Fault Detection and Optimization Potential on the Demand Side of District Heating Systems

Detection and realisation of optimisation potentials

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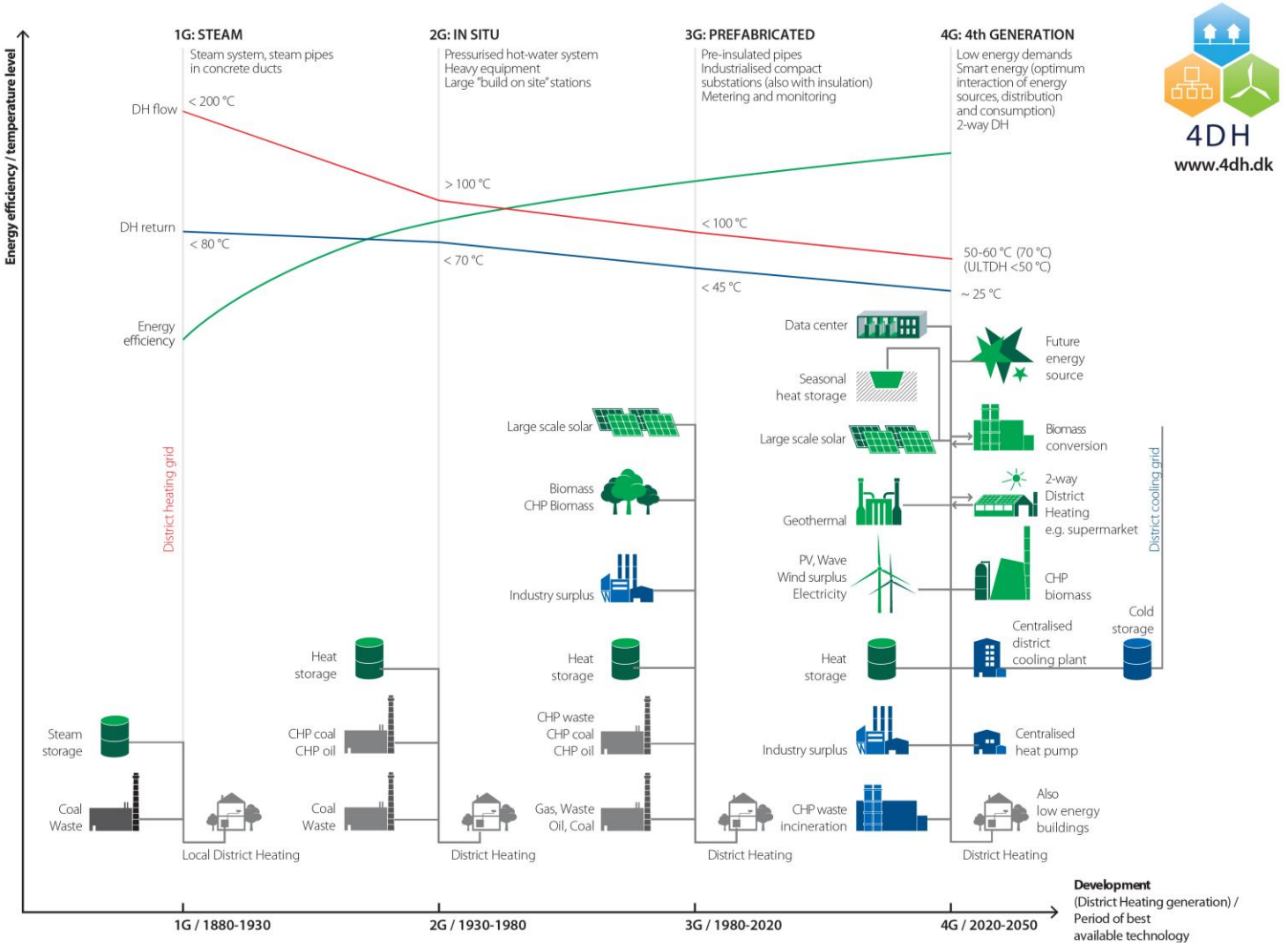
Development of DH generations



Source: Thorsen, J. E., Lund, H., & Mathiesen, B. V. (2018). "Progression of District Heating – 1st to 4th generation".

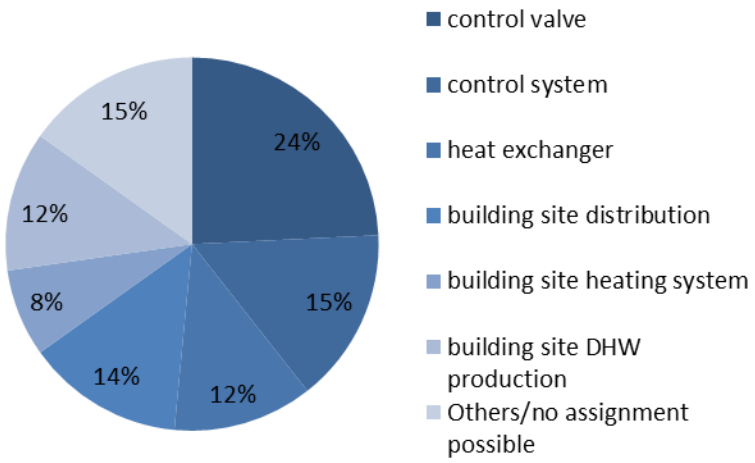
Project T2LowEx

- Transformation: conventional DH ⇨ low-temperature DH
  - Achieved by measures on the consumer side
- Systematic consumer analysis
- Estimation of potentials of the overall DH system
- Development of incentive-based business models
- Demonstration and evaluation of various improvements
- Evaluation of potential effects on the Austrian DH sector

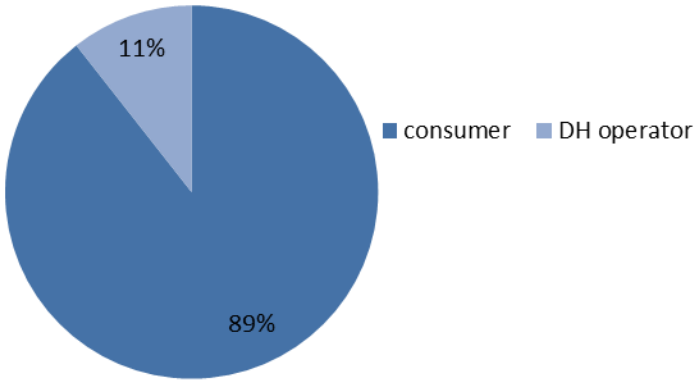
Dieses Projekt wird aus Mitteln des Klima- und Energiefonds gefördert und im Rahmen des Energieforschungsprogramms 2016 durchgeführt.

Reasons for increased return temperatures

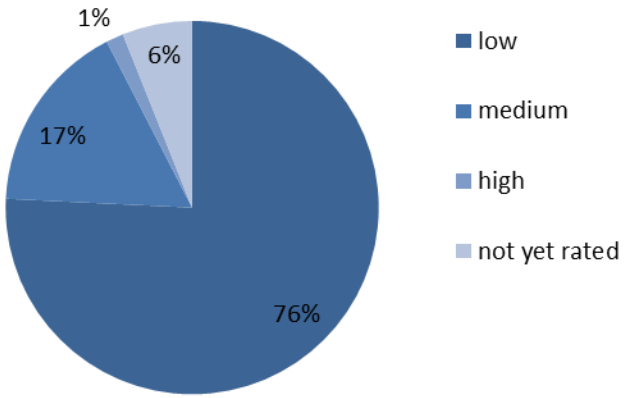
Affected component



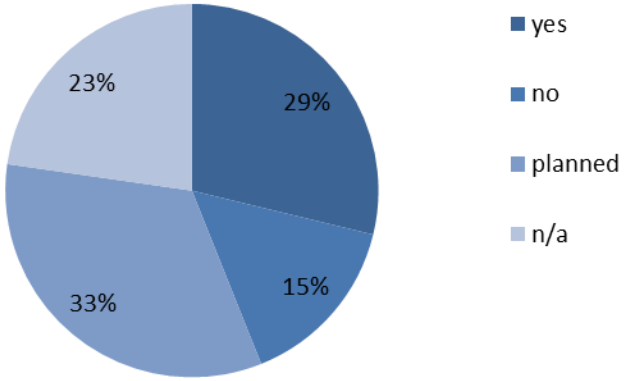
Responsibility for correction



Optimisation effort



Measures undertaken



Systematic investigation of optimization potentials

Weighting

energy / volume

reference temperature difference [K]

Ranking by optimization potential

Meter readings

energy [MWh/a]

volume [m³/a]

Performance indicators

avg. temperature difference [K]

spec. volume flow [m³/MWh]

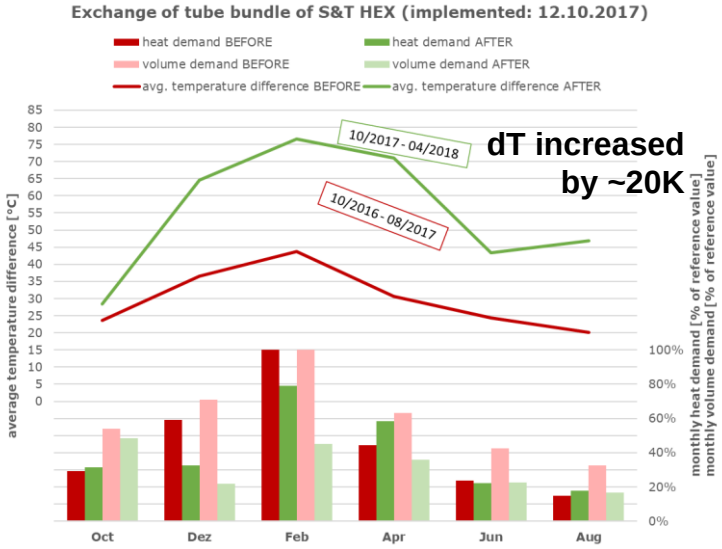
Method 1

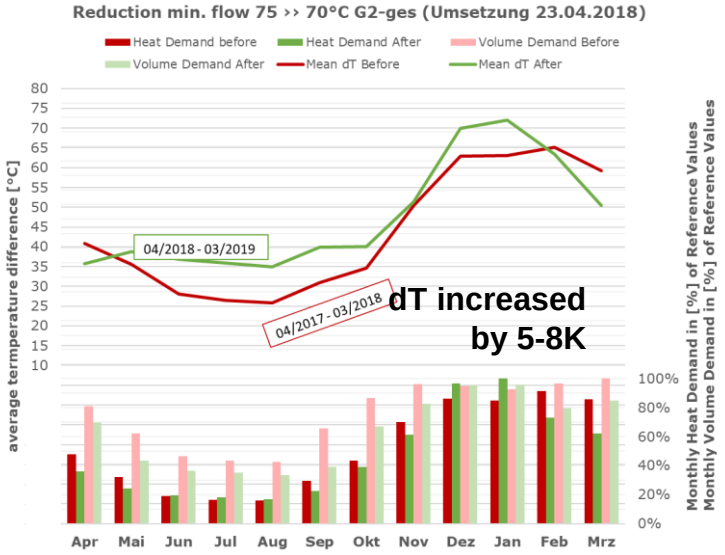
Cmr. Number	Annual Demand [kWh/a]	Annual Flow Volume [m³/a]	Mean ΔT [K]	Specific Volume [m³/MWh]	Weighting by Heat Sales [%]	Optimisation Potential	Rank by Optimisation Potential
37	448,575	48,577	8	108	8.72	945	**1**
1	885,604	32,304	24	36	17.22	628	**2**
9	289,018	14,656	17	51	5.62	285	**3**
40	294,775	14,447	18	49	5.73	281	**4**
3	293,240	10,679	24	36	5.70	208	**5**

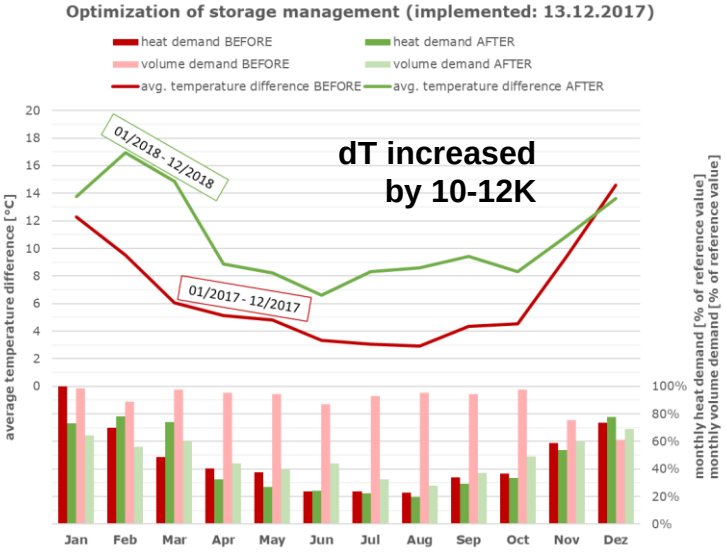
Method 2

Cmr. Number	Annual Demand [kWh/a]	Annual Flow Volume [m³/a]	Mean ΔT [K]	Specific Volume [m³/MWh]	Target ΔT [K]	Reference Volume [m³/a]	ΔT Network Ref [K]	Influence on Return (if optimised) [K]	Rank by Optimisation Potential
37	448,575	48,577	8	108	40	9,832	36.8	-8.0	**1**
1	885,604	32,304	24	36	40	19,411	31.0	-2.3	**2**
9	289,018	14,656	17	51	40	6,335	30.2	-1.4	**3**
40	294,775	14,447	18	49	40	6,461	30.1	-1.4	**4**
56	136,321	8,217	15	60	40	2,988	29.6	-0.9	**5**

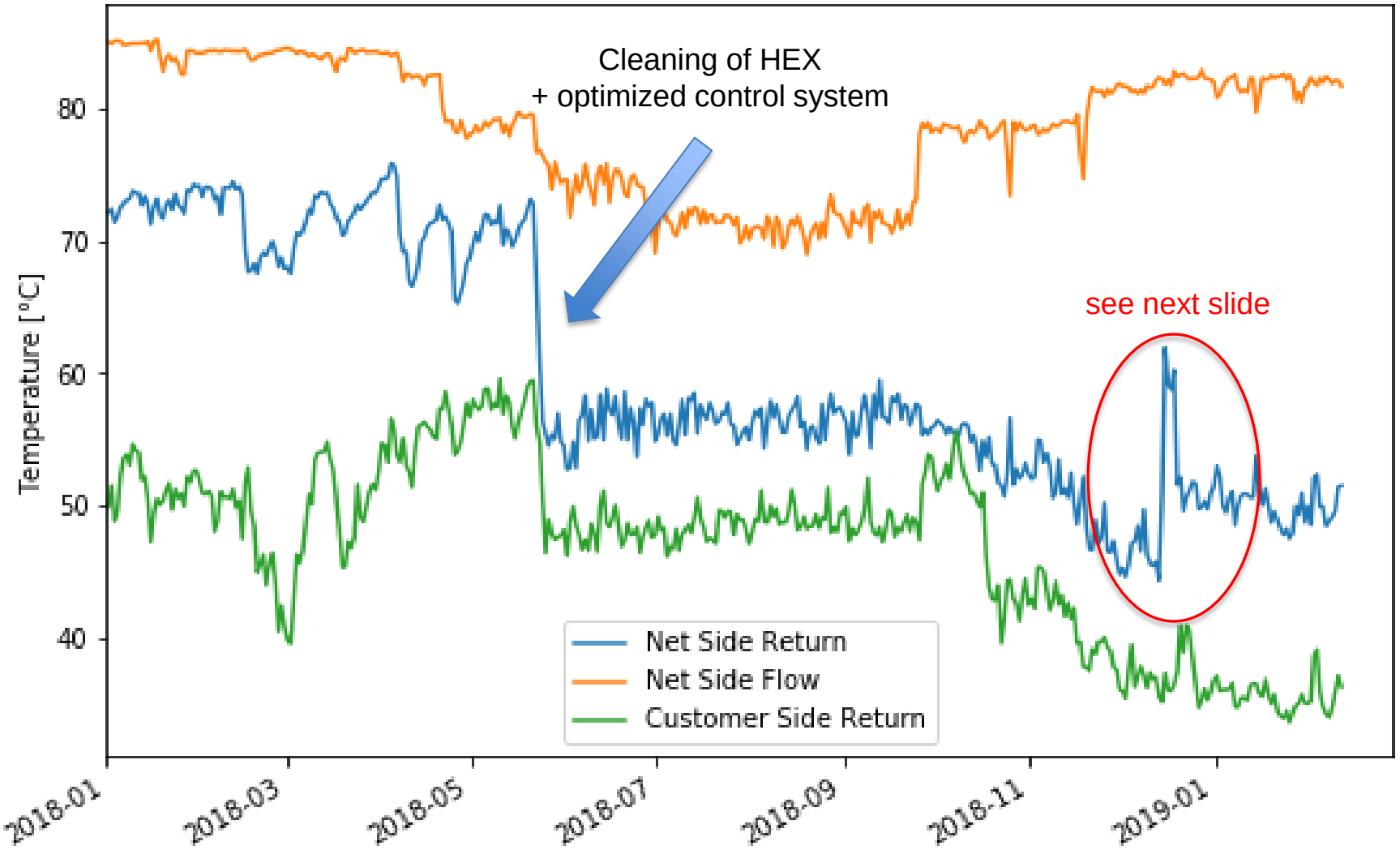
New tubes (shell & tube HEX)
Reduced supply temperature
Optimized storage control



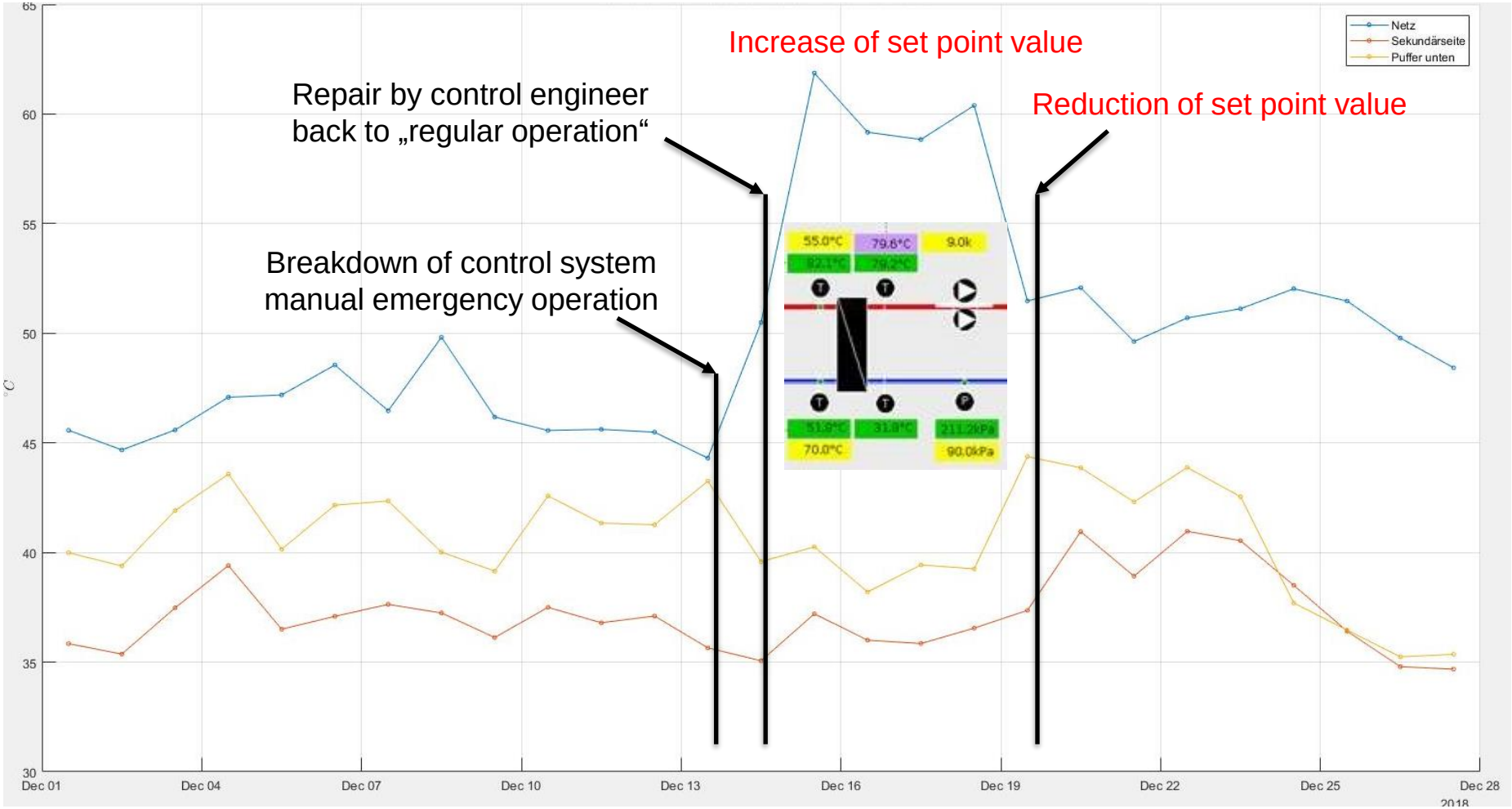




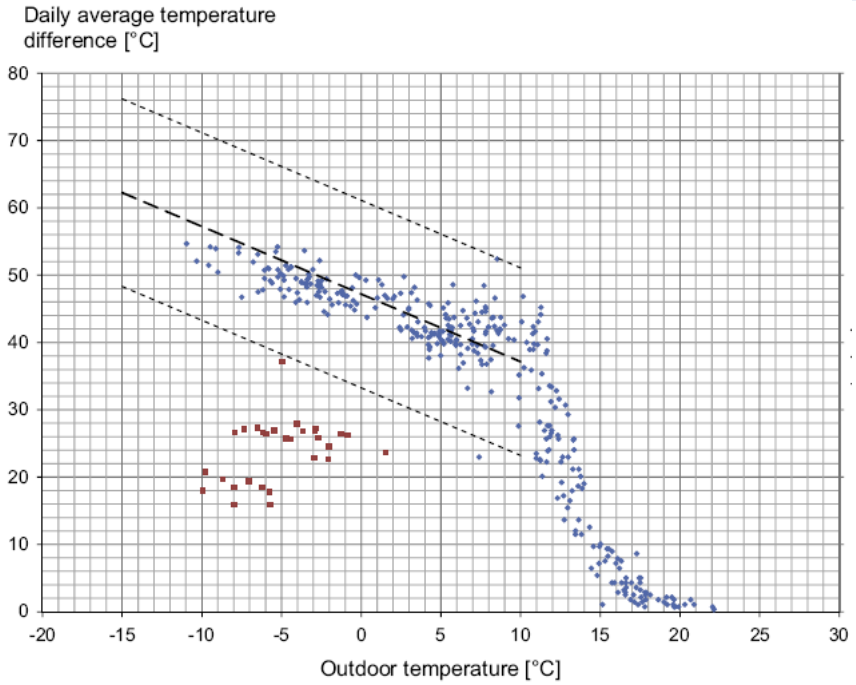
Cleaning of HEX + optimized control system



Optimization is good, …
… continous monitoring is better!

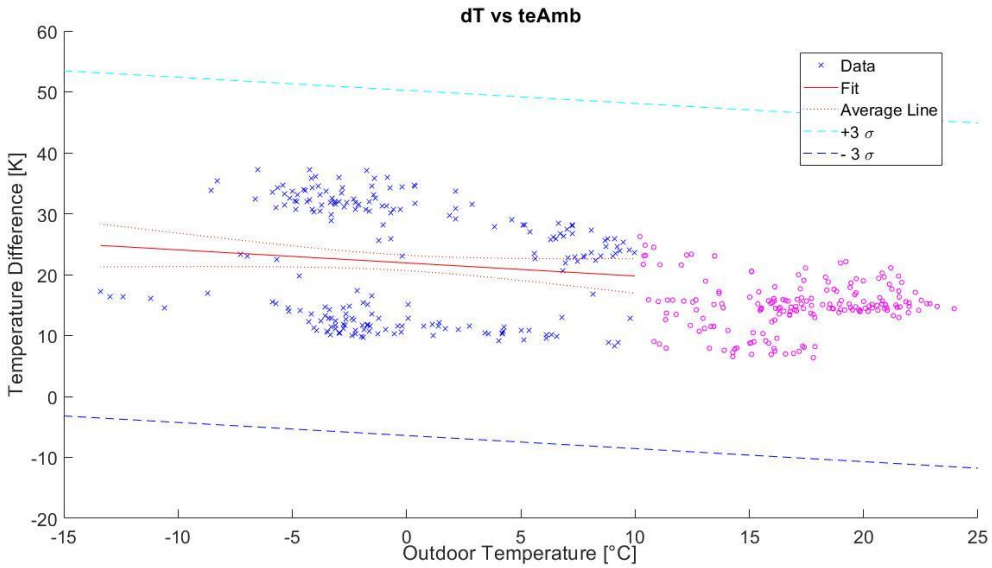


Advanced data based methods



Gadd/Werner 2014:
Achieving low return temperatures from DH heating substations

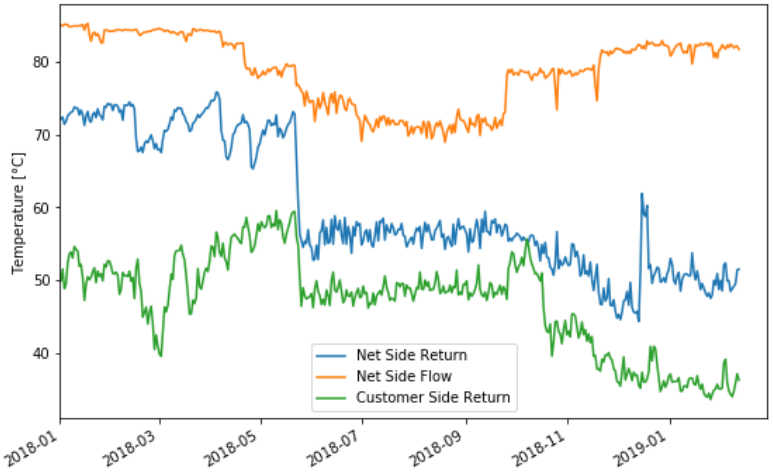
- Analysis: temperature difference vs. outdoor temperature
- Comparison: upper/lower limits of regular operation (3x standard deviation)



Application on consumers within T2LowEx-Project

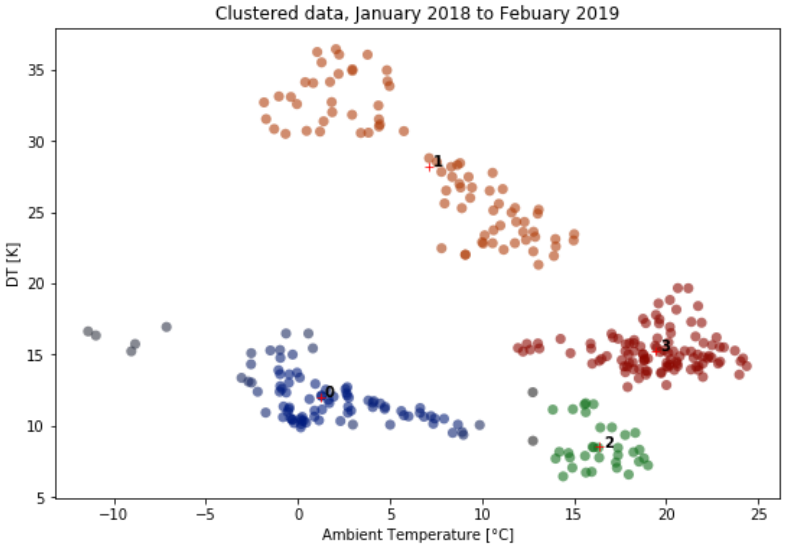
- Procedure, if malfunctions are already existent? (set point value?)

Fault detection with clustering algorithms

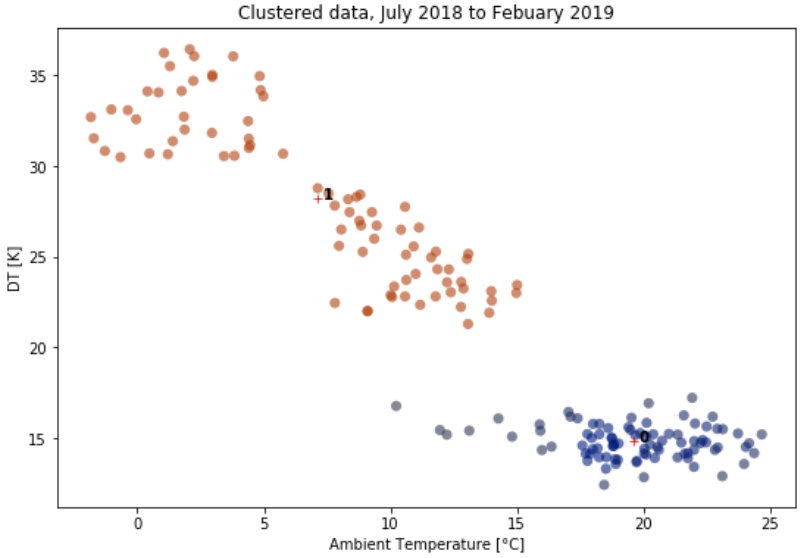


dT vs. T_{amb} in clusters!

All data



Only „good“ data (from July 2018 on)



Performance and Validation of cluster based method

- Detection of faults after ~10 days
  - Tests of reduction of detection time with moving window inconclusive.

- Qualitative Validation – Performed by visual examination of data on random customers from 4 heating networks.
- Most faults detected.
  - False positives significant but not unmanageable, can be reduced by further tuning.

No Fault

Network 1	Network 3
'Cmr014'	'Cmr013'
'Cmr027'	'Cmr042'
'Cmr015’	'Cmr025'
	'Cmr027'
	'Cmr032’

Network 2	Network 4
'cmr39'	'Cmr016'
'cmr29'	'Cmr010'
'cmr27'	'Cmr001'
'cmr27'	'Cmr018'
'cmr01'	'Cmr005'

Fault

Network 1	Network 3
'Cmr025'	'Cmr047'
'Cmr010'	'Cmr033'
'Cmr001'	'Cmr004'
'Cmr008'	'Cmr016'
'Cmr028'	'Cmr023'

Network 2	Network 4
'cmr05'	Cmr006'
'cmr03'	Cmr021'
'cmr02'	Cmr013'
'cmr21'	Cmr025'
'cmr32'	Cmr004'

How to realise optimisations and error corrections?

- Continuous monitoring required
  - Data analysis (manually/automatically, internal/external)
- Supply (sphere of responsibility of DH operator)
  - Check and adapt heating control system regularly
  - Guidelines for consumers with high supply temperature demand
  - Check and adapt heat supply contracts / connection requirements
- Return (frequently within the sphere of responsibility DH consumers)
  - Check and adapt heating control system regularly
  - Operators take responsibility for heat transfer stations and their maintenance
  - Create incentives for consumers (incentive-tariffs, subsidies)
  - Supply from the return line, low-temperature networks
- Requires optimization budget ⇨ estimate by effect of measure
  - Please see presentation by Andreas Müller (TU Vienna)

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IDEA TO ACTION

Thank You for Your Attention