Towards Positive Energy Districts – Innsbruck „Campagne Areal“

Fabian Ochs, Samuel Breuss, Elisa Venturi, Mara Magni, Georgios Dermentzis

ISEC 2024, Graz

New District Campagne Areal

Campagne Areal:

- 4 blocks
- ca. 1100 flats
- in 16 buildings
- ca. 78000 m^2

- **Residential**
- Shops and Cafes
- School and kindergarten
- Sport facilities

IIG, NHT

NHT Neue Heimat Tirol

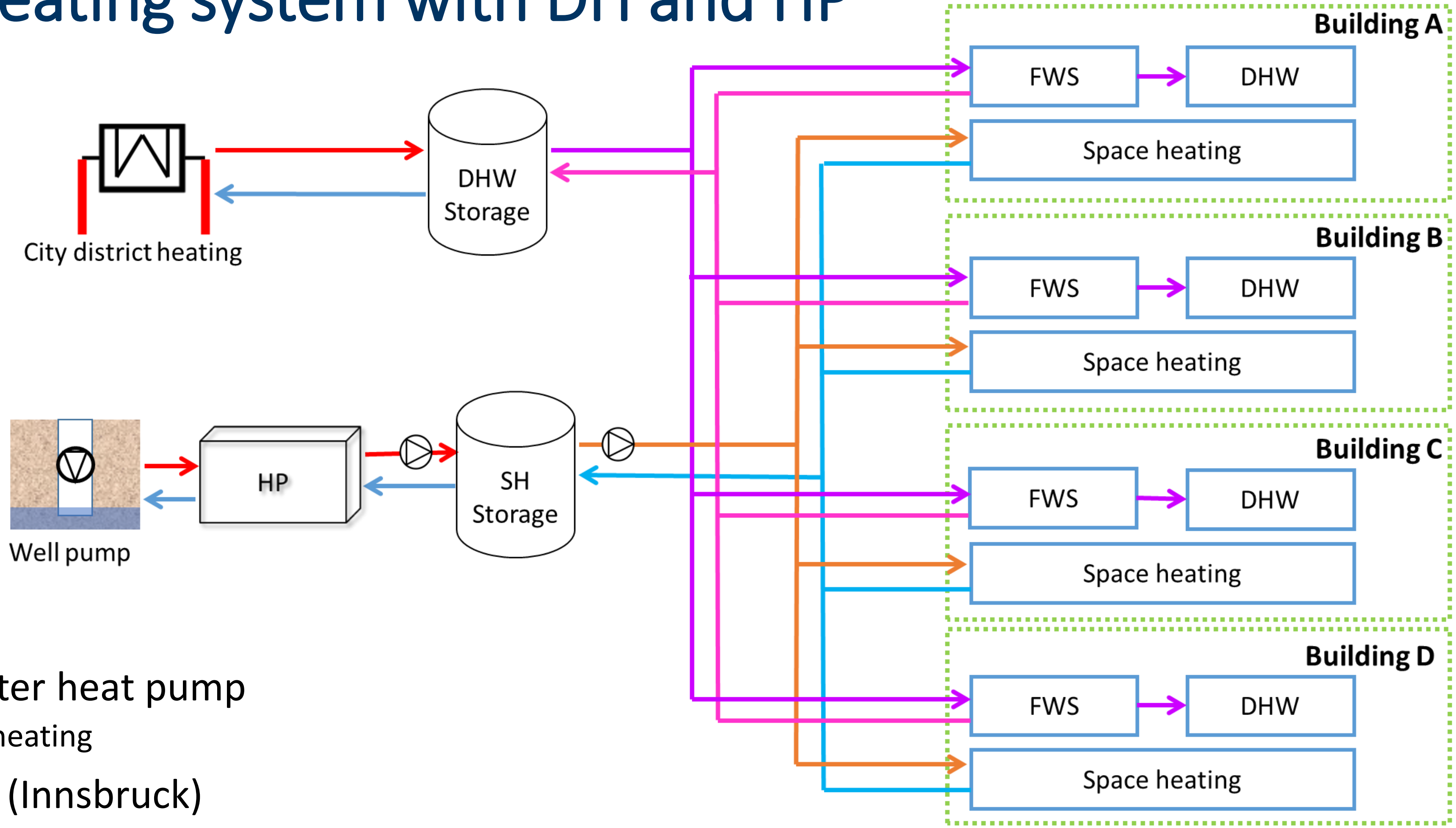
expressiv für Bogenfeld Architektur

New District Campagne Block 1

- 4 buildings
  - 307 flats and non-residential activities
  - 22277 m^2
- Space heating demand (PHPP):
  15 – 21 kWh/(m^2 a)
- MVHR
- Central block heating system (2+2 pipes)
  - Central groundwater heat pump (HP)
  - District heating (DH) Innsbruck
- PV on roofs of 3 buildings
  (B: 81, C: 80, D: 32; ca. 324 m², ca. 54 kW_p)

Towards Positive Energy District (PED) …

Central block heating system with DH and HP



2+2 pipe system:

- SH: central groundwater heat pump
  - Heat emission: floor heating
- DHW: district heating (Innsbruck)
  - Fresh water station (FWS) in each apartment

Integration of HP in DH

Motivation

- **Decarbonisation of DH**
- Source limitation (e.g. limited ground water)
- Restrictions/constraints regarding space or sound emissions (A-HP)

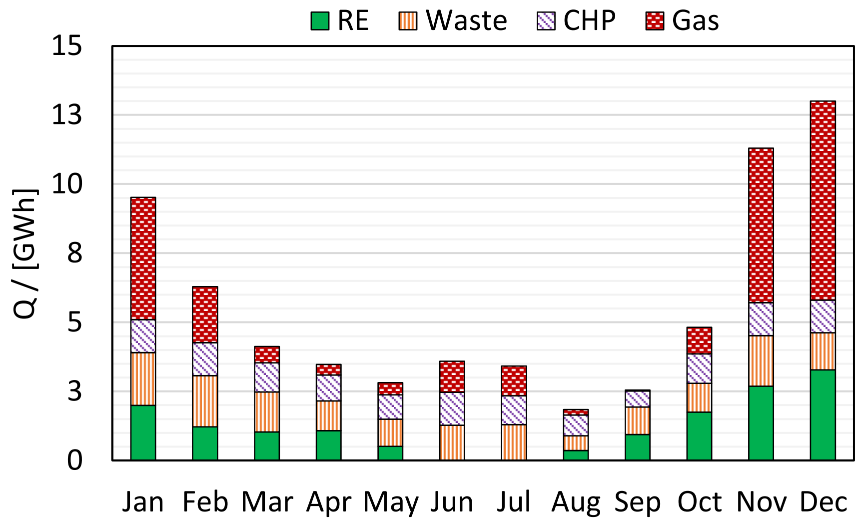
Centralisation

- District Level
- Block Level
- Building Level (individual source, common source)
- Flat Level (e.g. DHW-HP)

Application

- Space Heating (SH)
- Domestic Hot Water (DHW)
- SH + DHW

Share (0 … 100%)



DH Innsbruck (monthly balance, simplified)

G Dermentzis, F Ochs, A Thür, W Streicher, Supporting decision-making for heating and distribution systems in a new residential district-An Austrian case study, Energy 224, 120141

F Ochs, M Magni, G Dermentzis, Integration of Heat Pumps in Buildings and District Heating Systems—Evaluation on a Building and Energy System Level. Energies 2022, 15, 3889

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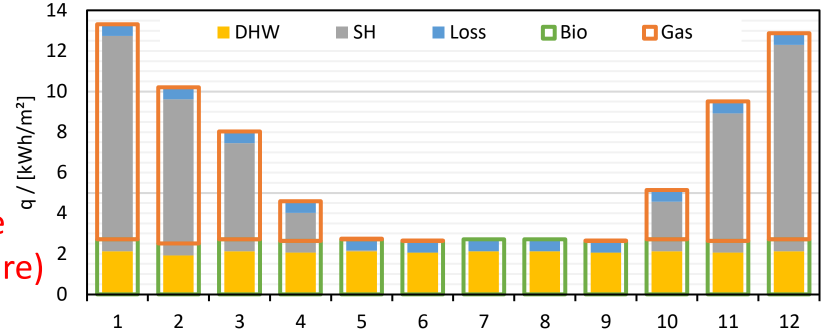
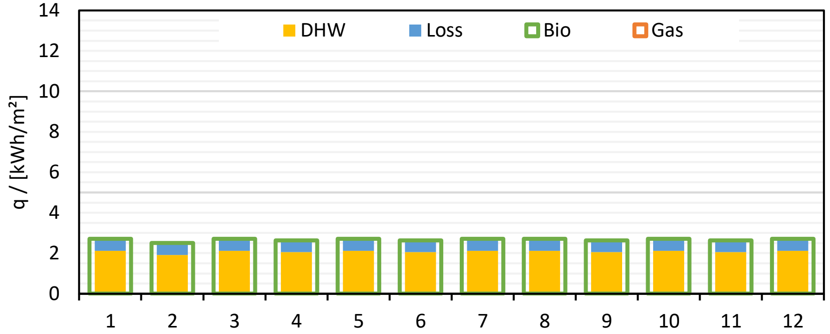
DH / Central HP

Low HP performance (high sink temperature)



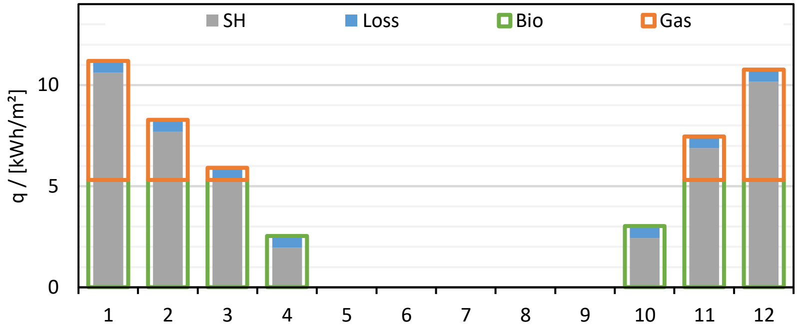
HP for SH, DH for DHW

Flat load curve



HP for DHW, DH for SH

Low load hours, high peak power



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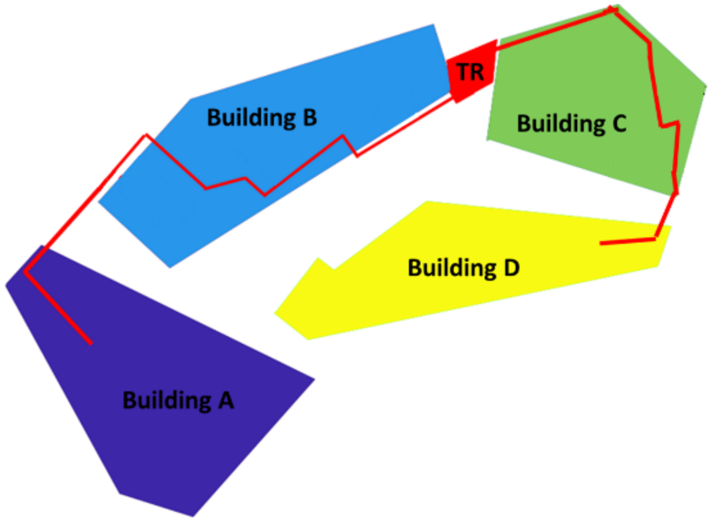
Analysis of monitoring data comparison with design values

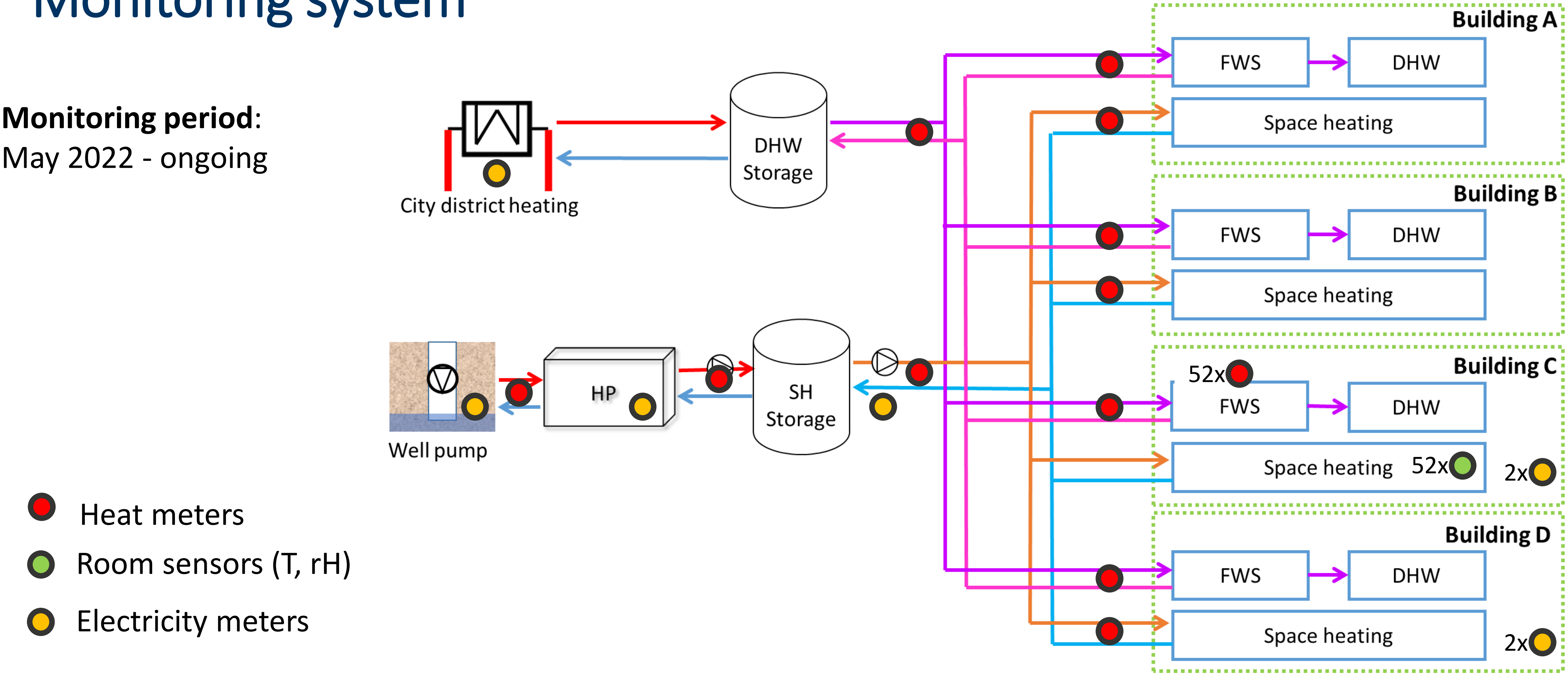
- Thermal comfort
- (IAQ)
- Space heating demand
- Domestic hot water demand
- Storage and Distribution losses
- Tapping profiles, simultaneity
- Heat pump performance

NHT Neue Heimat Tirol



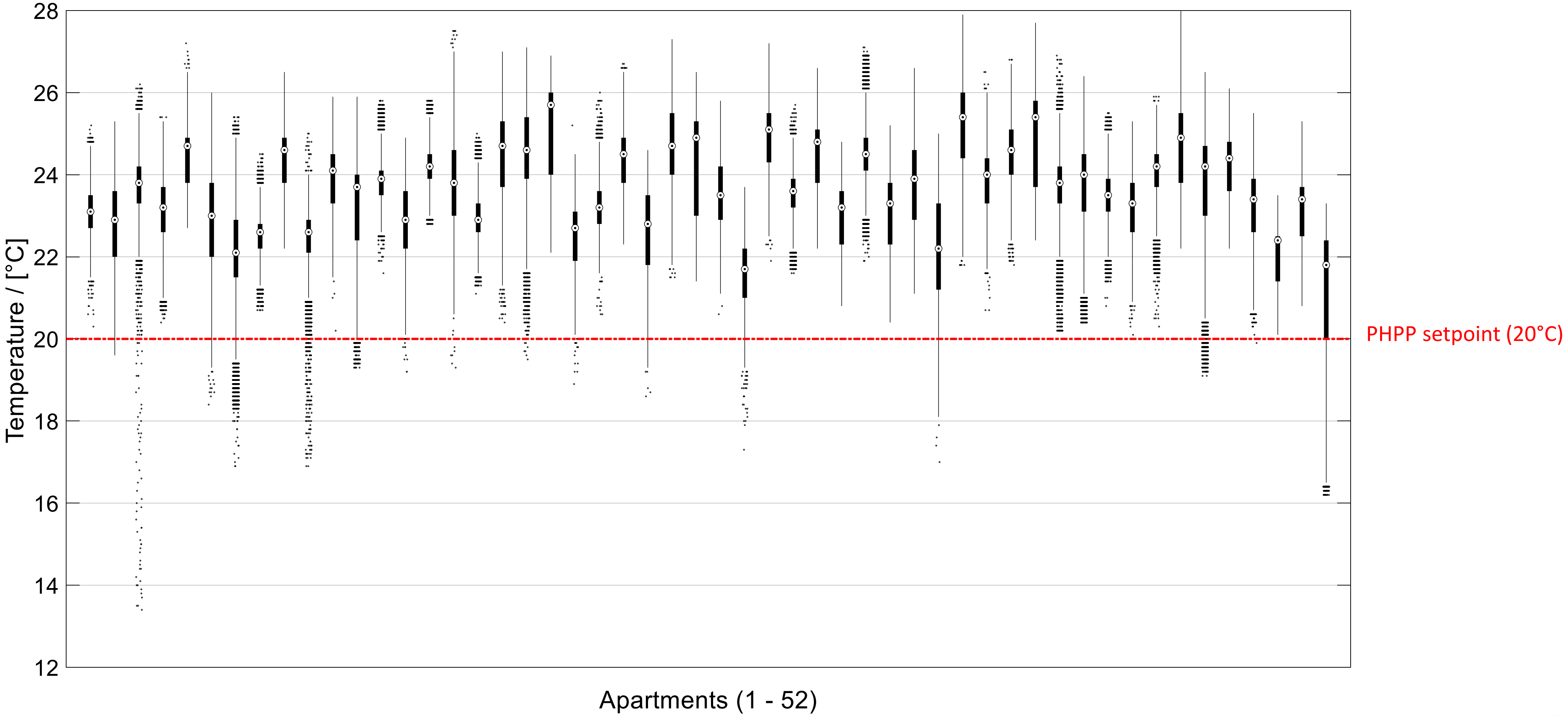
Monitoring system

Monitoring period:
May 2022 - ongoing



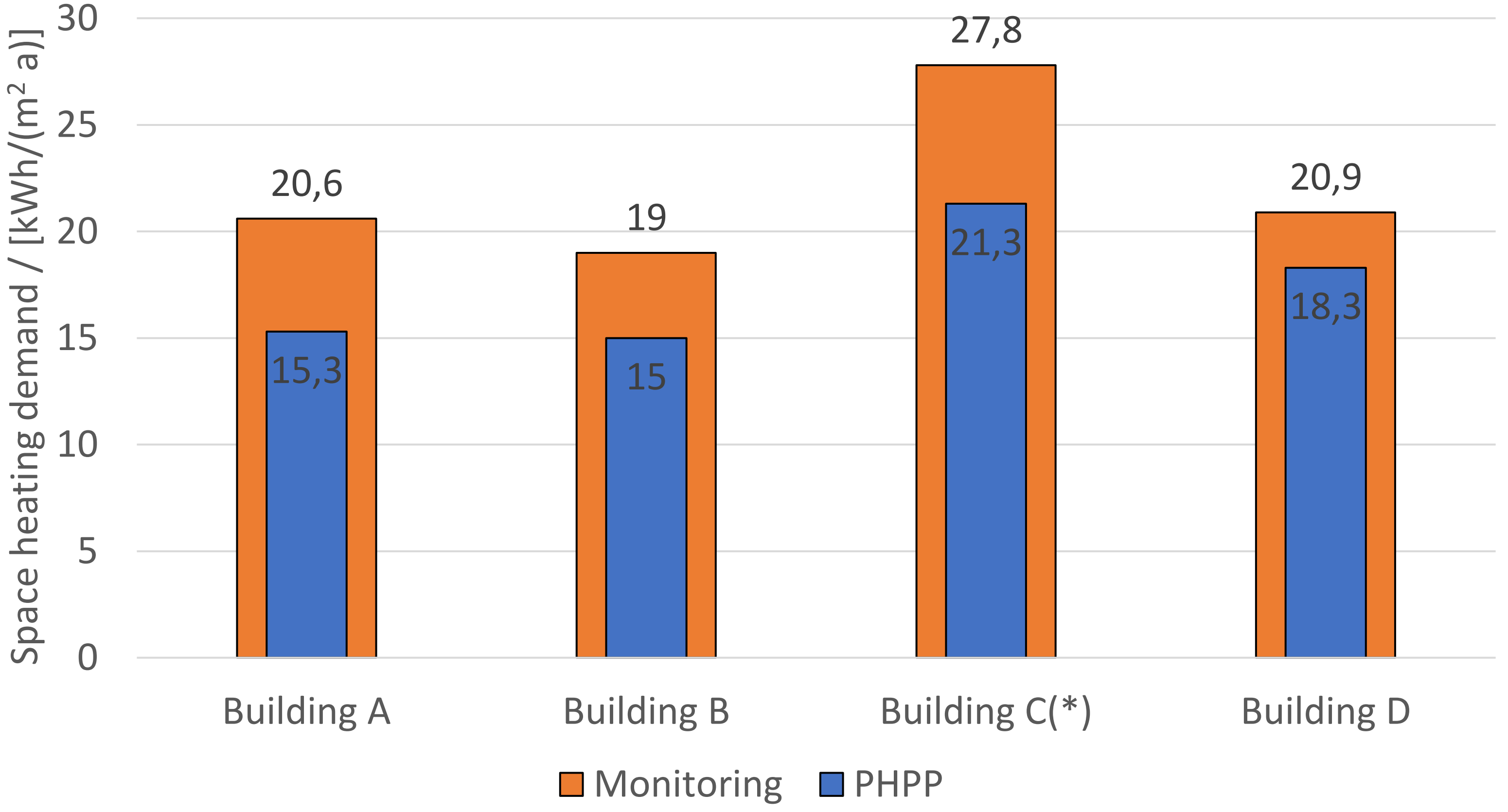
Time period: Winter 2023 / 2024
(01.10.2023 – 31.03.2024)

Thermal comfort (Building C)



Time period: **2023**
(01.01.2023 – 31.12.2023)

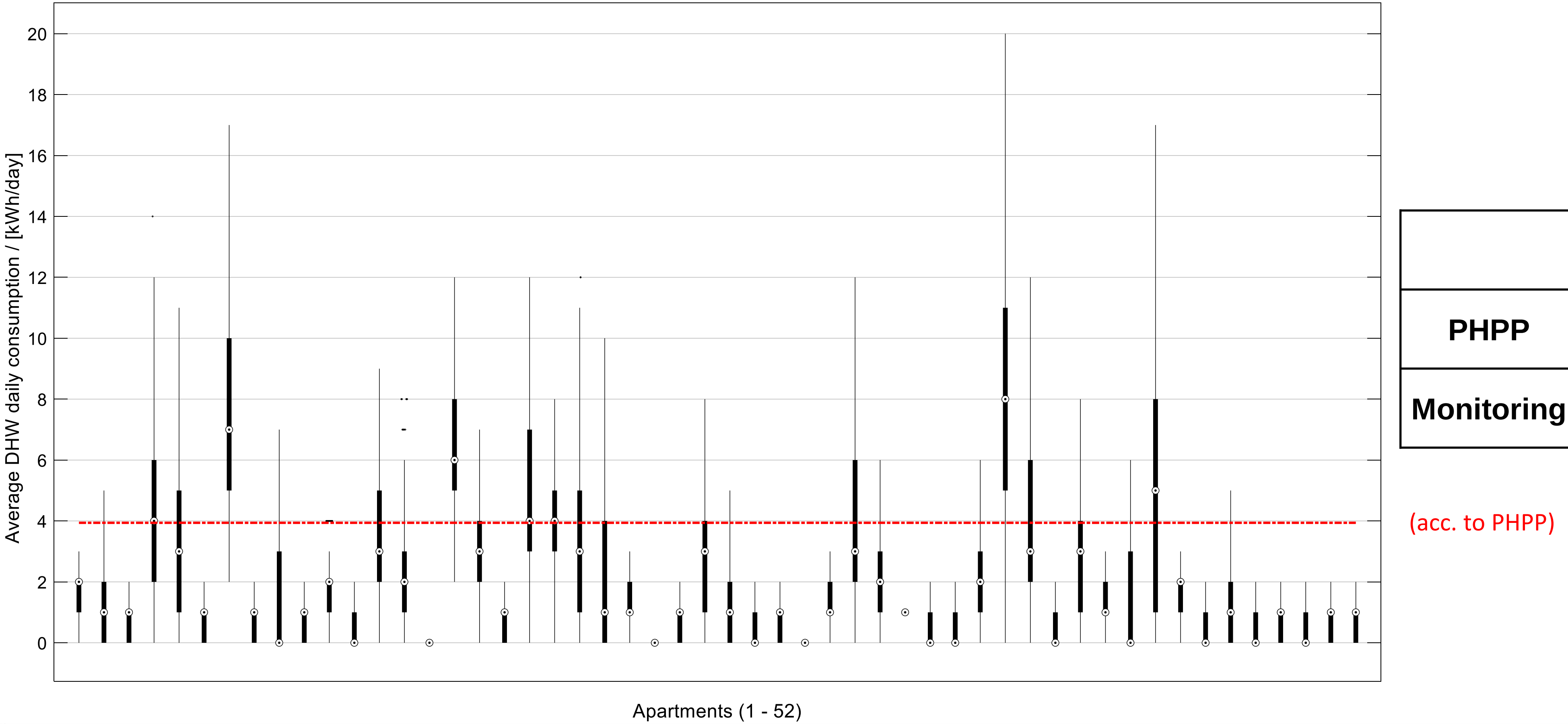
Space heating demand



(*) including part of the distribution losses

Time period: **2023**
(01.01.2023 – 31.12.2023)

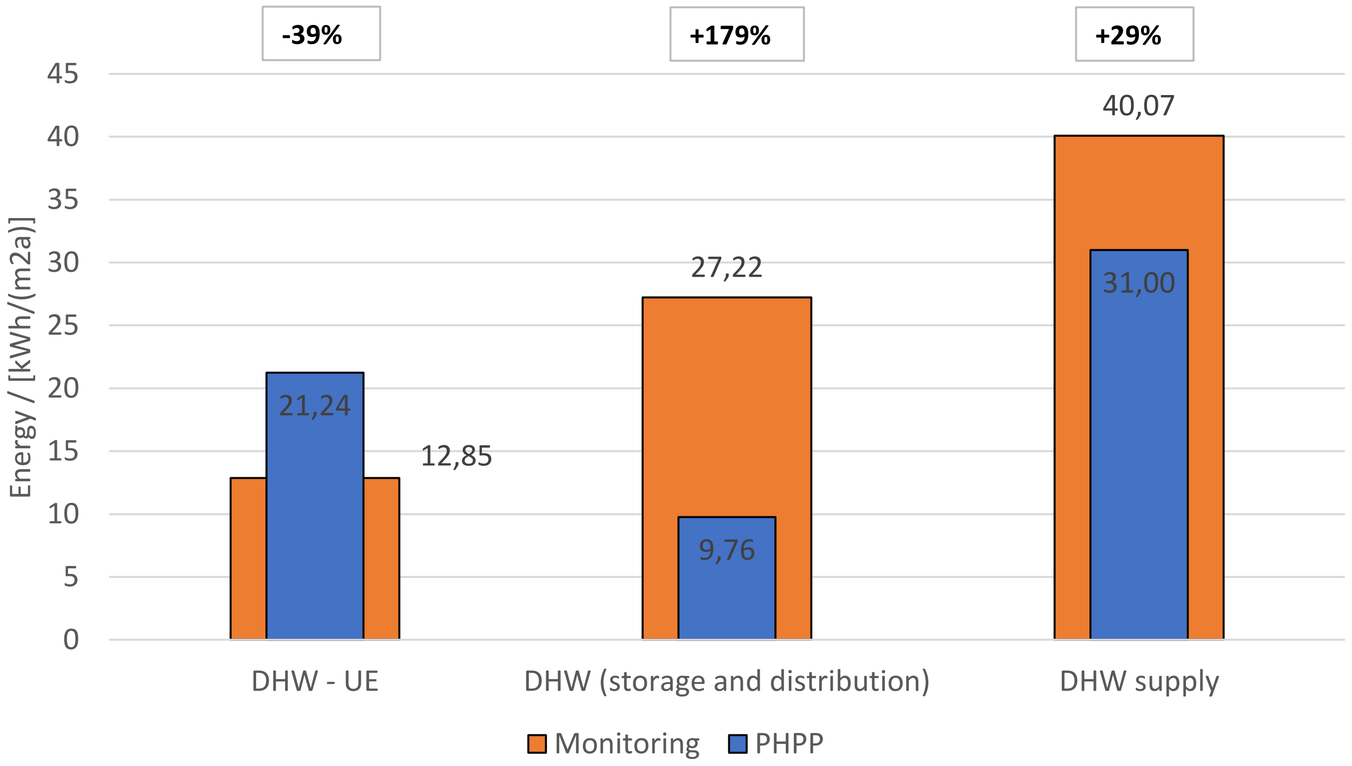
Domestic Hot Water (Useful energy) - Building C



	DHW demand [kWh/person/year]
PHPP	529
Monitoring	320

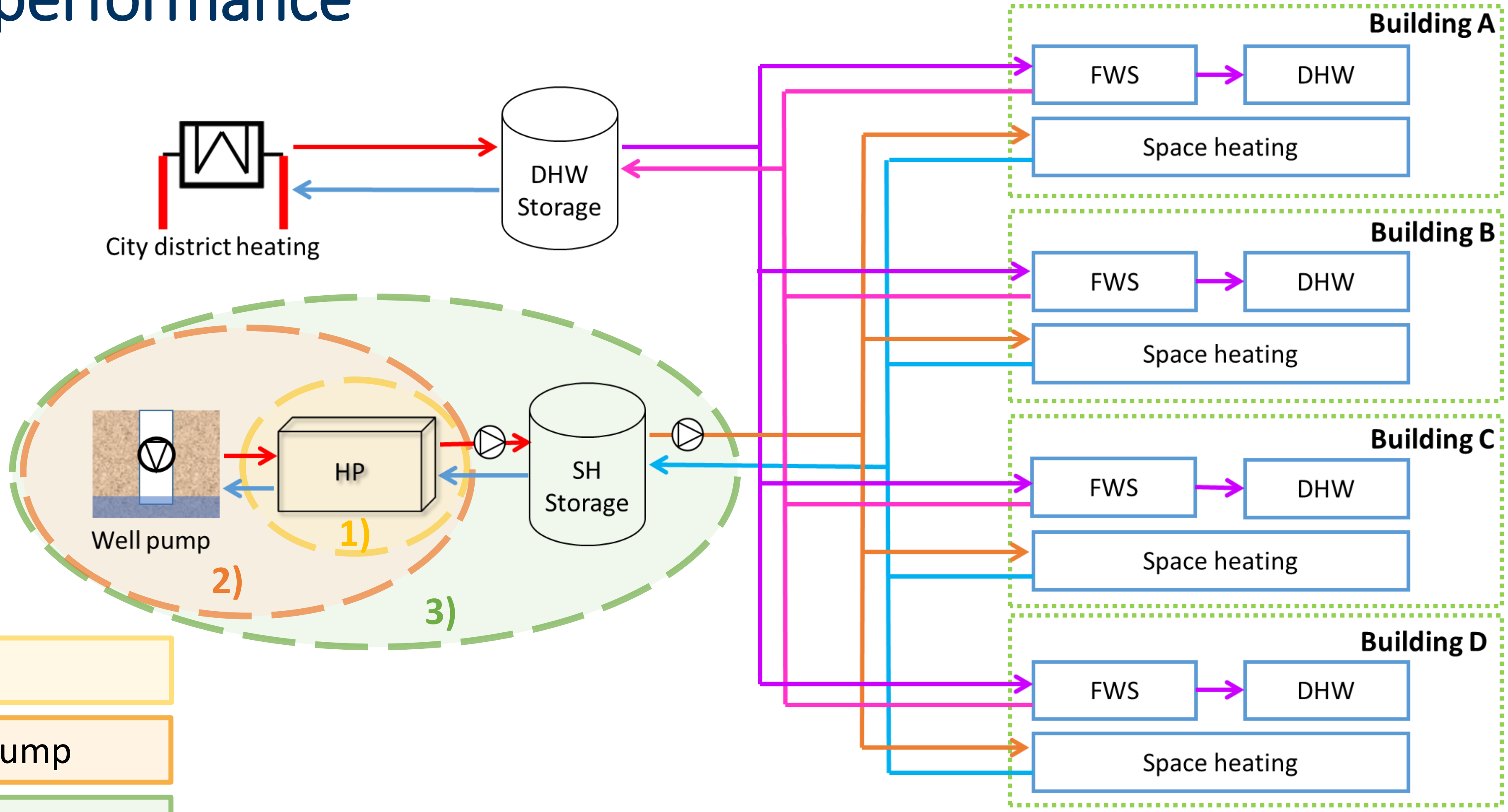
Δ = 39%

Storage and Distribution losses (Building C)



- High setpoint DHW heat exchangers (65°C → 60°C vs. 52°C PHPP)
- High distribution losses …

Heat pump performance

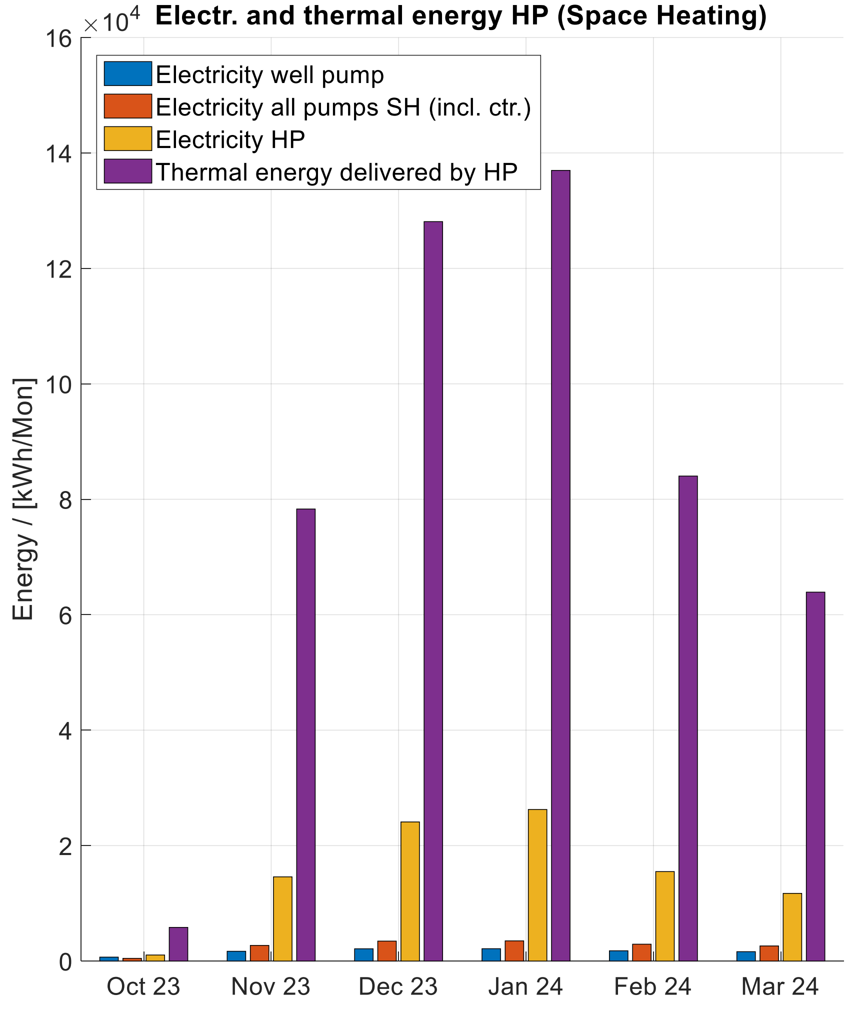


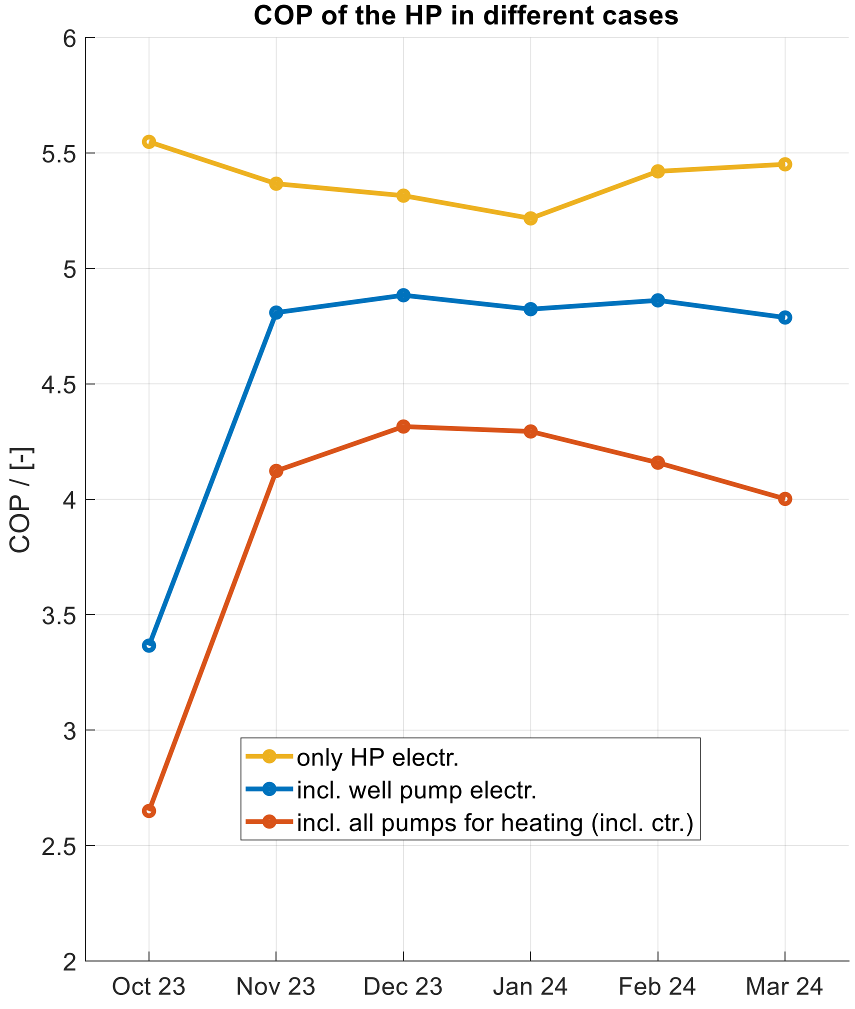
1) Heat pump

2) Heat pump and well pump

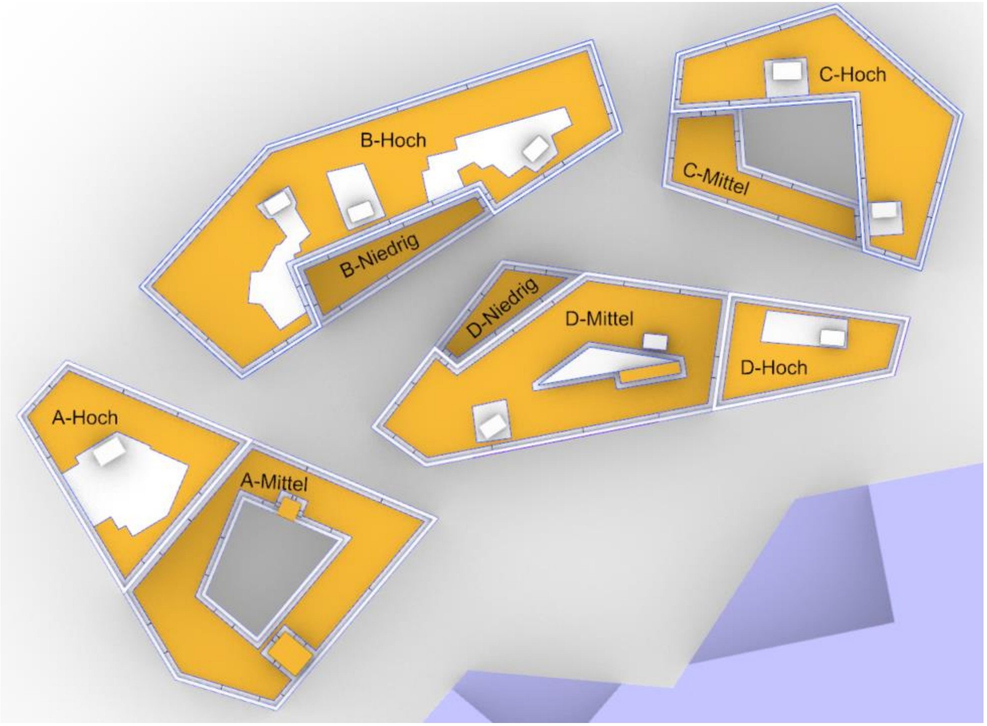
3) Central system

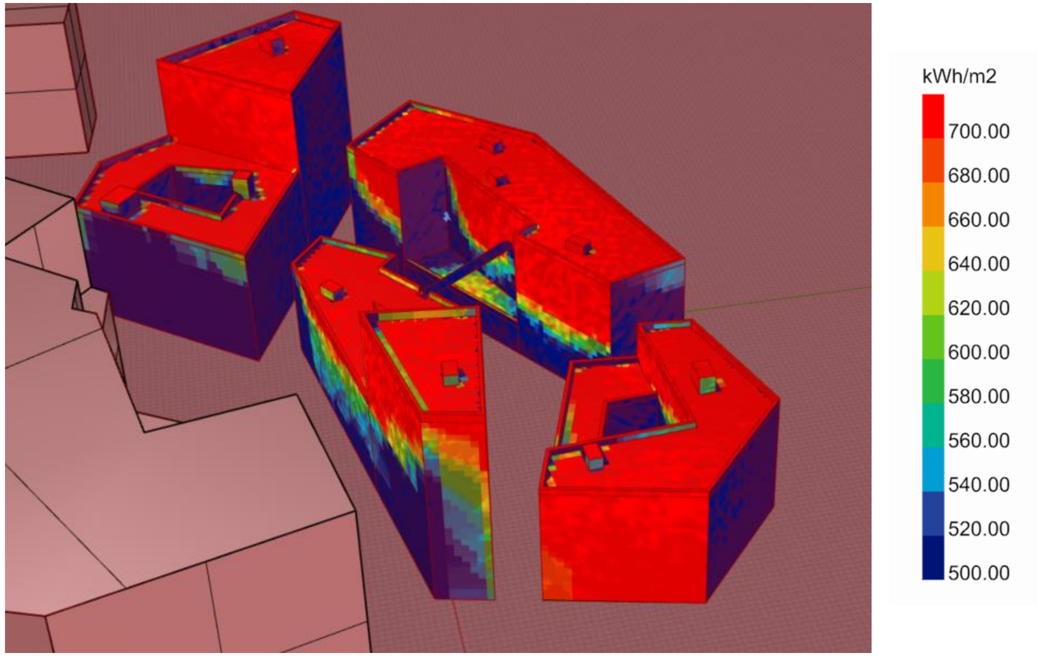
Heat pump performance

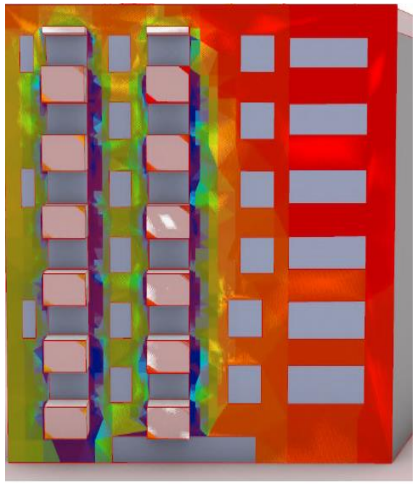


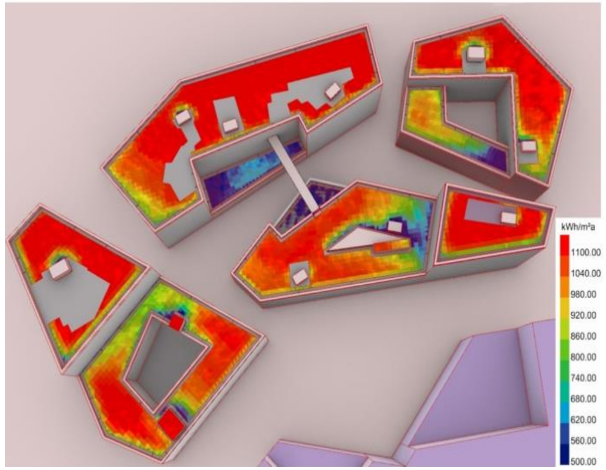


Solar Potential





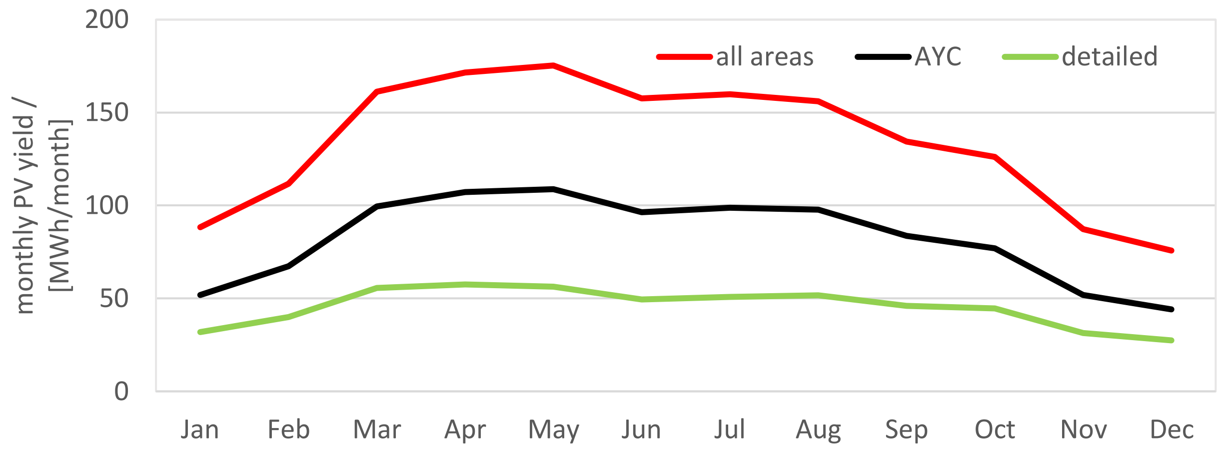


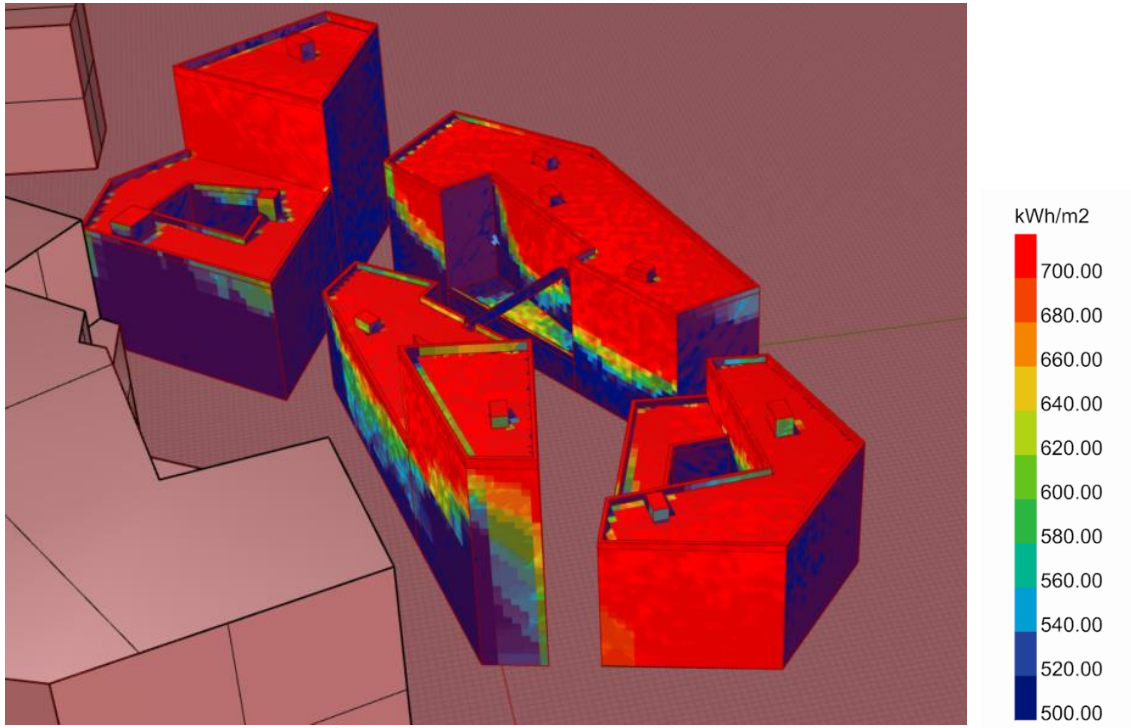


Solar Potential

Areas in *[m²] available for PV on roof and facades and share* in [%] *with respect to total available area*

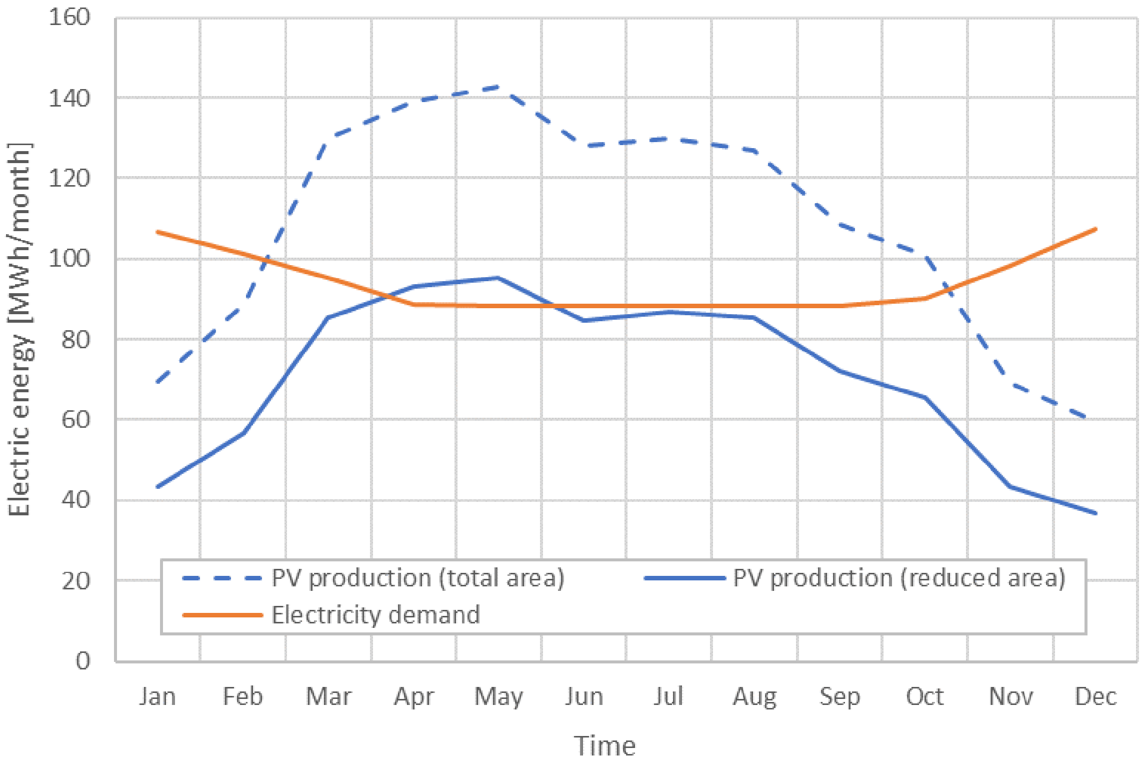
	Roof		Facades	
Total	4798		16430	
Available (ideal case)	2841	59 %	11175	68 %
Available (real case)	2658	55 %	2164	13 %

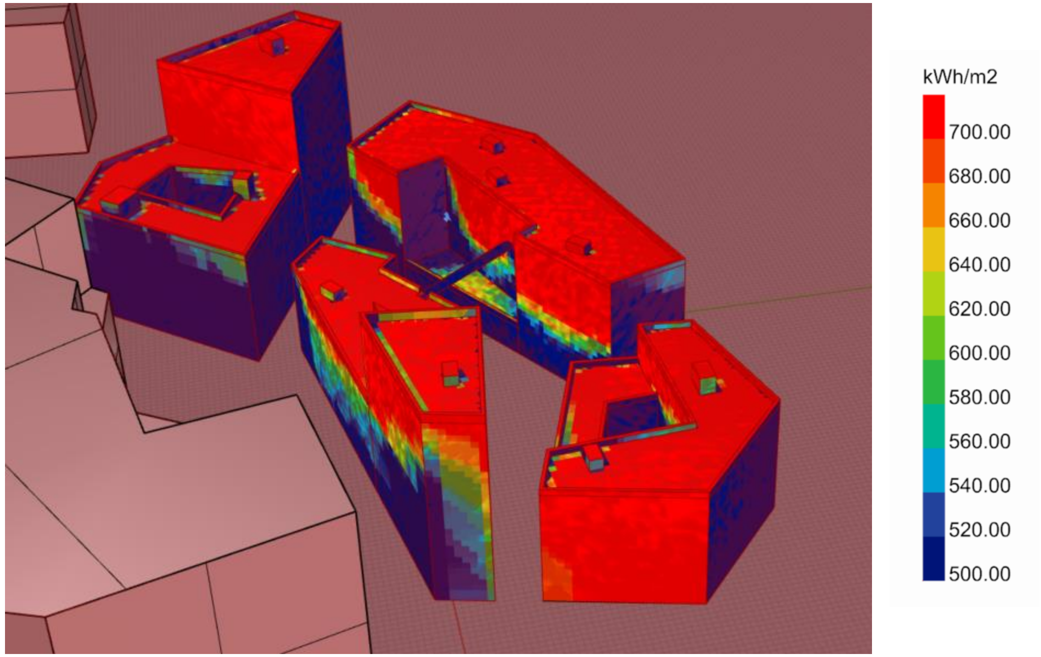




Solar Potential

Winter gap!





Solar Potential

Net CO_2 Balance

- SH
- DHW
- AUX
- APP

Additionally required (not shaded) horizontal PV area to reach Net Zero CO_2 balance (in [m²] and percentage of football fields)

	(a)		(b)		(c)		**(d)**	
$f_{monthly}$	1241	25%	2482	50%	3068	61%	**2347**	**47%**
f_{mean}	1031	21%	2184	44%	2614	52%	**2060**	**41%**
f_{OIB}	1031	21%	2184	44%	2146	43%	**1758**	**35%**

(a) Heat pump for each building (SH and DHW)
(b) Heat pump for each building (SH) and direct electric (DE) DHW preparation with E-boilers
(c) District heating for SH and DHW
(d) Central heat pump for SH, district heating for DHW (as built)

F Ochs, G Dermentzis, Evaluation of efficiency and renewable energy measures considering the future energy mix, IBPC 2018

Conclusions and Outlooks

- Very high building quality (Passive House) is prerequisite to reach PED
- Low storage and distribution losses and minimal auxiliaries (careful planning and quality control)
- Appliances included (EV not)
- Real PV potential significantly reduced due to (self) shading
- Winter gap – monthly CO_2 conversion factors
- Future work on detailed evaluation of PED with DH

PED … more a vision

Acknowledgments

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- The outcomes of the Campagne-Areal project will contribute to the international projects:

IEA EBC A83 Positive Energy Districts

IEA HPT A61 Heat Pumps in Positive Energy Districts

IEA SHC T66 Solar Energy Buildings

- The authors are grateful for the collaboration and support:

Thank you!

fabian.ochs@uibk.ac.at