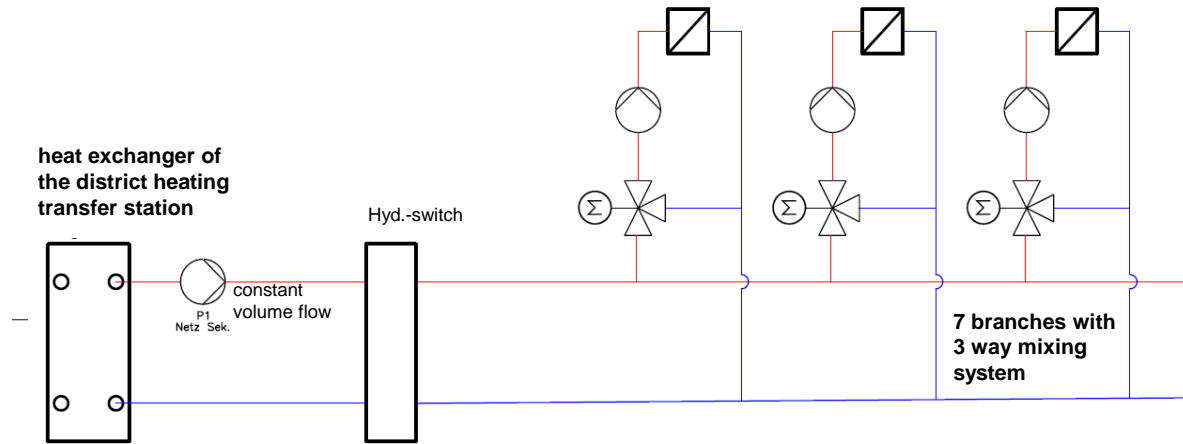


Optimization at customer side

- ◆ Analysis of district heating consumers
- ◆ Key figures ($\emptyset \Delta t$ supply/return) to classify DH consumers
- ◆ Optimization usually only makes economic sense for large customers
- ◆ Largest consumer (~ 25% heat) => problem => on-site analysis

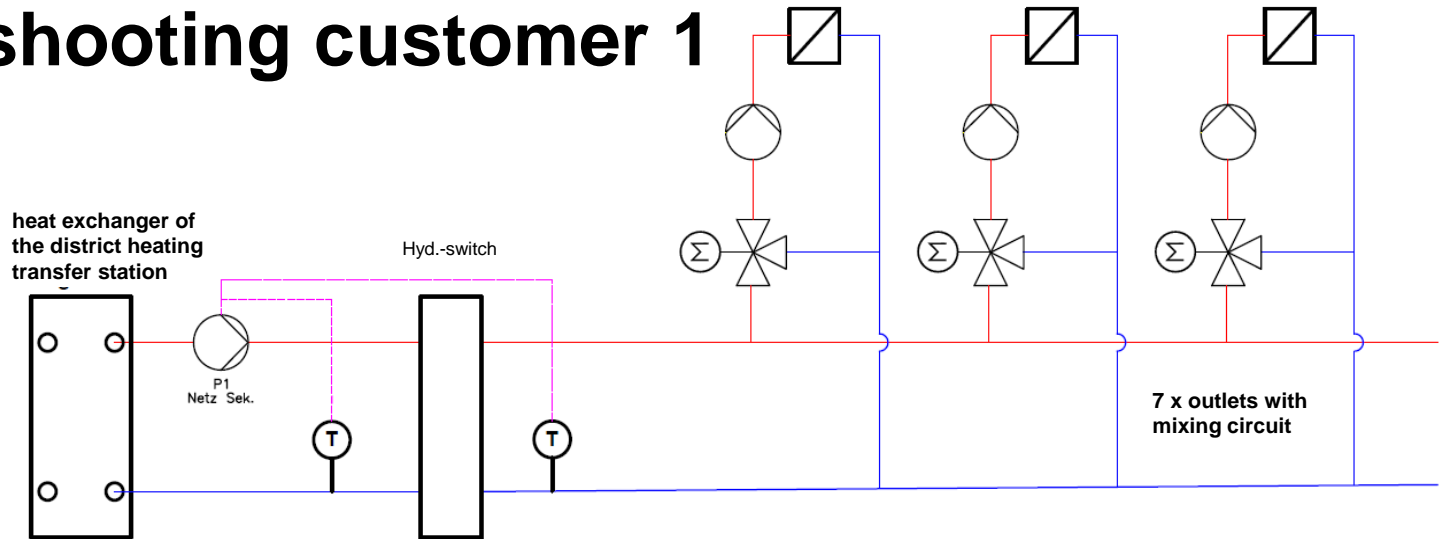
Nr.	District heating customer	Data 2016	
		Annual energy	Spreading
		[kWh]	[°C]
1	FW customer 1	169.781	12,8
2	FW customer 2	35.632	23,8
3	FW customer 3	34.654	24,5
4	FW customer 4	30.438	13,0
5	FW customer 5	30.296	18,5
6	FW customer 6	26.940	16,0
7	FW customer 7	25.262	16,0
8	FW customer 8	24.907	17,8
9	FW customer 9	24.552	31,5
10	FW customer 10	22.410	10,7
11	FW customer 11	21.752	27,4
12	FW customer 12	21.706	24,9
13	FW customer 13	20.556	14,9
14	FW customer 14	18.905	21,7
15	FW customer 15	18.818	26,3
16	FW customer 16	18.623	31,4
17	FW customer 17	18.026	16,3
18	FW customer 18	15.195	8,9
19	FW customer 19	15.146	14,5
20	FW customer 20	14.179	35,4

On-site analysis customer 1



- ◆ Actual status at the time of inspection
- ◆ Problem: Pump with const. volume flow between DH heat exchanger and hydraulic switch
- ◆ Return temperature to DH heat exchanger rises => mixing in hydraulic switch

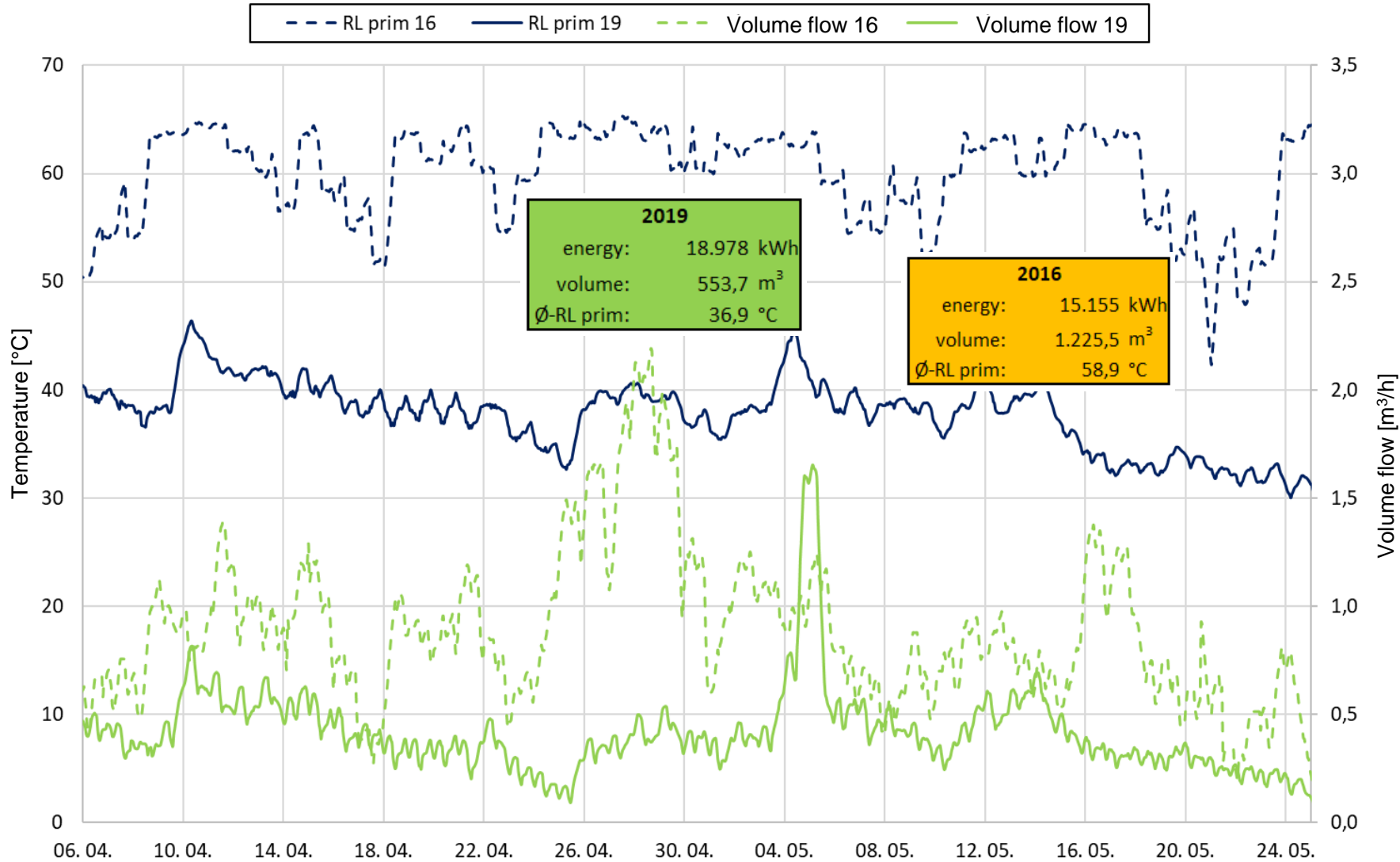
Troubleshooting customer 1



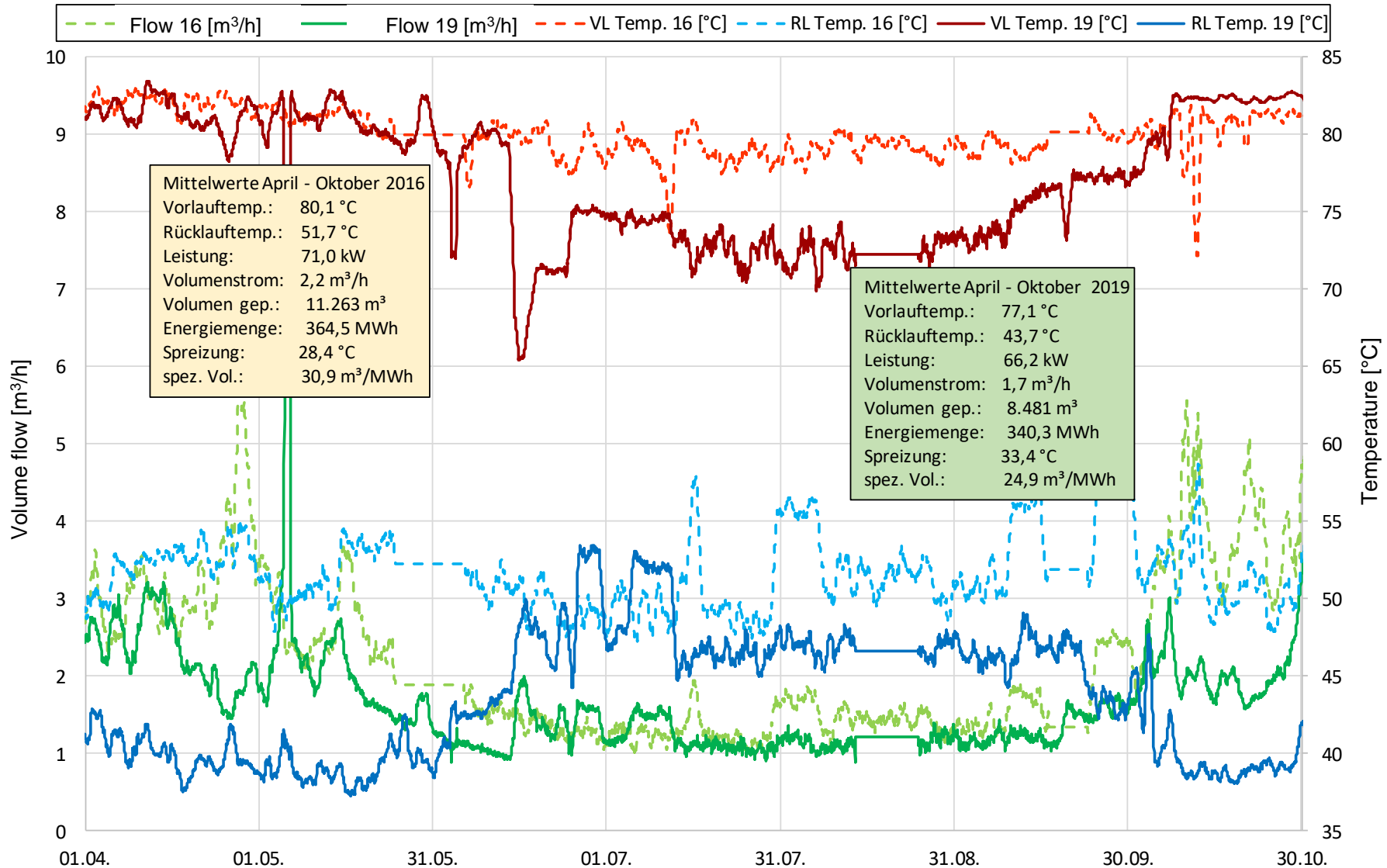
- ◆ Intelligent pump with ΔT control and 2 external temperature sensors
- ◆ Pump minimizes volume flow and return temperature between the heat exchanger and hydraulic switch



Comparison of consumer 1 - 2016 and 2019 - April 6th to may 25th



DH Mischendorf grid heat meter - Comparison April - October 2016/2019 with daily mean values



Result of the optimization measures

Savings of

55 MWh/a biomass

20 MWh/a electr. energy

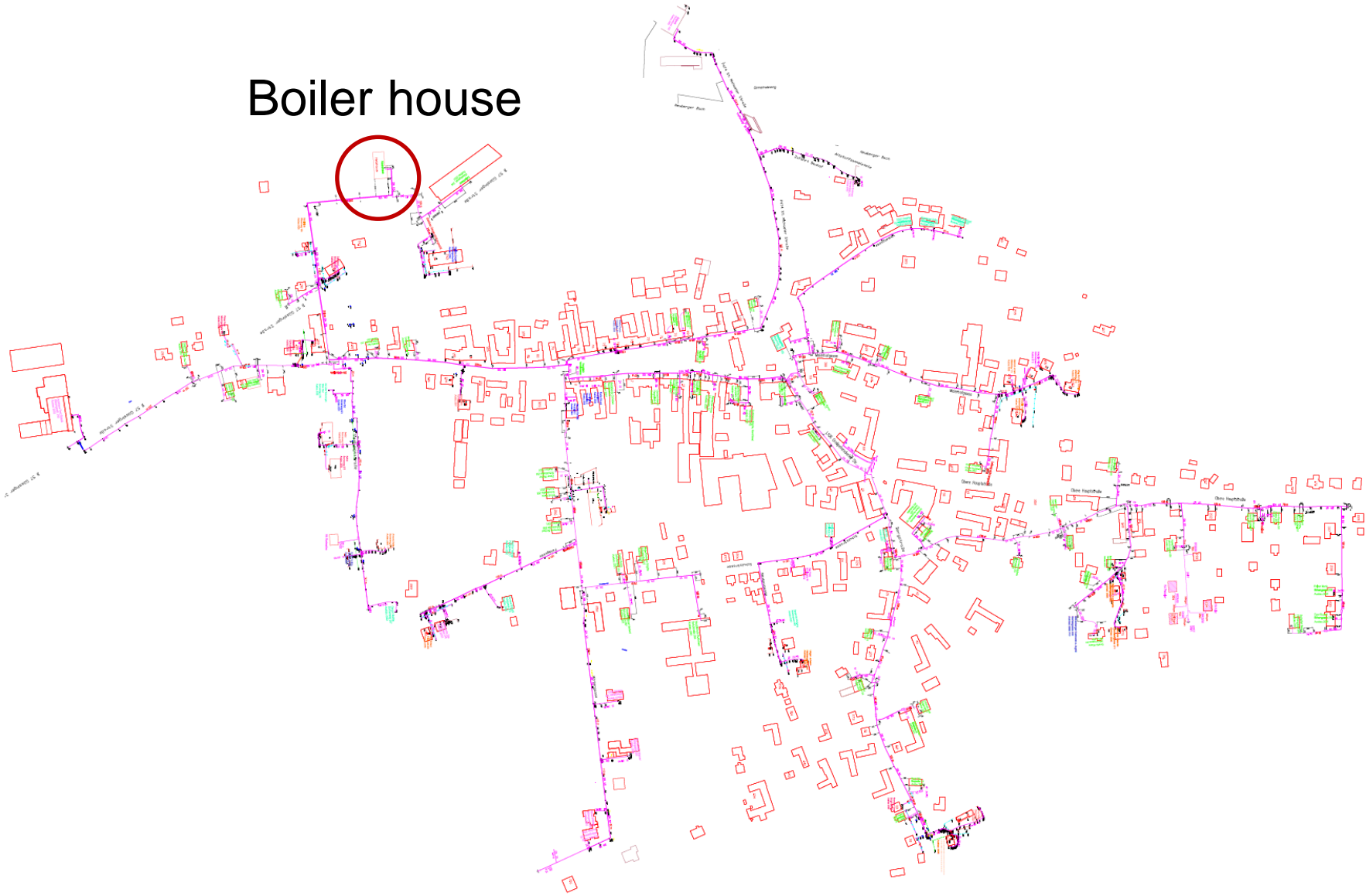
3.800 €/a costs

~ 5 years payback time

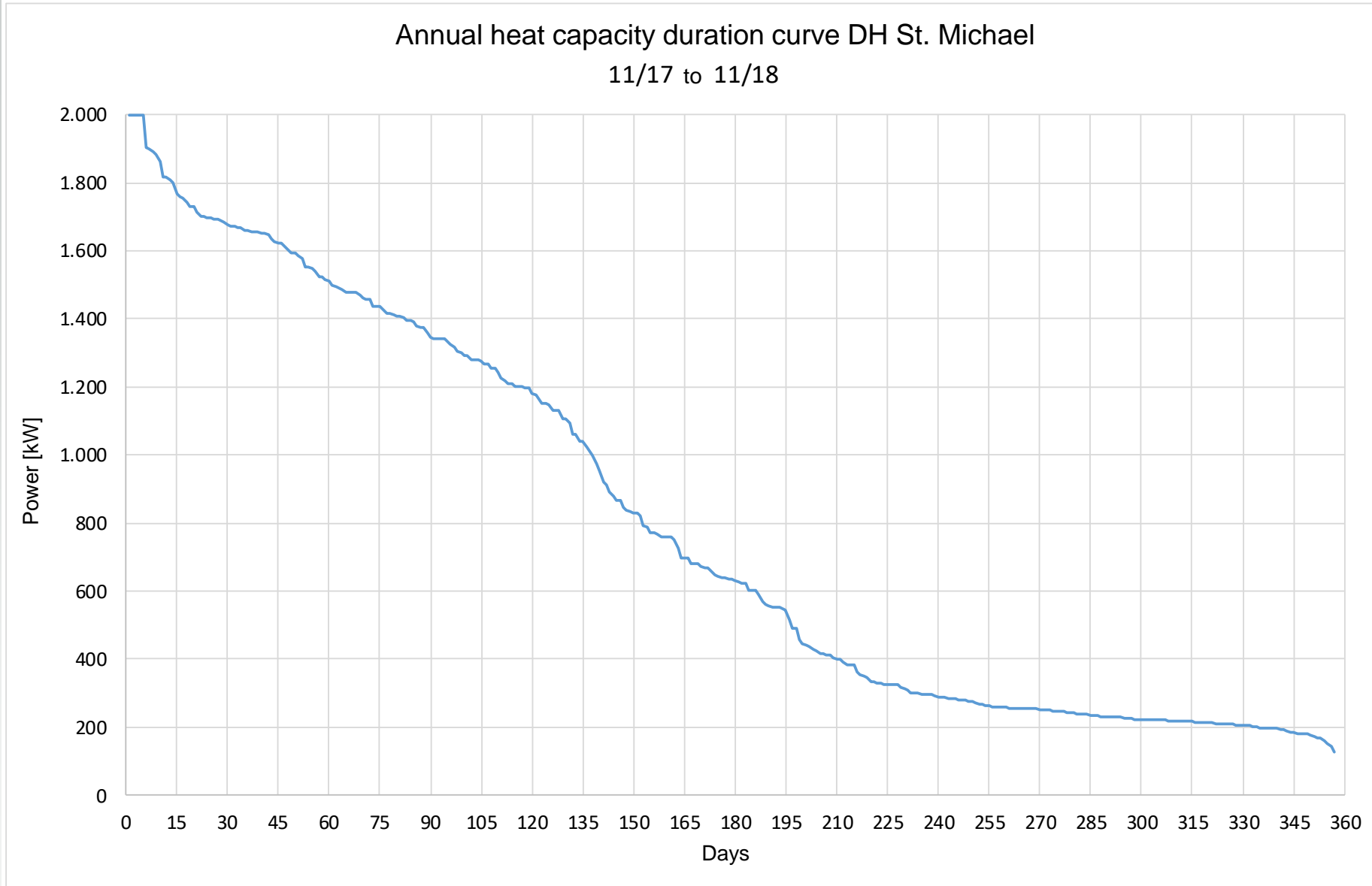
Basic data for district heating St. Michael

- ◆ Urbas boiler: 1.700 kW nominal output
- ◆ Biogas CHP: 280 kW nominal output
- ◆ Storage 2 x 30 m³
- ◆ DH network grid: 8.666 trm trench length
- ◆ 115 heat consumers
- ◆ Annual energy sold to consumers: 3.278 MWh/a

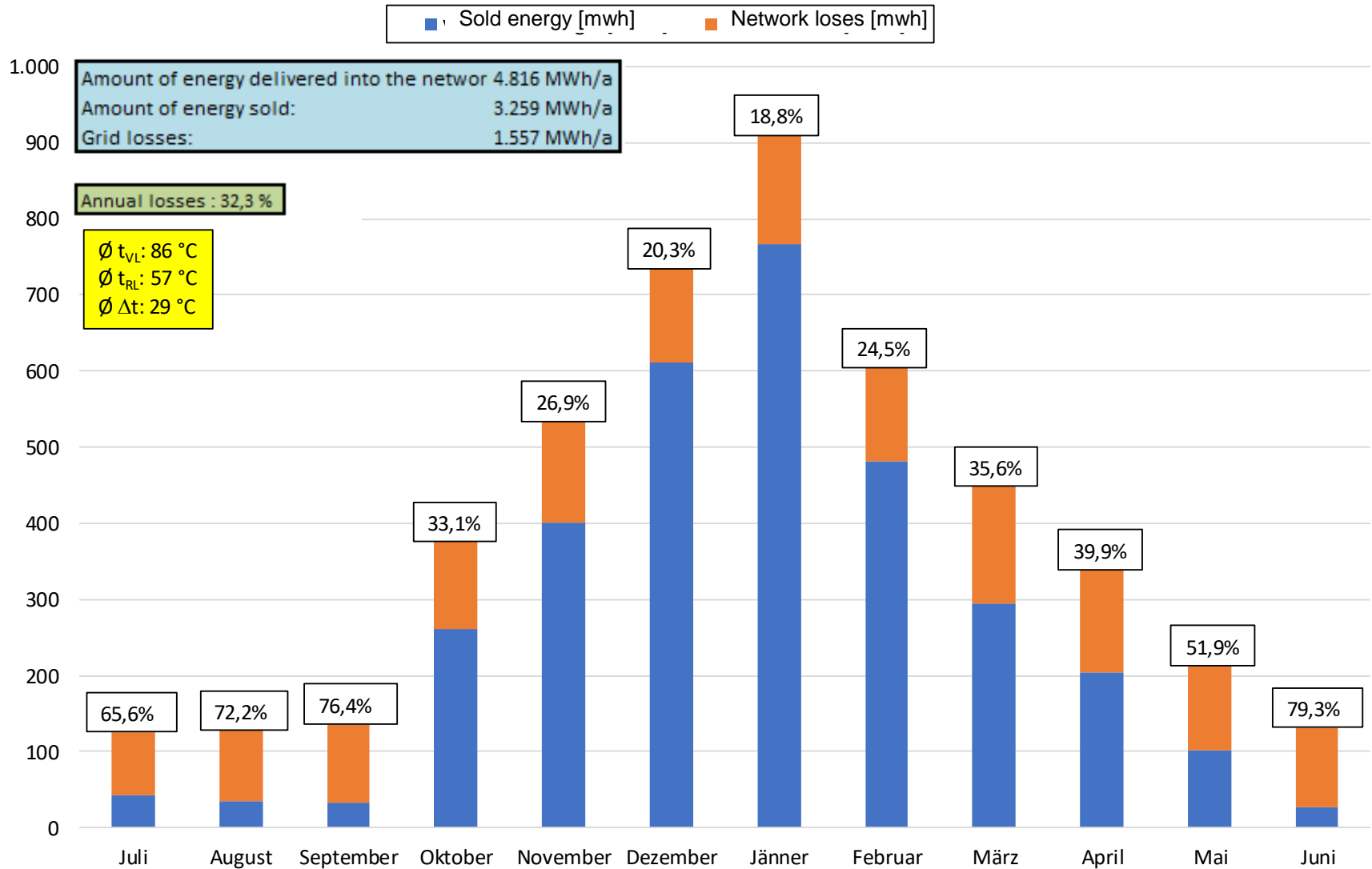
Boiler house



Annual heat capacity duration curve



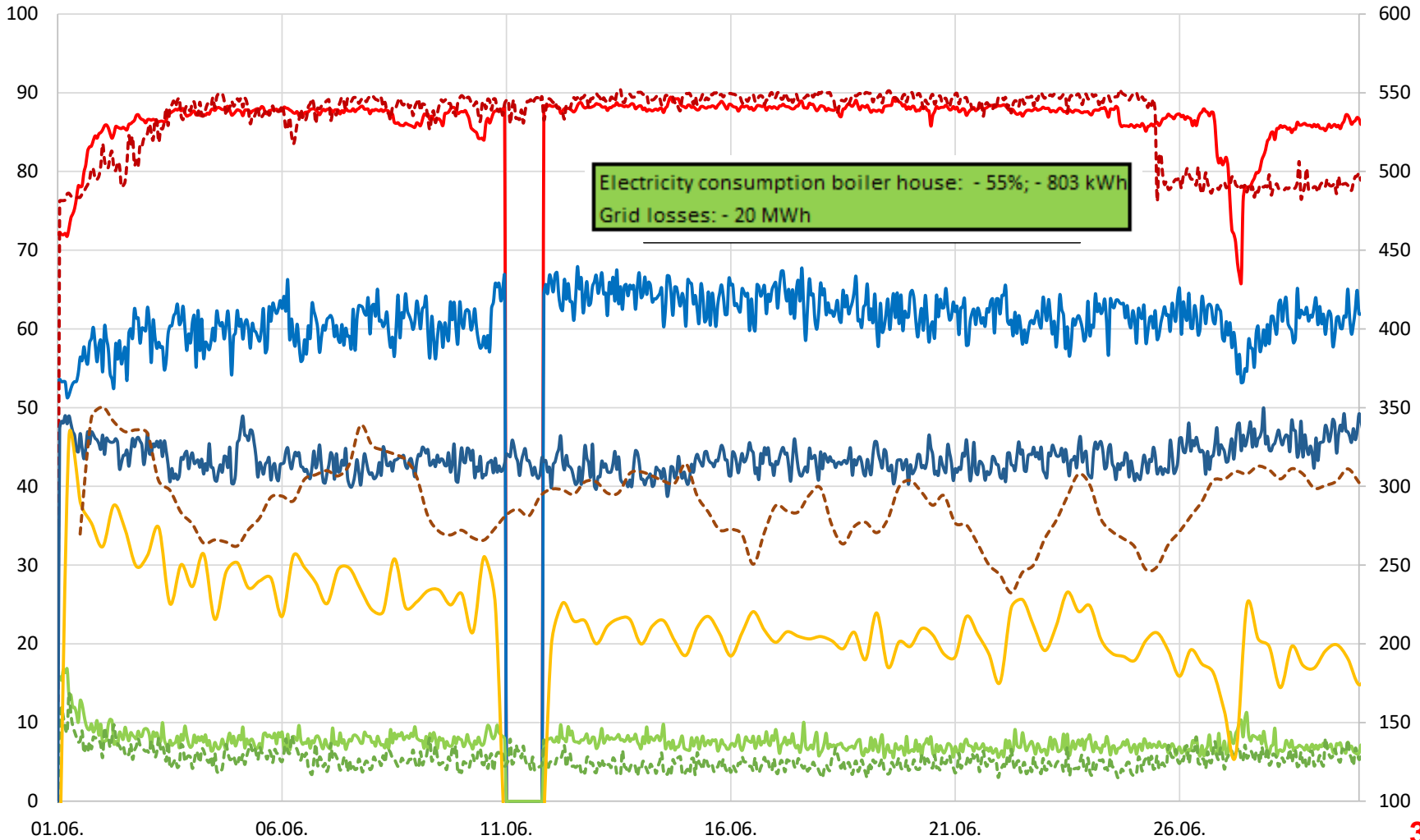
DH St. Michael total energy analysis 01.07.2016 to 30.06.2017



Boiler house optimization steps

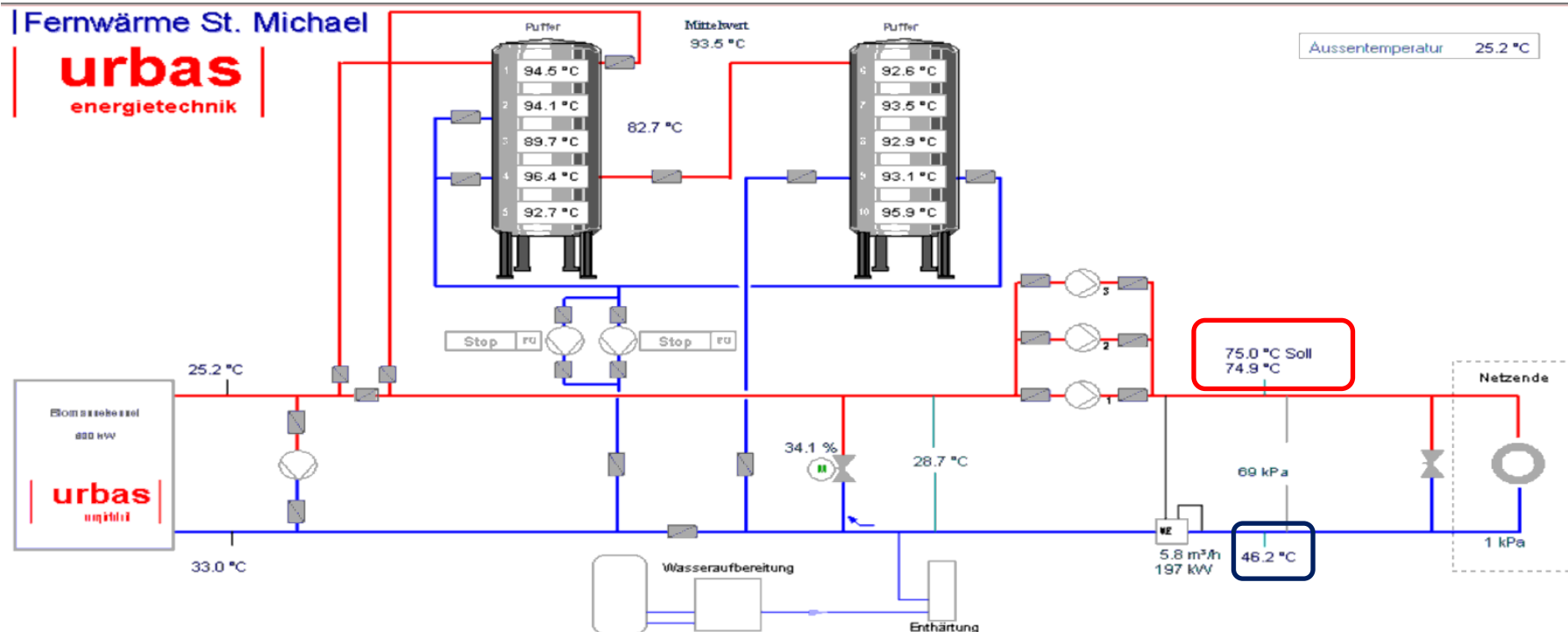
- ◆ Implementation of the network grid pump control by a pressure loss curve => wire to most unfavourable section of the grid is damaged
- ◆ Optimization of the supply temperature over summer
- ◆ Installation of a summer grid pump

FW St. Michael - Comparison June 19 with June 20



Güssing, 23.06.2021

- ◆ Reduction of the network flow temperature to 75 ° C instead of 85 ° C
- ◆ Return temperature at approx. 46 ° C instead of 55 ° C
- ◆ Drive power mains pump approx. 150 W instead of approx. 500 W previously (summer pump)



Güssing, 23.06.2021

Operating time:	8760 h			
Temperature flow:	86 °C			
Temperature return:	57 °C			
Temperature soil:	8 °C			
Sold amount of heat:	3.224 MWh			
Pipe dimension	Pipe length	Heat transfer coefficient T-dependent	Loss power	Fictitious annual heat loss
[text]	[m]	[W/mK]	[kW]	[kWh/a]
<u>10</u>	<u>11</u>	<u>13</u>	<u>14</u>	<u>15</u>
DN 20	1.543	0,1261	12,3526	108.209
DN 25	3.988	0,1130	28,6179	250.693
DN 32	3.997	0,1340	34,0124	297.949
DN 40	2.194	0,1450	20,2036	176.984
DN 50	1.298	0,1840	15,1668	123.861
DN 65	1.961	0,2070	25,7707	225.751
DN 80	736	0,2160	10,1016	88.490
DN 100	1.077	0,2499	17,0909	149.716
DN 125	681	0,2851	12,3344	108.049
DN 150	0	0,3249	0,0000	0
DN 200	0	0,3644	0,0000	0
DN 250	0	0,3501	0,0000	0
DN 300	0	0,3976	0,0000	0
	0	0,0000	0,0000	0
Summe:	17.476		175,65	1.538.703
Ergebnis:				
Net length terrace:		8.738 trm		
Network length of pipeline network:		17.476 m		
Spread in the design case:		29 °C		
Heat dissipation network:		175.65 kW		
Annual heat loss (based on the currently assumed operating mode):		1.539 MWh		
Maximum heat loss - reference value:		1.539 MWh		
Sell annual heat quantity including network loss:		4.763 MWh		
Potential reference value network loss:		32,31 %		

Measurement data ~ calculation

⇒ no big insulation damage

Grid losses - metering value: 1.557 MWh/a

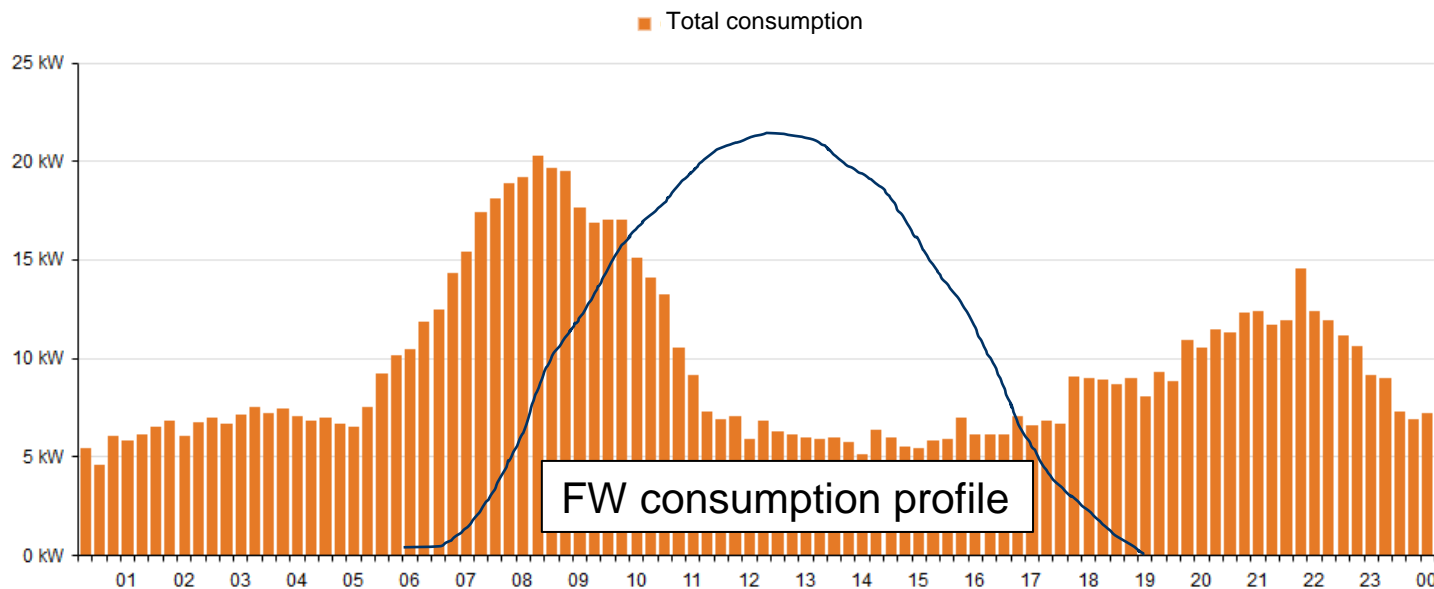
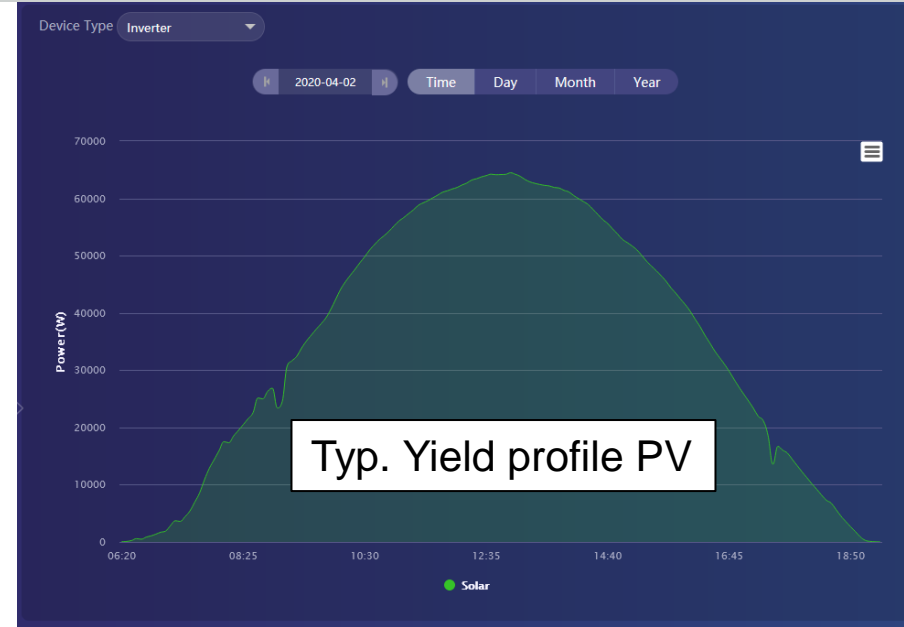
Minimize network grid losses

- ◆ Optimization of consumer side

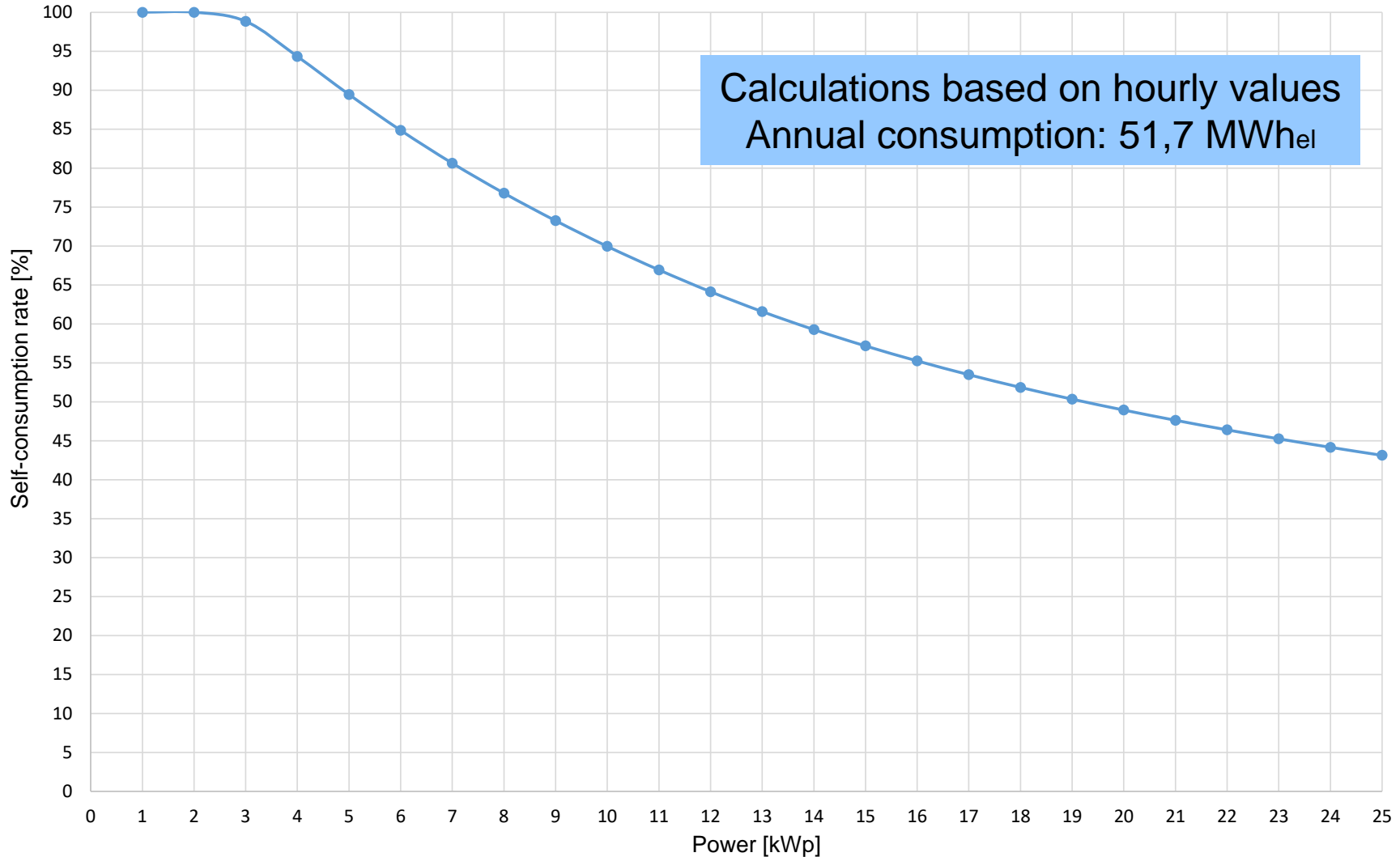
Knd.Nr.	Name	Volume [m ³]	Ø ΔT [°C]	Consumption [kWh]
D000250		7.882,7	37,9	339.677
D000240		6.513,0	26,6	197.360
D000339		5.723,6	13,5	88.120
D000101		5.304,5	24,8	149.371
D000243		4.294,4	16,5	80.400
D000300		4.144,1	22,3	104.967
D000008		3.118,2	29,2	103.631
D000010		2.703,2	19,0	58.560
D000015		2.252,1	34,2	87.521
D000399		1.703,9	18,3	35.423
D000163		1.623,7	28,5	52.674
D000377		1.563,2	19,4	34.533

PV- Investment

- ◆ Yield and consumption profile of boiler house
- ◆ Target: Maximize consumption in boiler house



Self-Consumption rate DH St. Michael



Conclusion and learnings on practical examples

- ◆ Metering data is the most important source of information
- ◆ DH network grid pumps => often potential to save electricity
- ◆ Minimize return temperature level
- ◆ Optimization at consumer side
 - Start with big consumers
 - Check average Δt [°C] or specific pump energy [m³/MWh]

Contact

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