Heat Roadmap Europe 2050
A low-carbon heating and cooling strategy

4DH
4th Generation District Heating Technologies and Systems

reINVEST

Energy efficiency of district networks compared with individual systems

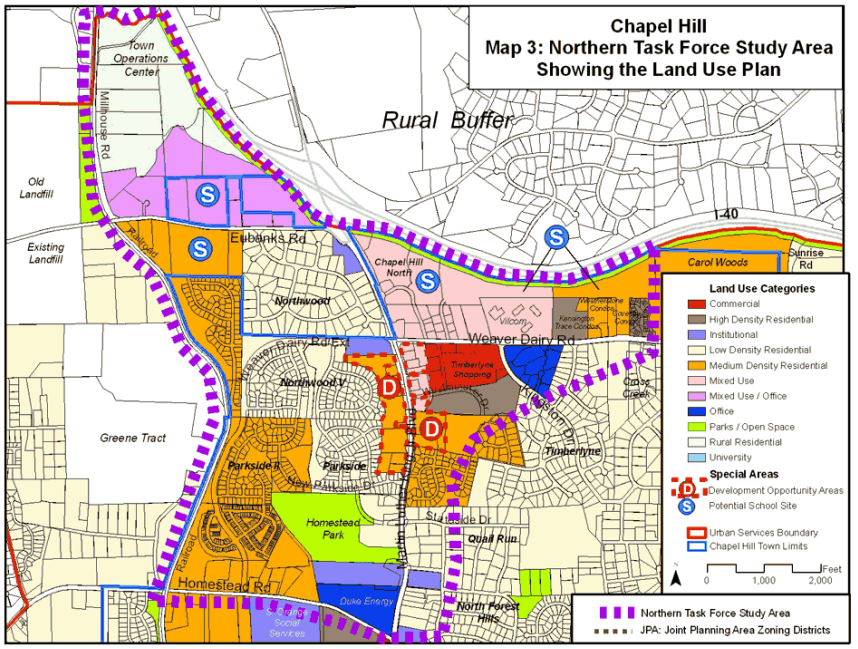
Ashreeta Prasanna, Viktor Dorer

Empa
Materials Science and Technology

sccer future energy efficient buildings & districts

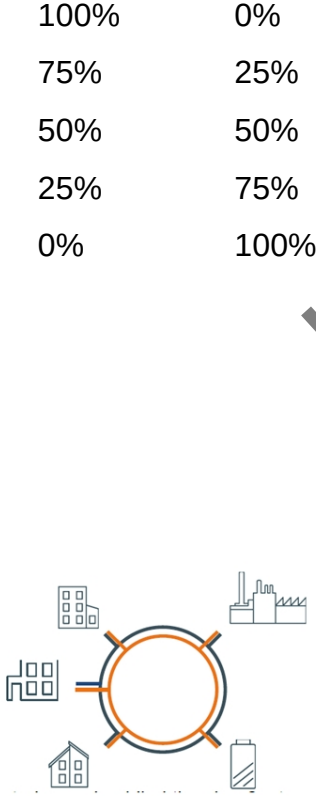
Energy supply for mixed-use districts

- New-build mixed districts
- Balance of social, economic and environmental needs
- Design considering both demand and supply

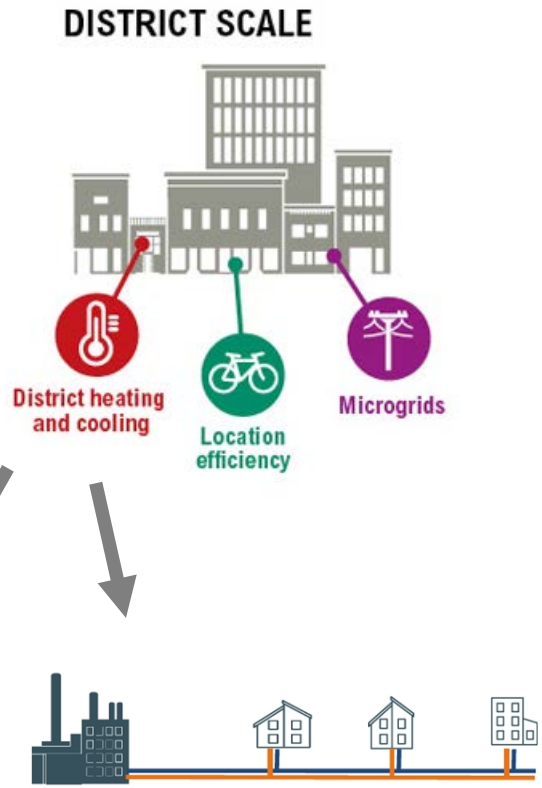


Mixed-use districts and heat pump systems

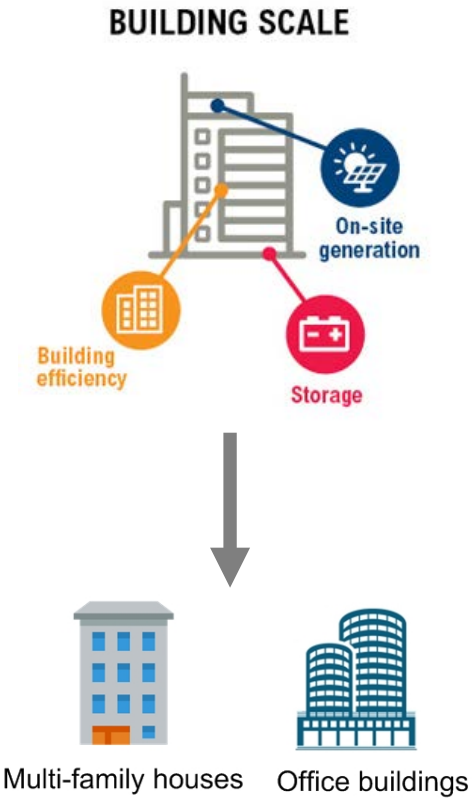
Case no.	Residential Area	Office Area
1	100%	0%
2	75%	25%
3	50%	50%
4	25%	75%
5	0%	100%



Low temperature district heating
Decentralised HP
(8°C - 22°C supply)



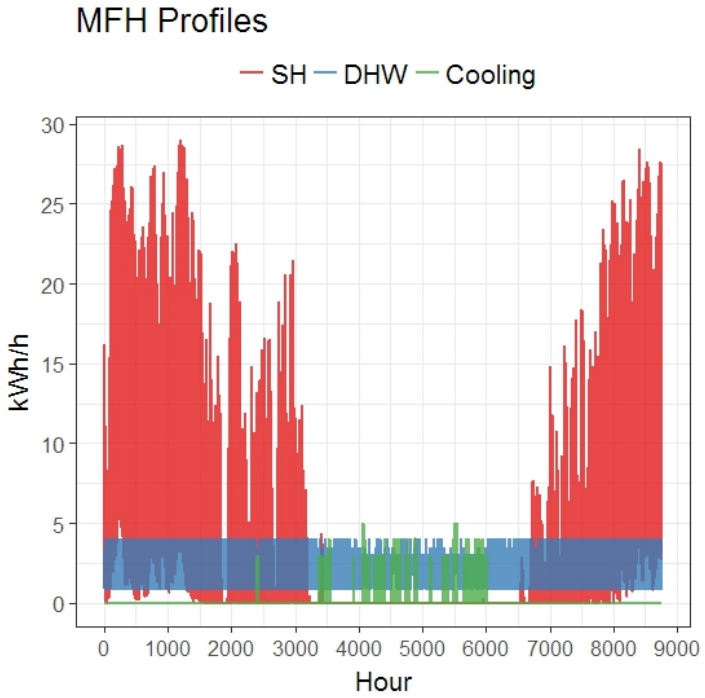
Low temperature district heating
Centralised ASHP/ GSHP
(55°C supply, 20°C return)

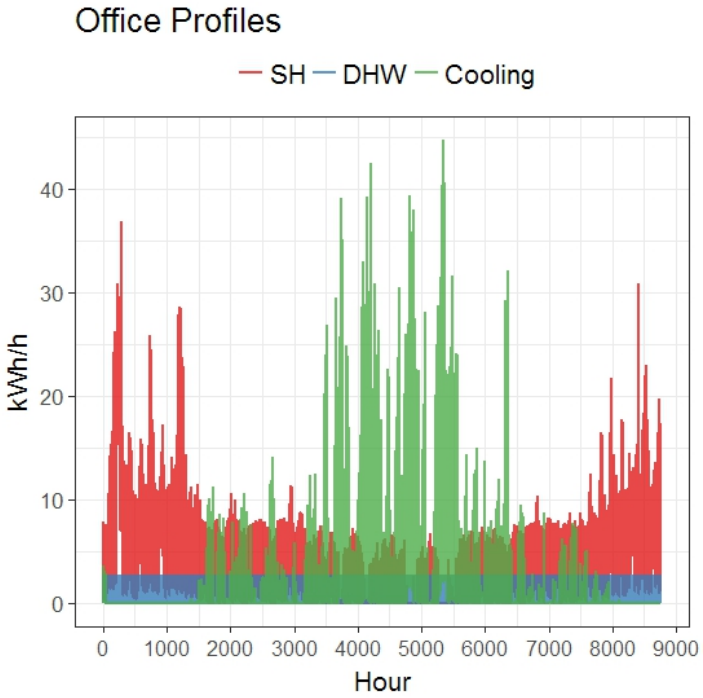


Individual Building
ASHP/GSHP
(35°C SH, 55°C DHW,
<18°C Free-cooling/Cooling)

Demand profiles of different building types

Multi-family house (MFH)			Office building		
SH kW/m²/y	DHW kW/m²/y	Cooling kW/m²/y	SH kW/m²/y	DHW kW/m²/y	Cooling kW/m²/y
21.5	19.2	3.3	39.4	6.3	20.5

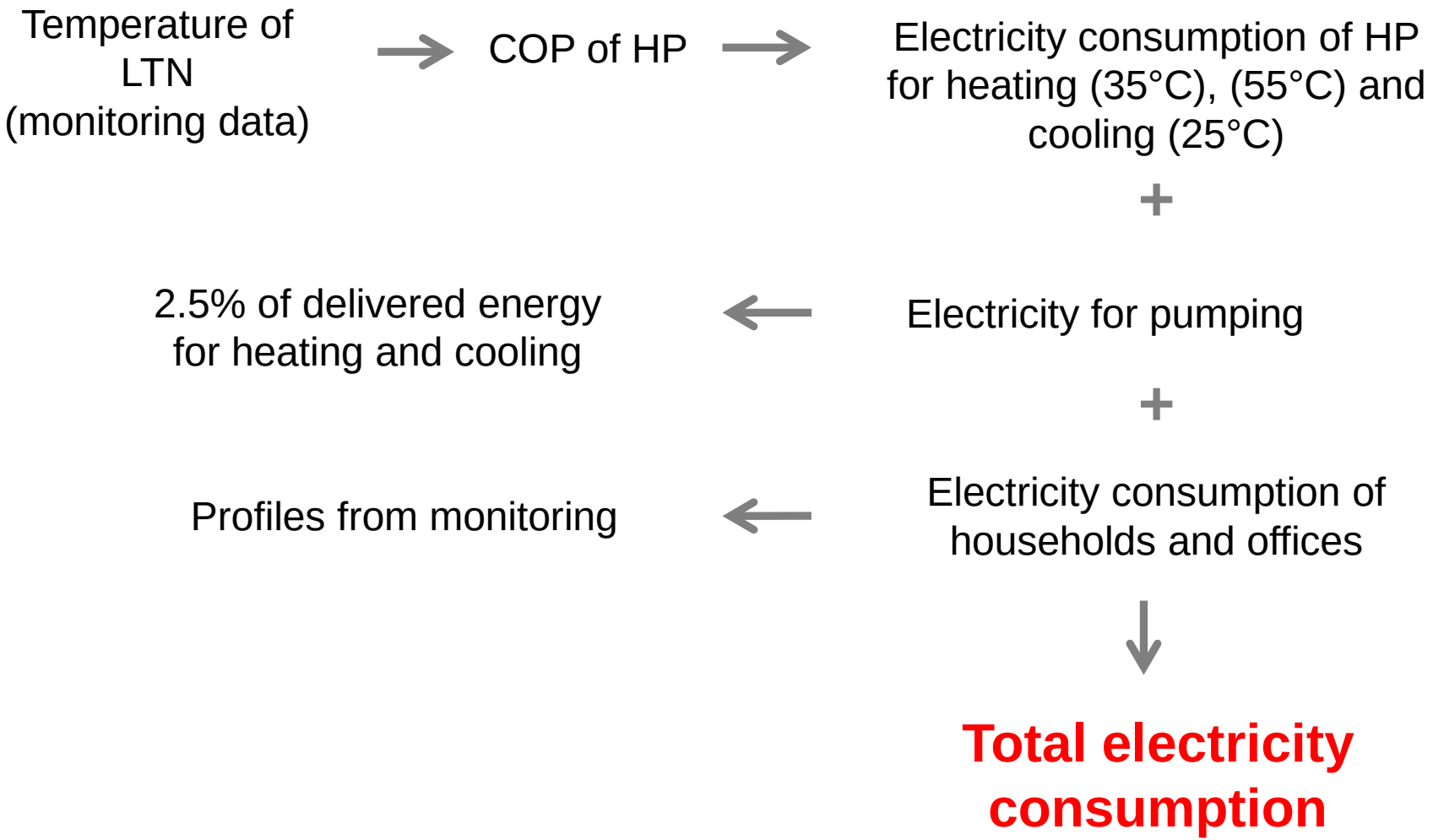




Data for profiles from PLUSQUA project, report accessible at:
http://www.bfe.admin.ch/forschunggebaeude/02107/02134/index.html?lang=de&dossier_id=06738

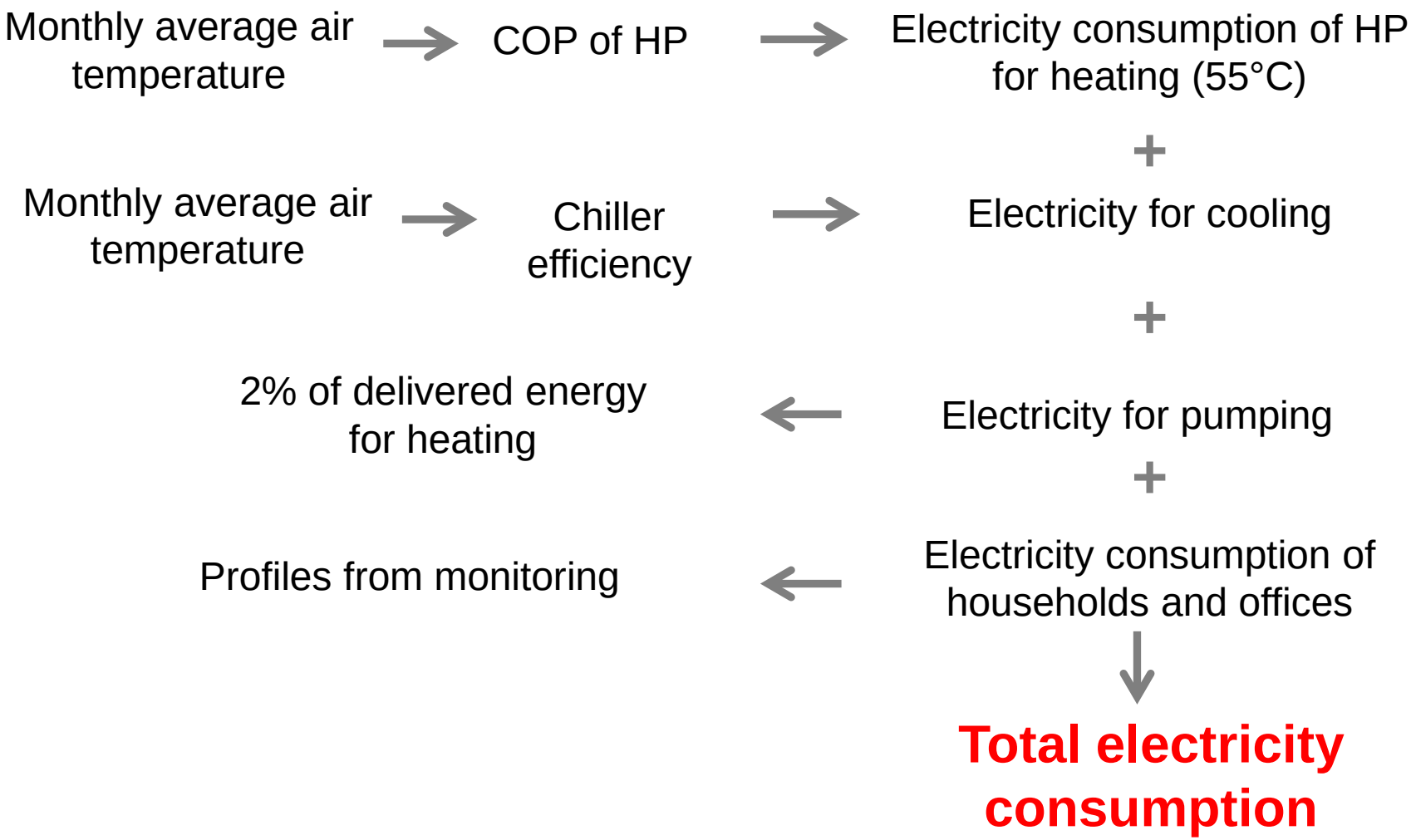
Methodology:

District with LTN and decentralized HPs



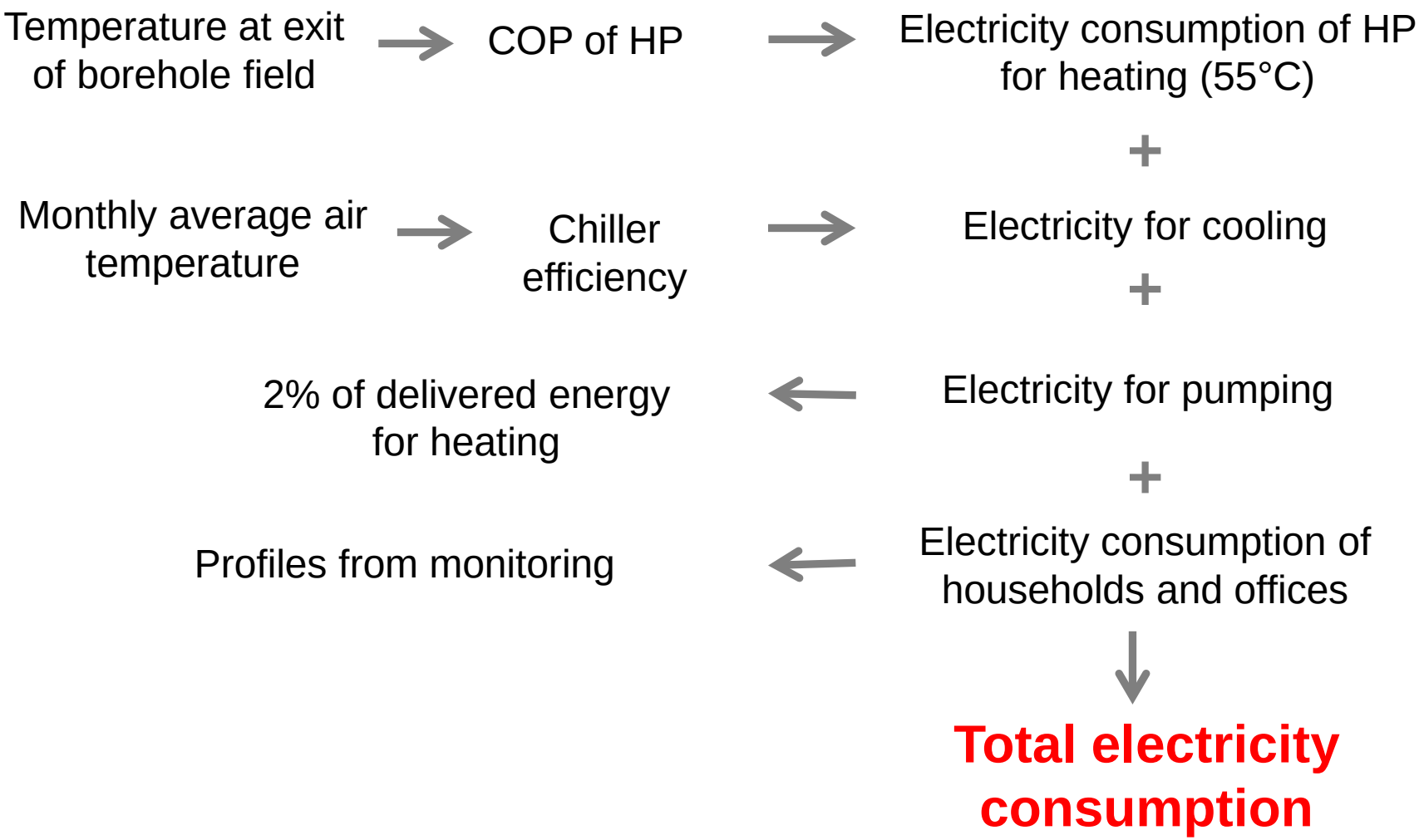
Methodology:

District heating (55°C) with centralized ASHP

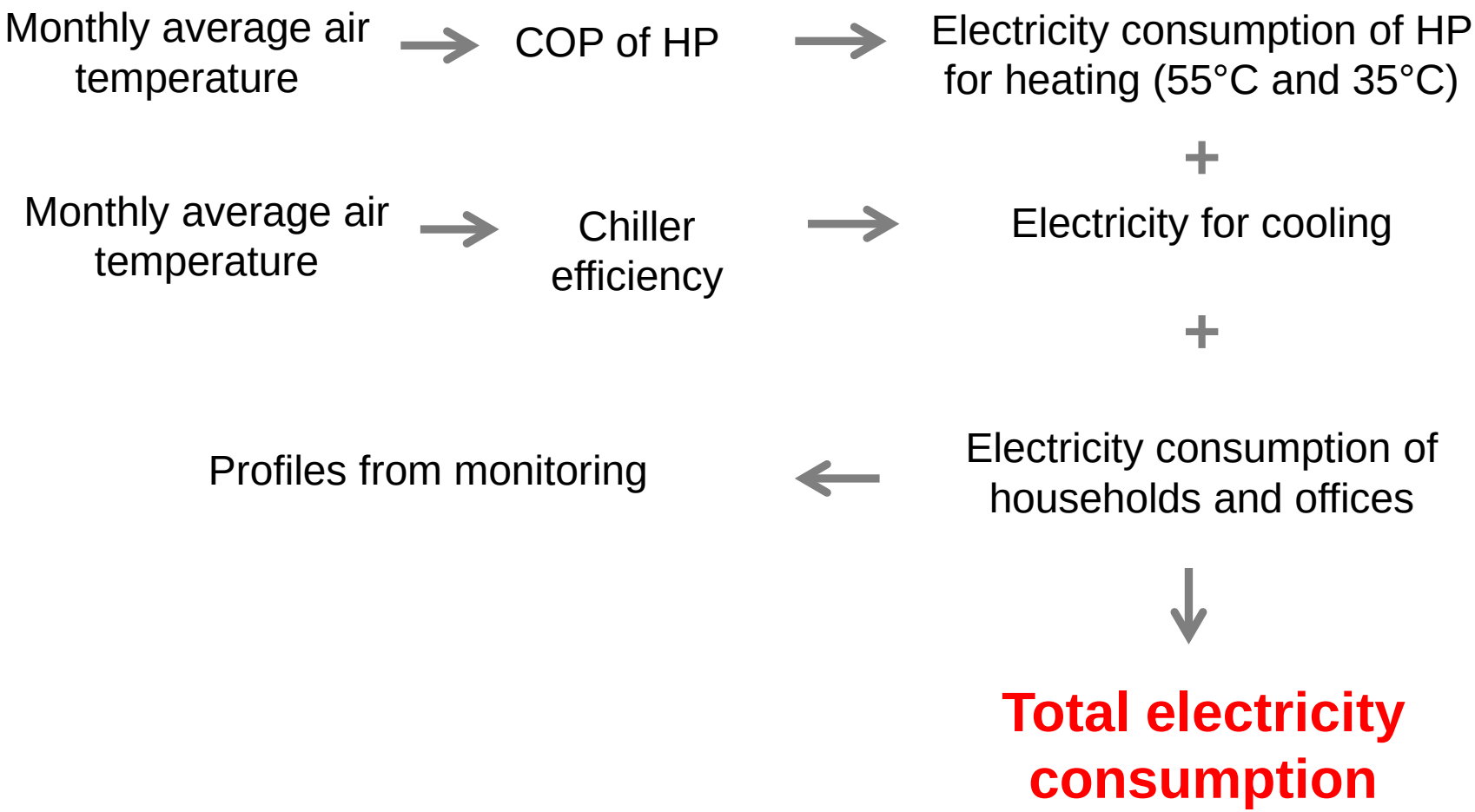


Methodology:

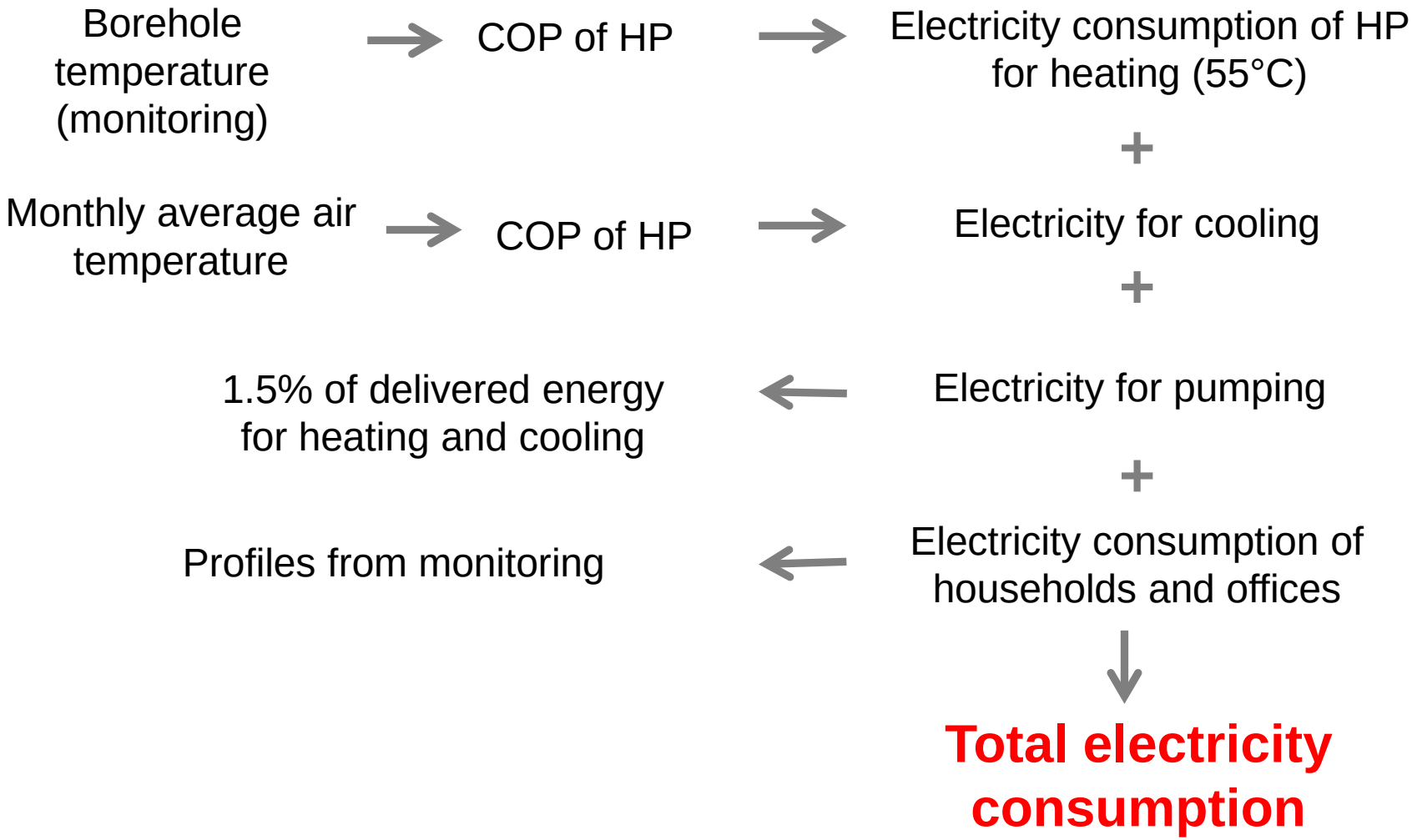
District heating (55°C) with GSHP

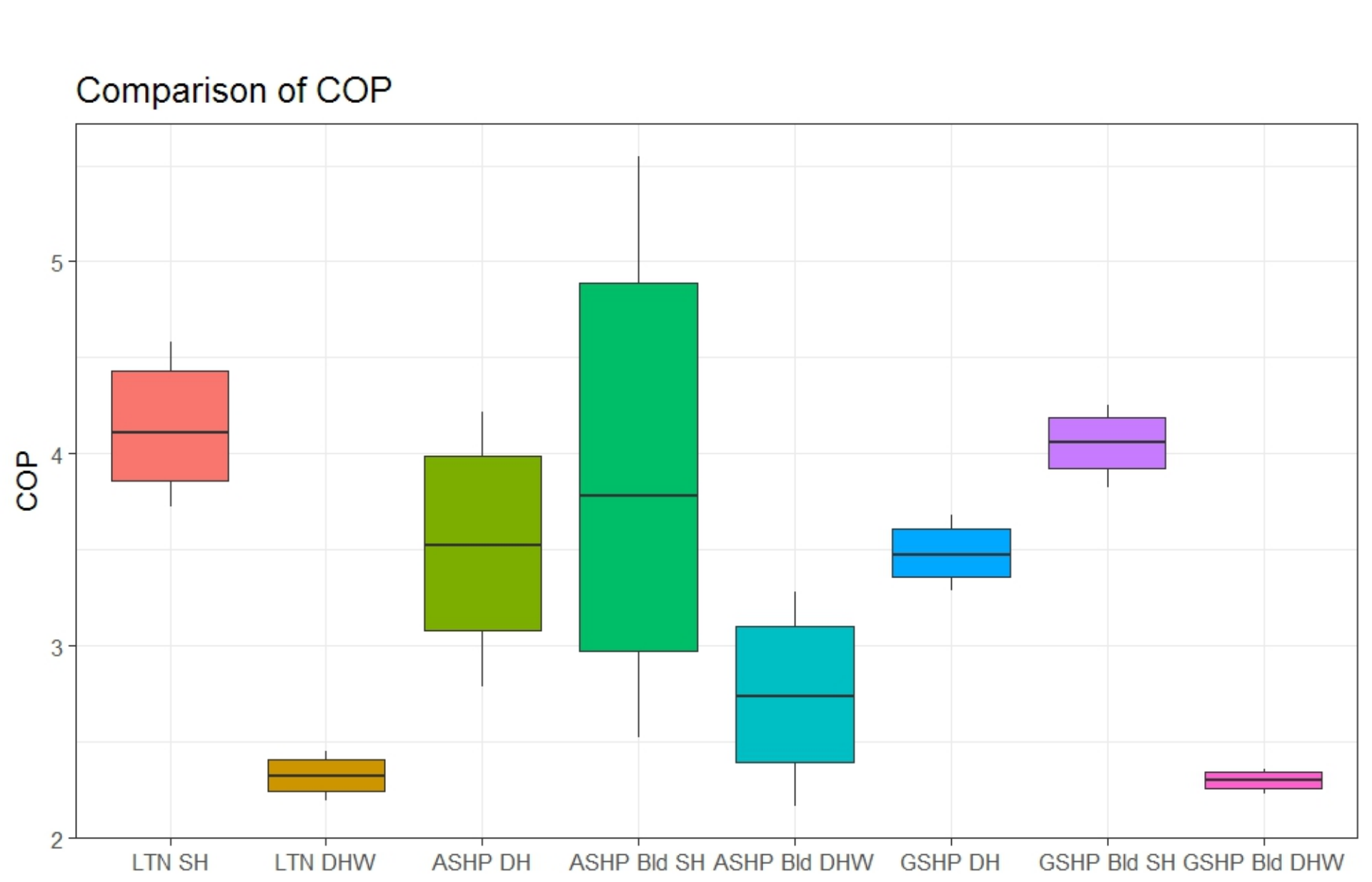


Methodology:
Individual buildings with ASHPs



Methodology:
Individual buildings with GSHPs




Comparison of COP
COP
5
4
3
2
LTN SH
LTN DHW
ASHP DH
ASHP Bld SH
ASHP Bld DHW
GSHP DH
GSHP Bld SH
GSHP Bld DHW

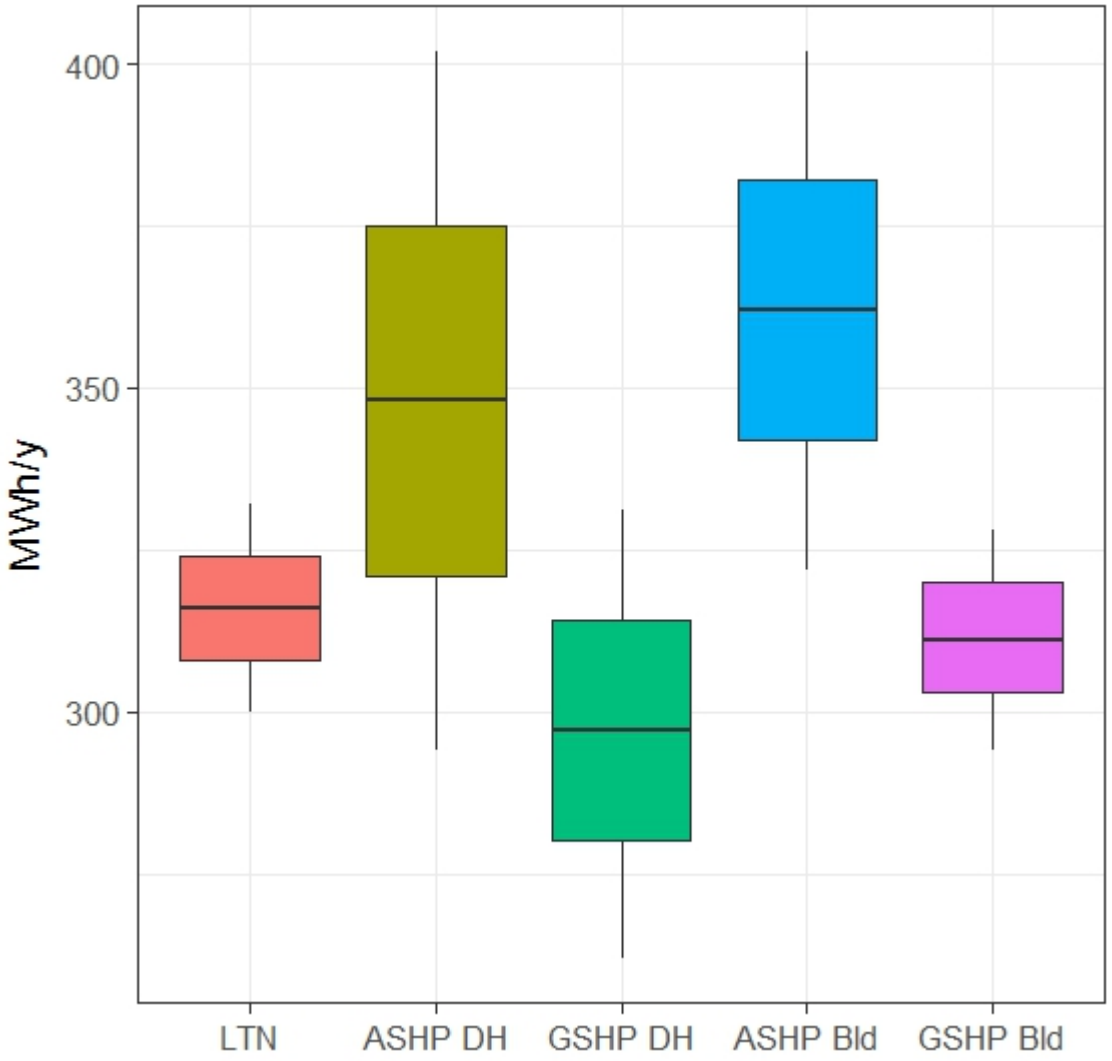
Comparison of electricity demand

Case No.	LTN 20°C [MWh/y]	ASHP DH 50°C [MWh/y]	GSHP DH 50°C [MWh/y]	ASHP Building [MWh/y]	GSHP Building [MWh/y]	User demand [MWh/y]	PV [MWh/y]
1	300	294	262	322	294	189	318
2	308	321	280	342	303	318	318
3	316	348	297	362	311	448	318
4	324	375	314	382	320	577	318
5	332	402	331	402	328	707	318

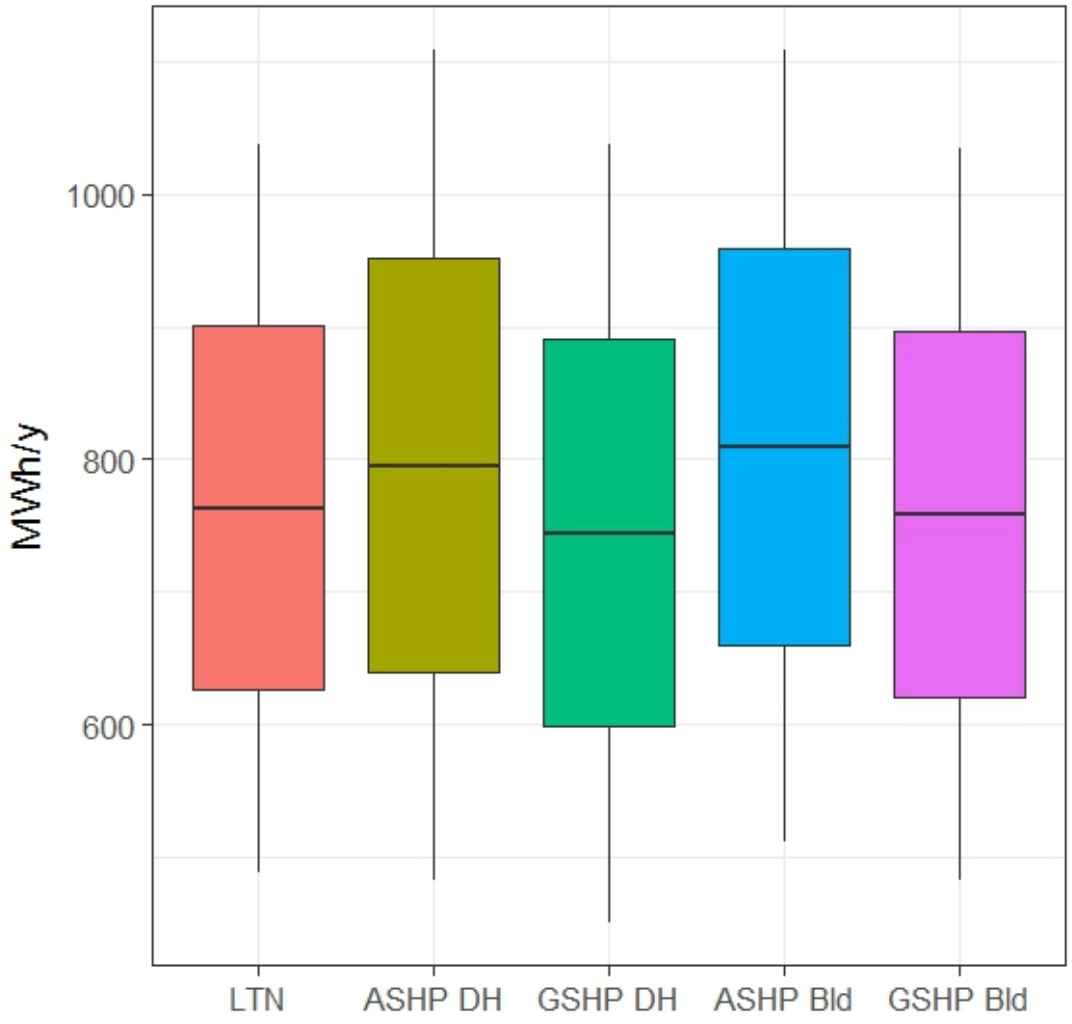
Case No.	MFH Area [m^2]	Office Area [m^2]	PV Area [m^2]
1	20,000	0	2000
2	15,000	5,000	2000
3	10,000	10,000	2000
4	5,000	15,000	2000
5	0	20,000	2000

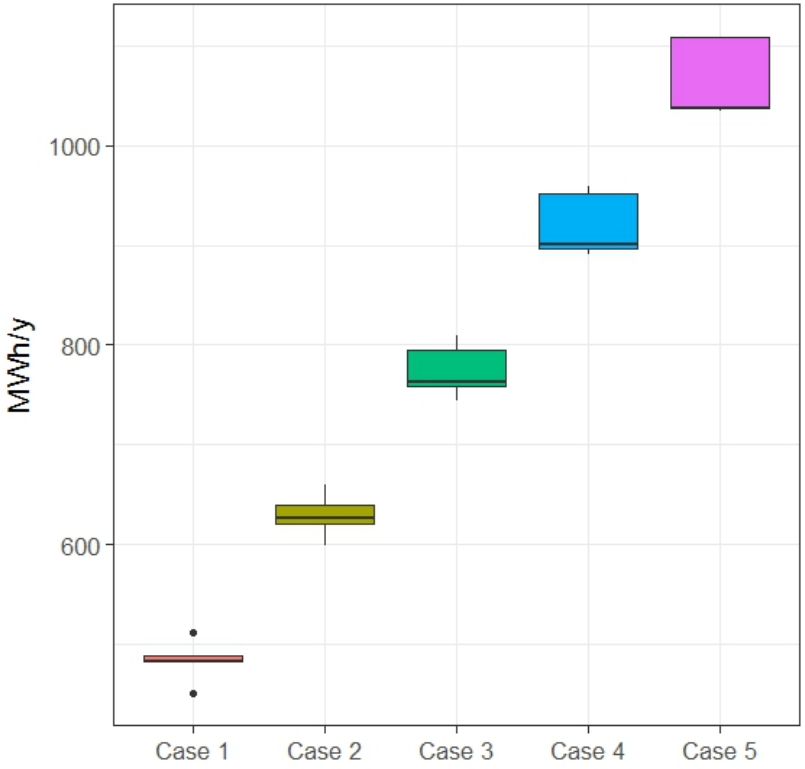
Comparison of electricity demand

Electricity required to supply heating and cooling

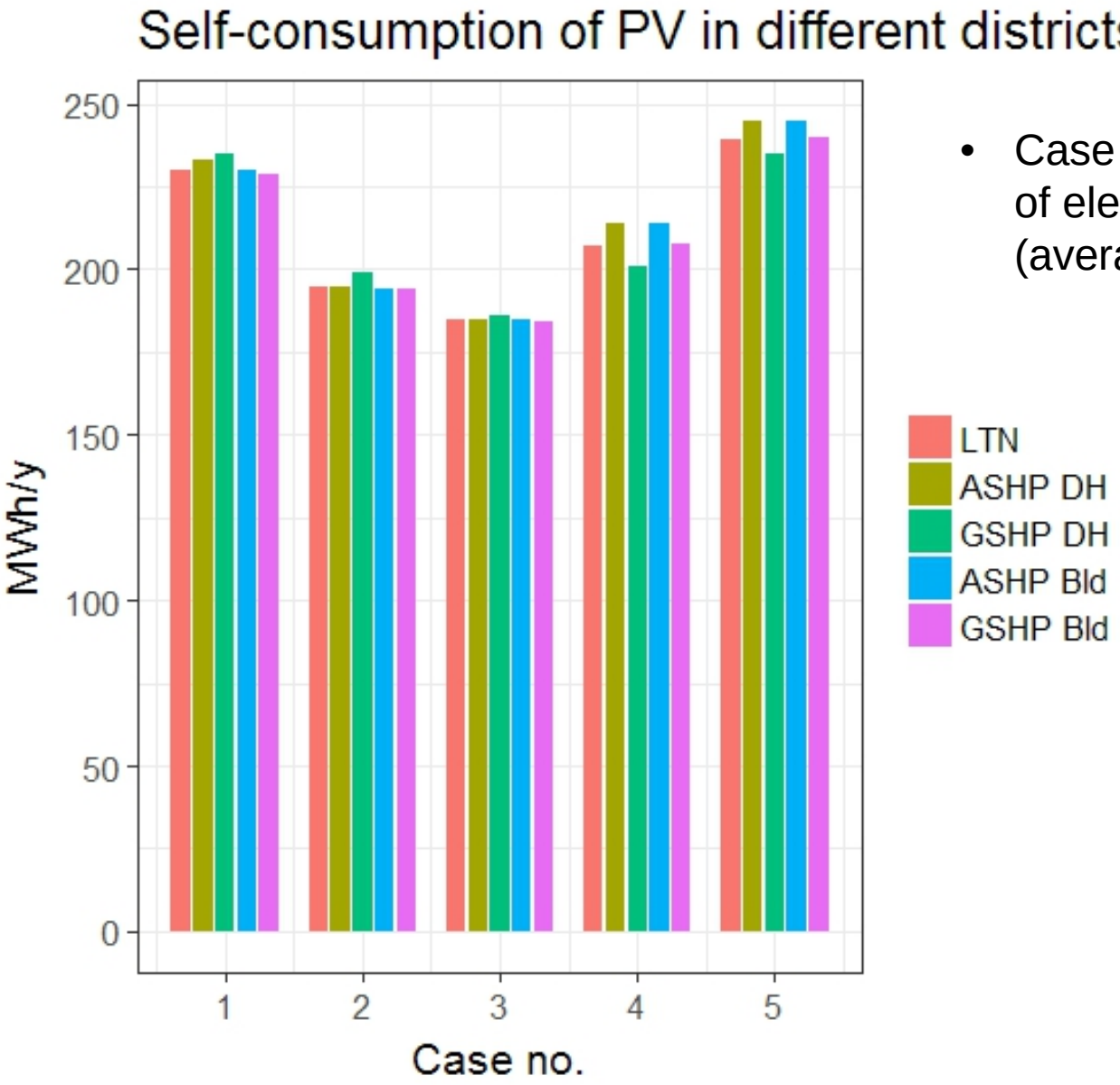


Total electricity required (including households and offices)





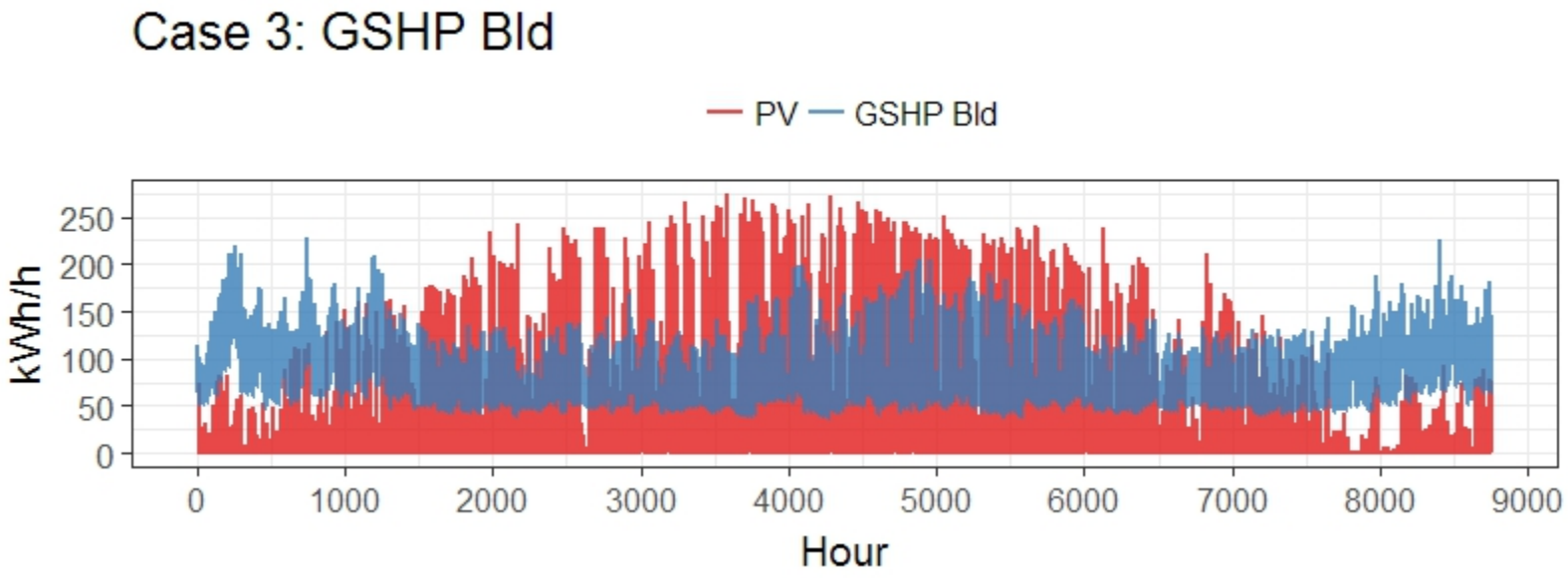
Electricity from rooftop PV (hourly balance)

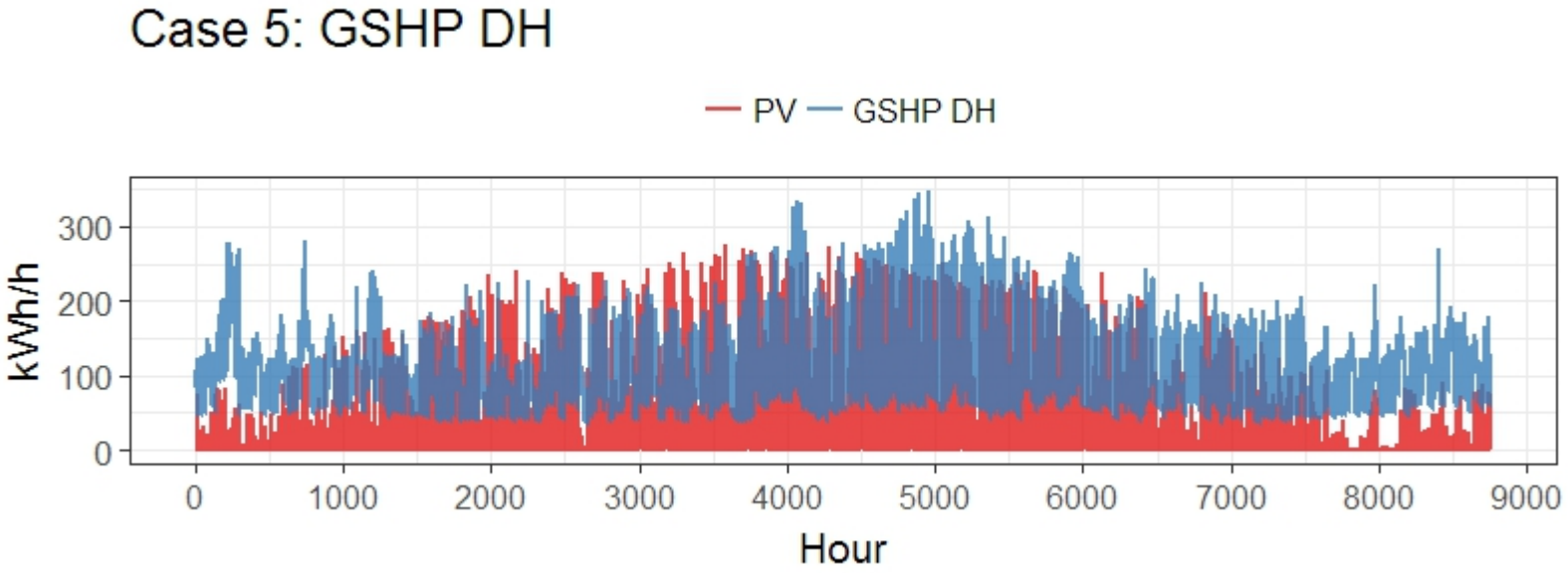


- Case 5 has 76% self-consumption of electricity from rooftop PV (average)

Case no.	Average self-consumption
1	73%
2	61%
3	58%
4	66%
5	76%

Electricity balance with rooftop PV





Discussion and future work

- Electricity demand similar regardless of heating system chosen due to high influence of user demand
- GSHP systems which can supply both heating and cooling are less sensitive to change in use (needs to be validated for other district types)
- Certain system choices require additional equipment (additional chillers for cooling, or solar thermal panels for re-generation of borehole fields)
- Balance with PV (production and demand) higher for certain district types
- Further analysis of sensitivity to demand profiles and electricity for pumping
- Further analysis considering districts with additional use-types (industry, restaurants, etc.)
- Include of cost analysis in tool

HUES Platform – Resources

An ecology of open source computational resources to support distributed energy systems (DES) design and control

Resources:

Models & algorithms

Modeling tools

Data

Code

Purpose:

1. To **accelerate DES research** by making models, data and code more accessible and understandable to researchers.
2. To **improve DES design & control** in practice by developing innovative, validated tools for practitioners.

Publicly accessible and open source:
https://hues-platform.github.io

Integrates ongoing research in:

sccer | future energy efficient buildings & districts

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Thank you for your time
Questions?

Ashreeta.Prasanna@empa.ch

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Further information at www.sccer-feebd.ch

EMPA Materials Science & Technology

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ETH zürich

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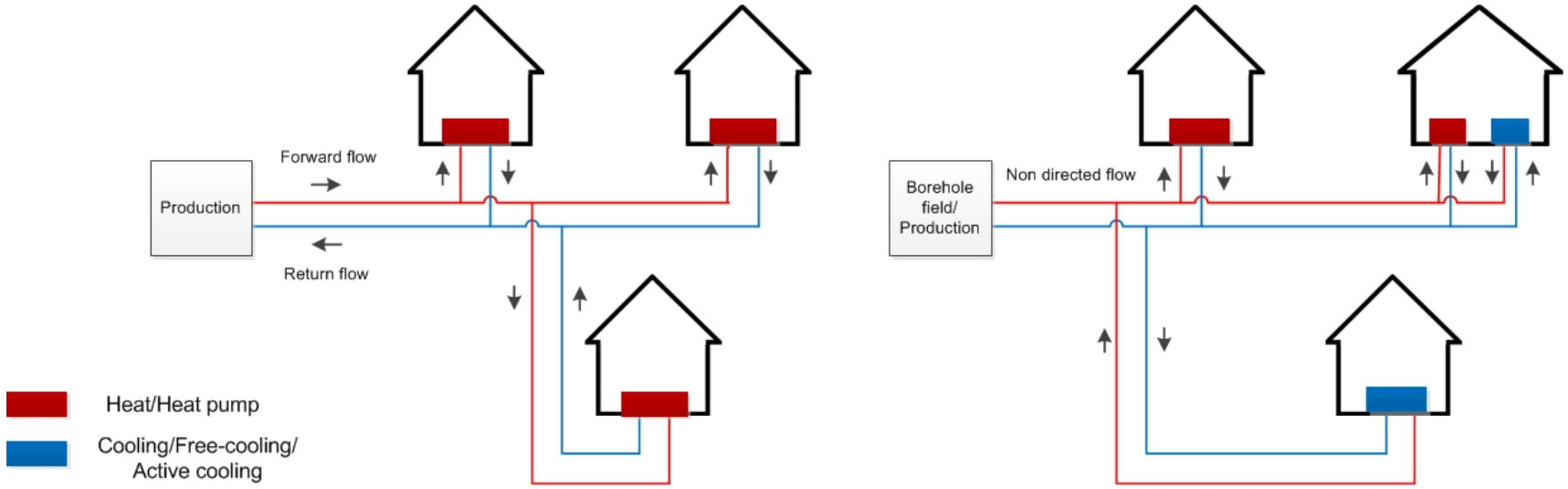
Low temperature bi-directional networks (LTN)



Direction of **energy** flow

Direction of **fluid** flow	unidirectional	Bi-directional
directed	Heat or cooling operation, central pump, forward and return flow clearly defined	Heat and cooling operation, central pump, mix of temperatures in return flow pipe
non directed	n.a.	Heat and cooling operation, decentralized pumps, no clearly defined forward or return flow pipe