only numbers count

life cycle costs in social housing

Arch. Walser + Werle, foto: Energieinstitut Vorarlberg

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Funding is managed by FFG.

content

1. **research project „KliNaWo“ – life cycle costs in social housing**

   - starting point, objectives and approach

   - energy demand, investment and life cycle costs

   - energy consumption, thermal comfort and settled costs

2. **lessons learned**

   - further optimisation of „KliNaWo“-project

   - transfer of findings to subsequent projects

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starting point and objectives

Arch. H. Kaufmann (top), G. Zweier

- Vorarlberg was a passiv house frontrunner region
- passive house mandatory in social housing since 2008
- criticism on high extra costs and performance gap since 2011
- unobjective discussion due to lack of facts

> „KliNaWo“-project in cooperation with sceptical partners aims at:

- quantifying impact of energetic quality on investment costs
- developing a method for comparison of life cycle costs
- measuring real consumption and thermal comfort

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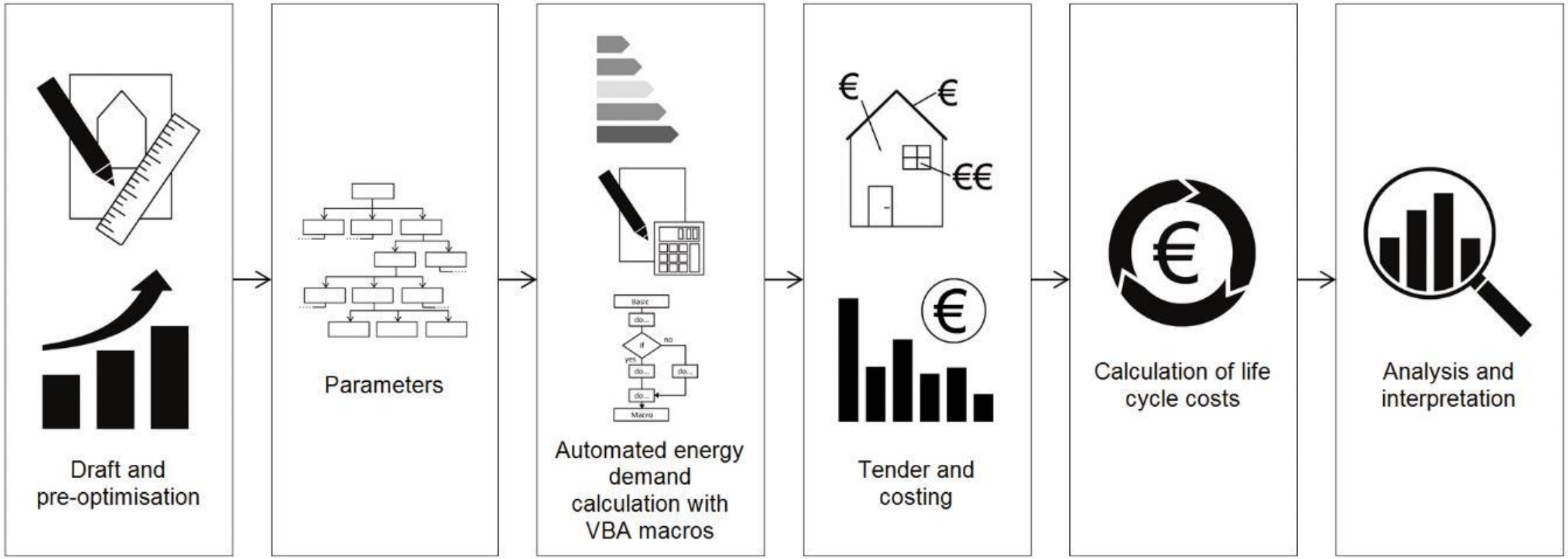
approach



- 60.000 variants considered
- variant with lowest life cycle costs realised in 2016/17
- monitoring of energy consumption and thermal comfort since 10/2017

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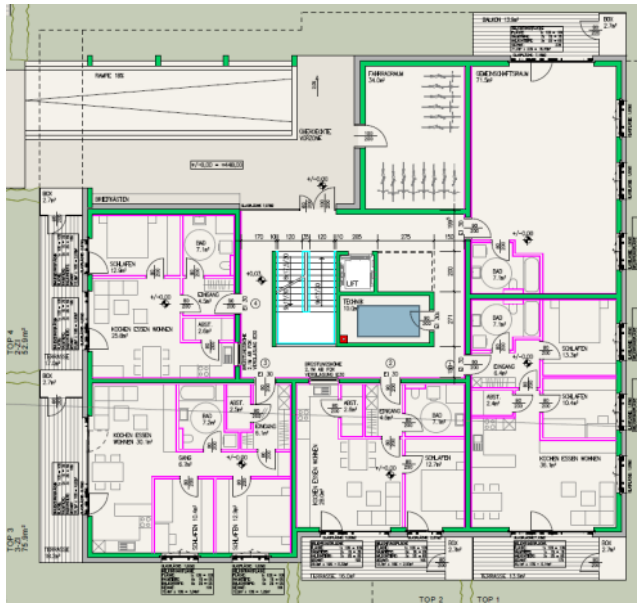
main figures and architectural design



house builder		VOGEWOSI (social housing company)
site		Feldkirch, Austria
climate-data for PHPP-calculations		TRY Feldkirch (ZAMG 1994-2012)
flats	number	19
size of flats	m^2	53 and 76
area PHPP	m^2	1.421
net dwelling area	m^2	1.281

sources: drawings Arch. Walser + Werle

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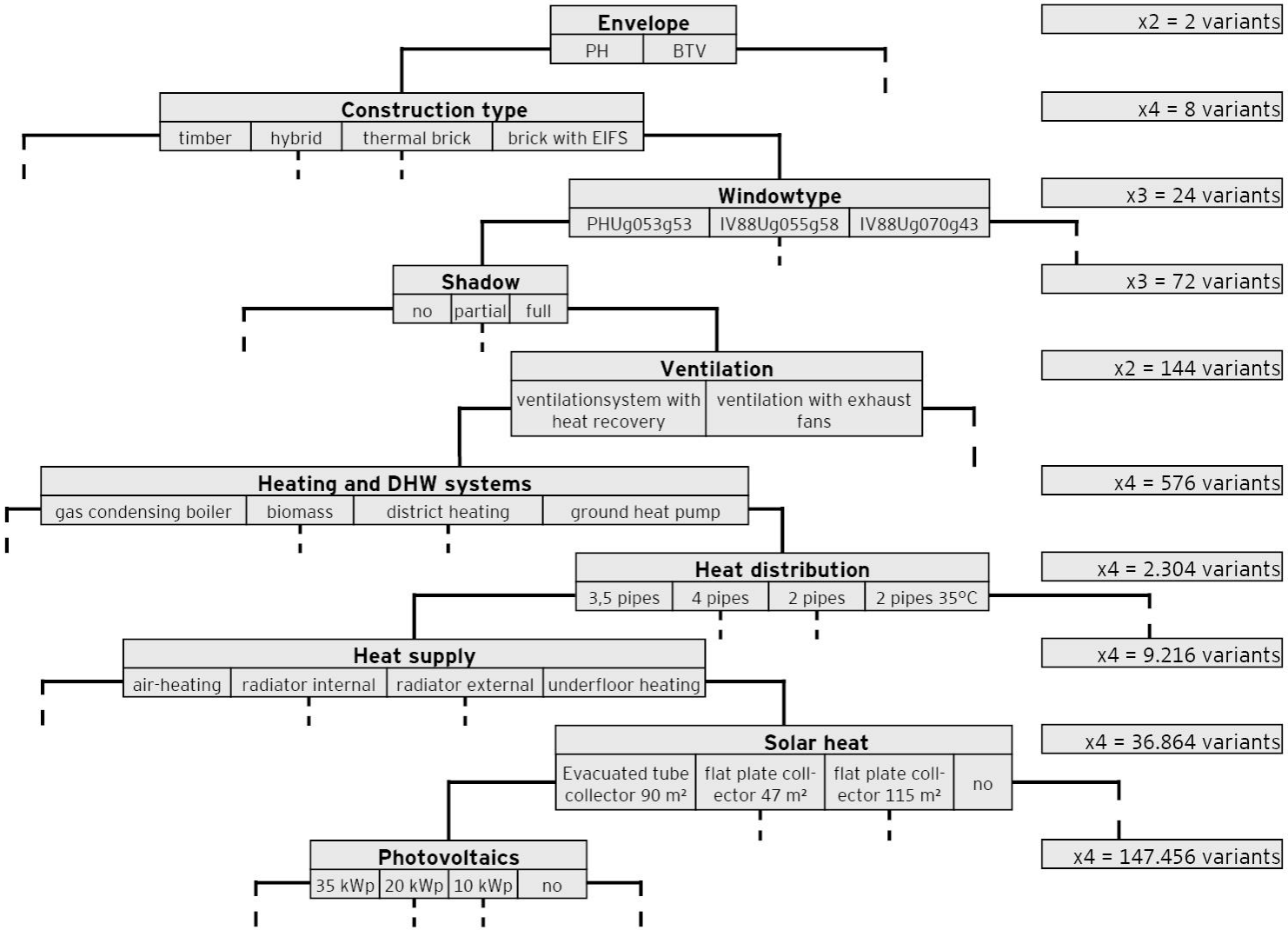
matrix of variants analysed



- **60.000 relevant variants under consideration**
- estimation of energy costs based on realistic PHPP-calculations (22°C, +30% dhw-demand…)
- conservative estimation of costs of service
- calculation of life cycle costs for investment, service and energy

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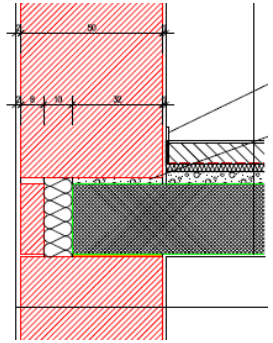
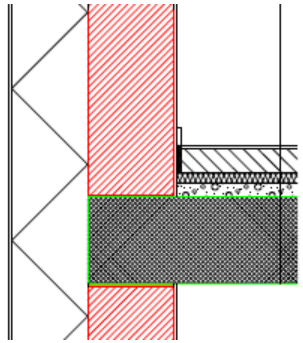
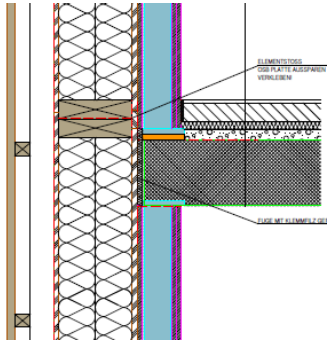
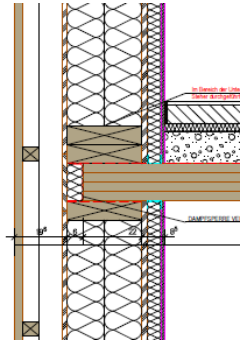
modular call for tenders

- modular call for tender for both construction and technical systems
- result: investment costs for 60.000 variants









sources: drawings: Walser + Werle

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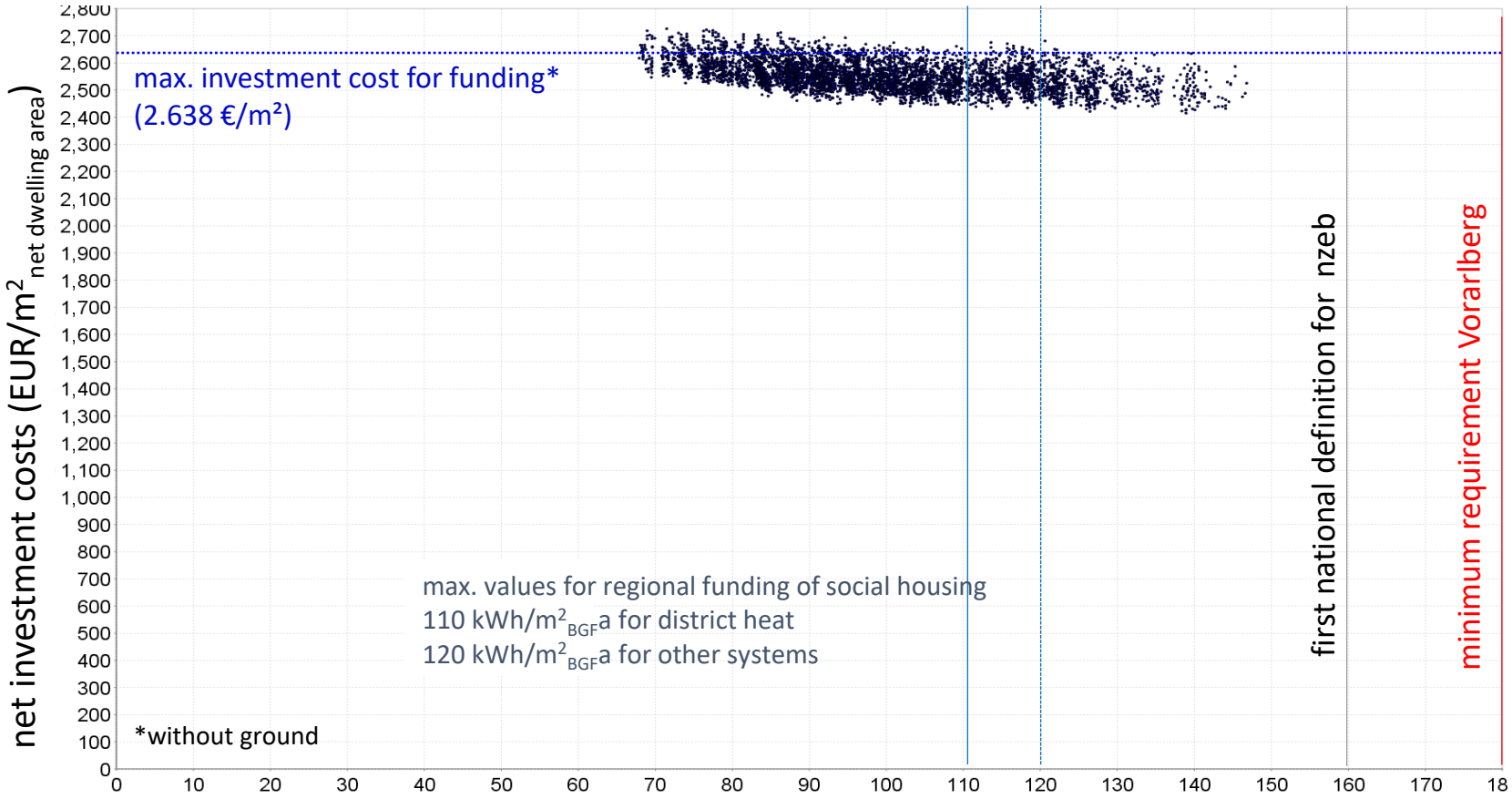
net investment costs and calculated primary energy demand



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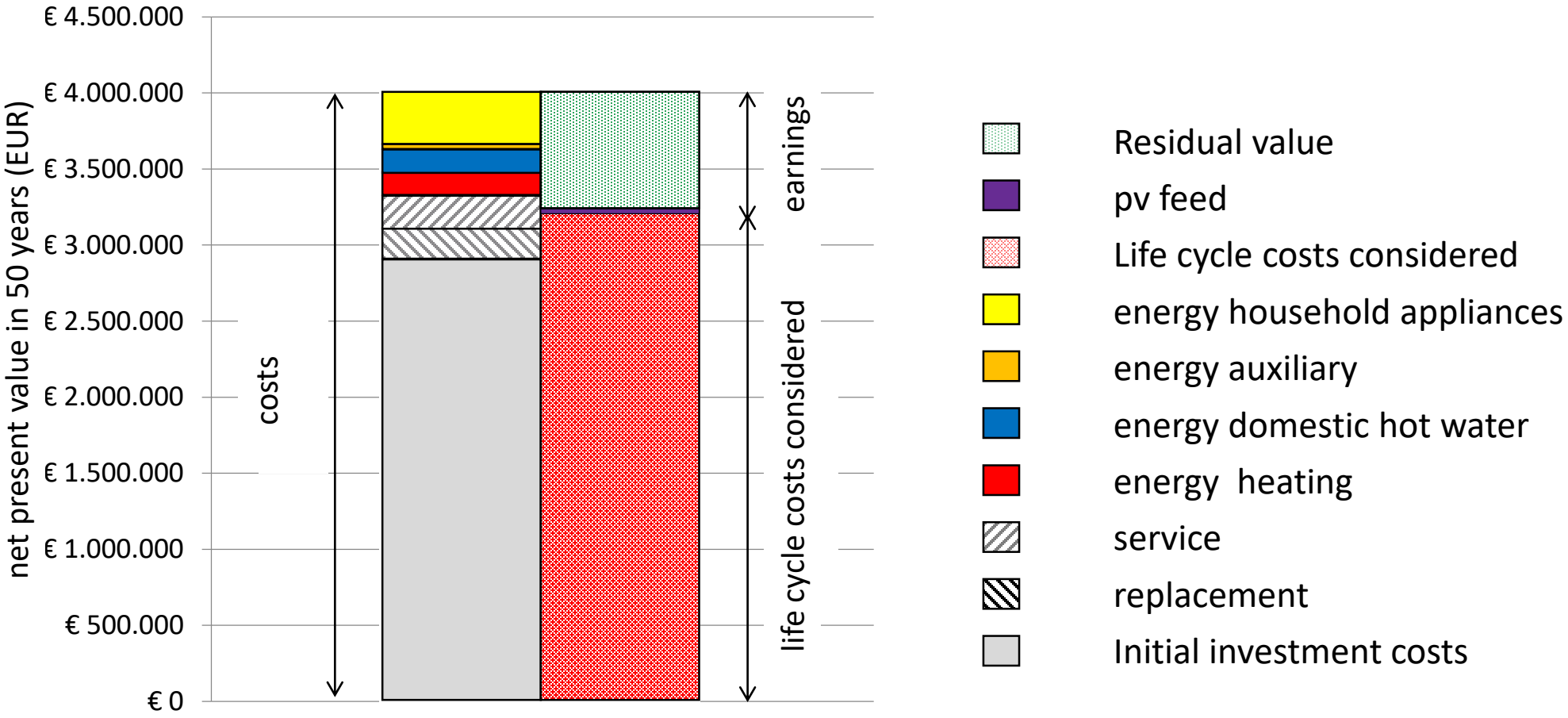
calculation of life cycle costs – net present value methode



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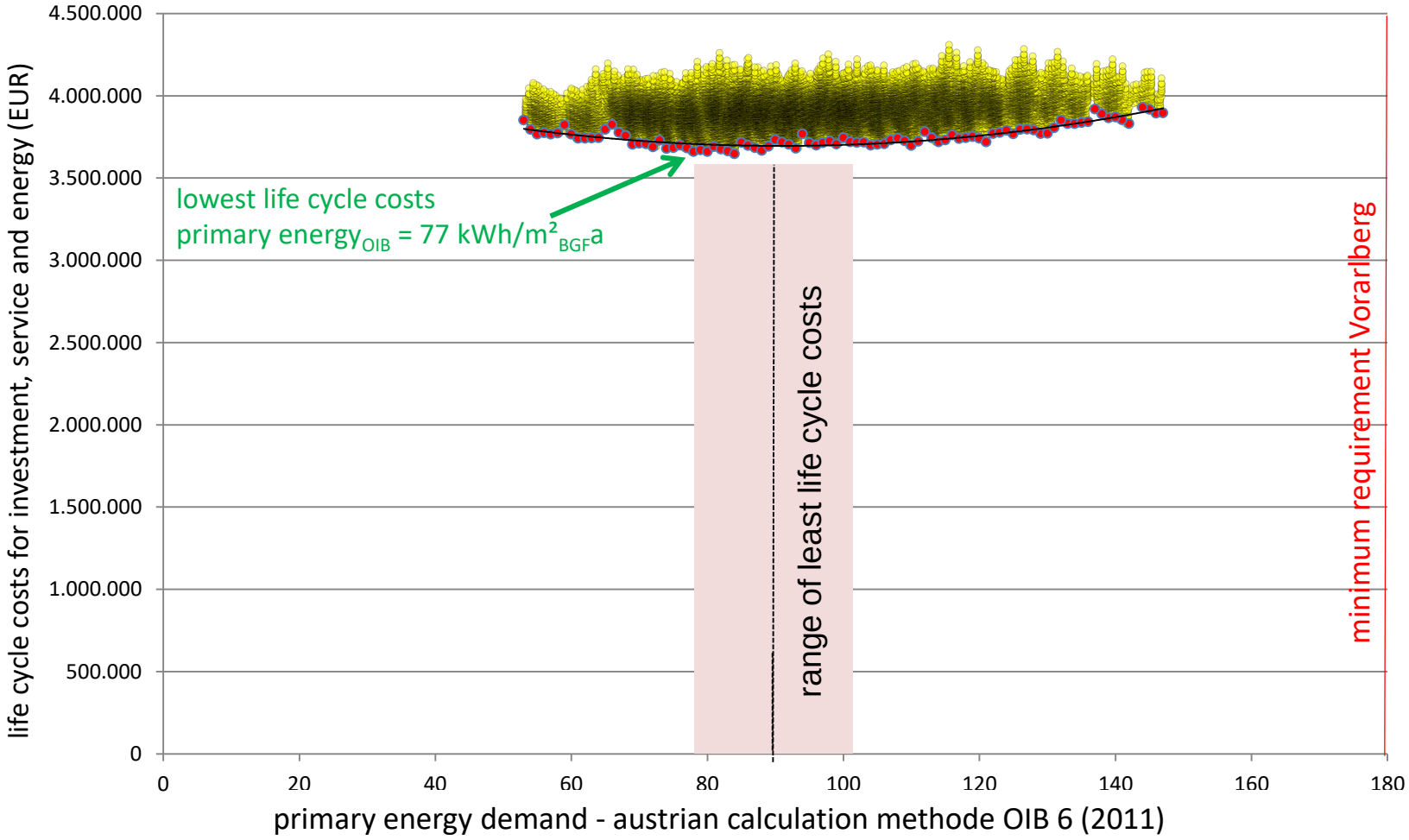
life cycle costs



- flat cost optimality curve
- min. lcc: 77 kWh/m$^2_{BGF}$a, i.e. 2/3 lower compared to min. regional requirements

Assumptions:

- periode under consideration: 50 a
- interest rate: 3,0%
- energy price increase: 3,5%
- no funding

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net investment costs in detail

	variant minimum requirements	realised variant
	EUR/m²$_{\text{net dwelling area}}$	EUR/m²$_{\text{net dwelling area}}$
construction brick + thermal insulation composite system	1 116	1 142
Windows: very good triple glazing, wood frame IV 90	97	97
sunscreens	23	23
heat supply system (2 ground coupled heat pumps, underfloor heating variant minimum requirements: without thermal solar realised variant: 98m² collectors + 6.700 liters buffer tank	124	157
sanitary	91	91
ventilation system without heat recovery	32	32
electric installation	102	102
other identical costs	329	329
total costs („Bauwerkskosten“, ÖNORM 1801-1, KG 2-4)	**1 914**	**1 973**
extra costs		59
extra costs (percent)		**3,1%**
heating demand PHPP 20°	36,2	28,1
reduction of primary energy demand and CO_2-emissions (without household appliances)		**-67%**

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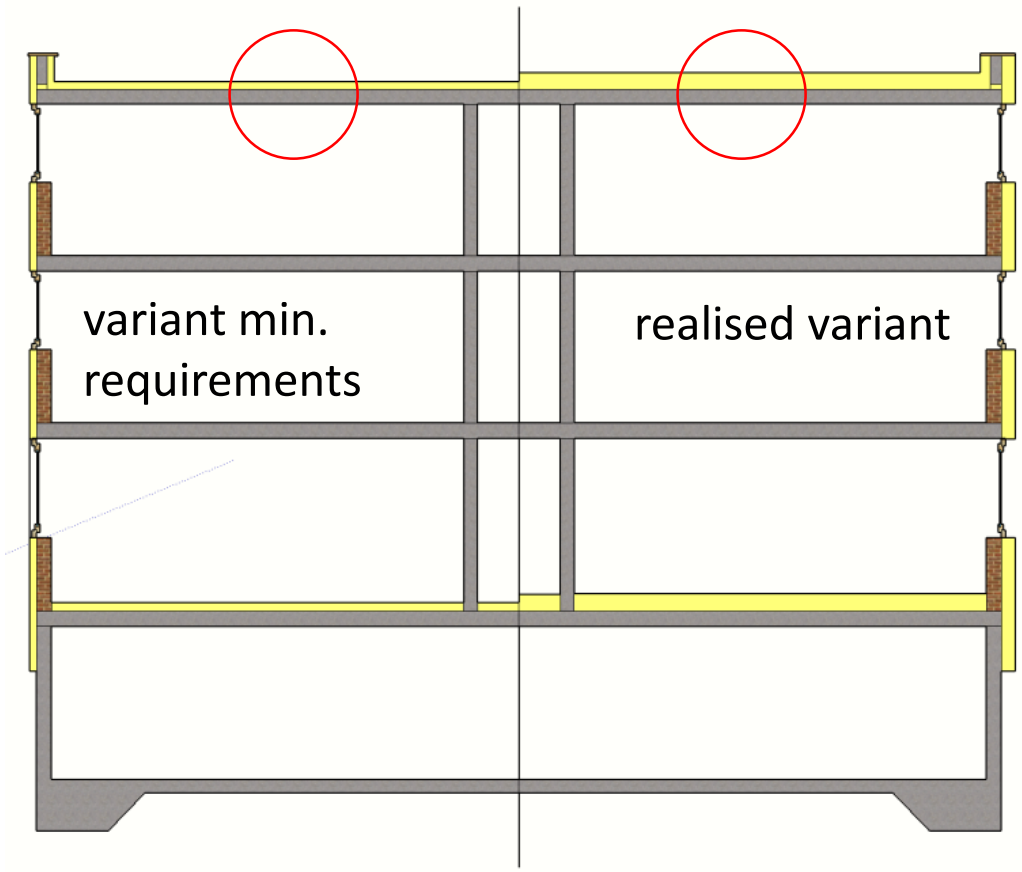
key figures of realised variant - envelope

	unit	value
U-wall	W/(m²K)	0,118
U-roof	W/(m²K)	0,081
U-ceiling basement	W/(m²K)	0,146
U-glass / g-glass	W/(m²K) / %	0,51 / 53%
U-frame	W/(m²K)	0,97



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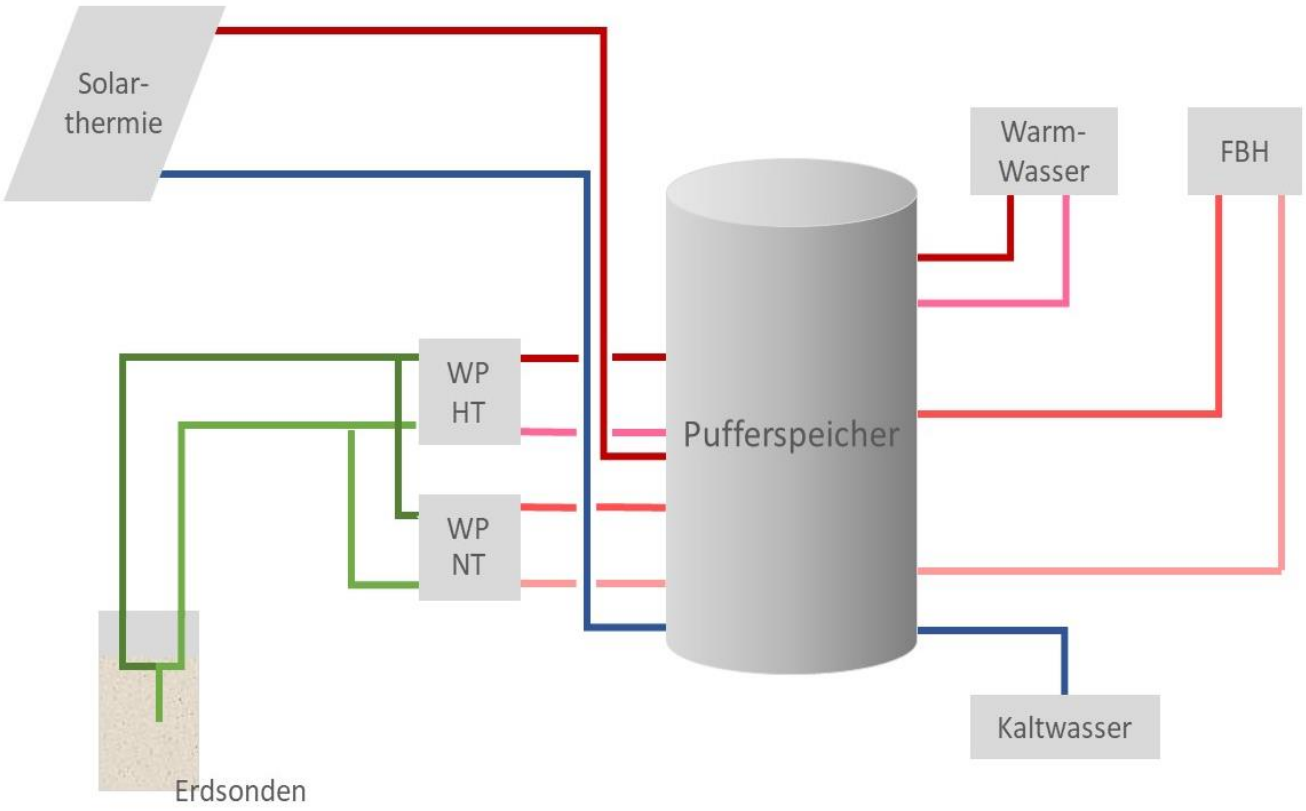
key figures of selected variant – technical systems

	unit	value
efficiency ventilation system	%	0
specific heat load PHPP 20°	W/m^2_{PHPP}	14,9
ground coupled heat pump heating	kW	36
ground coupled heat pump dhw	kW	10
net collector area	m^2	98
storage tank	liters	6.740



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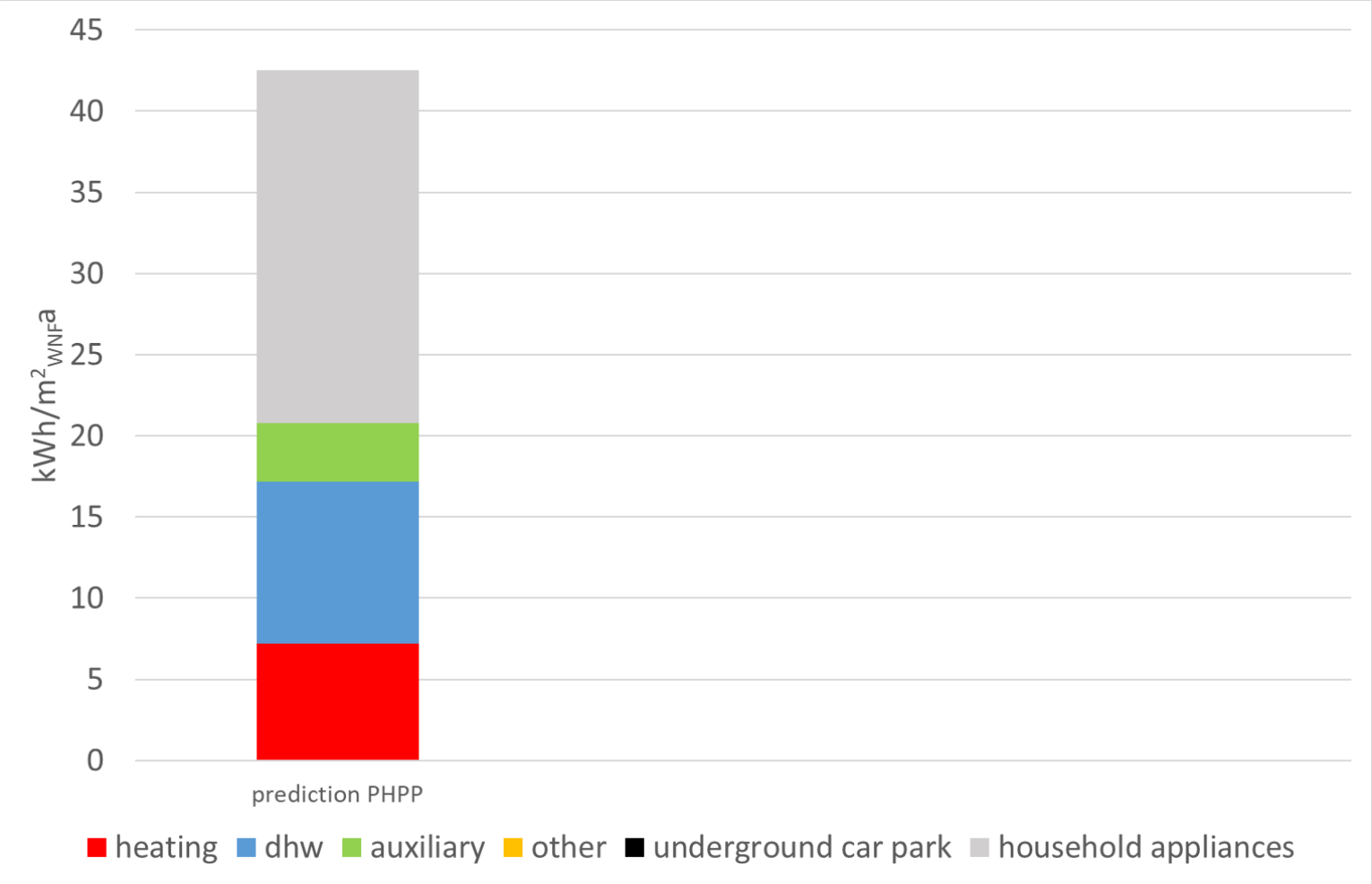
final energy demand of realised variant – PHPP calculation with realistic assumptions (PHPP-“prediction“)



assumptions

- mean indoor temp. winter: 22°C
- dhw-demand: PHPP-standard +30%
- per capita living area: PHPP standard
- internal heat: PHPP standard
- climate: TRY Feldkirch (1994-2012)

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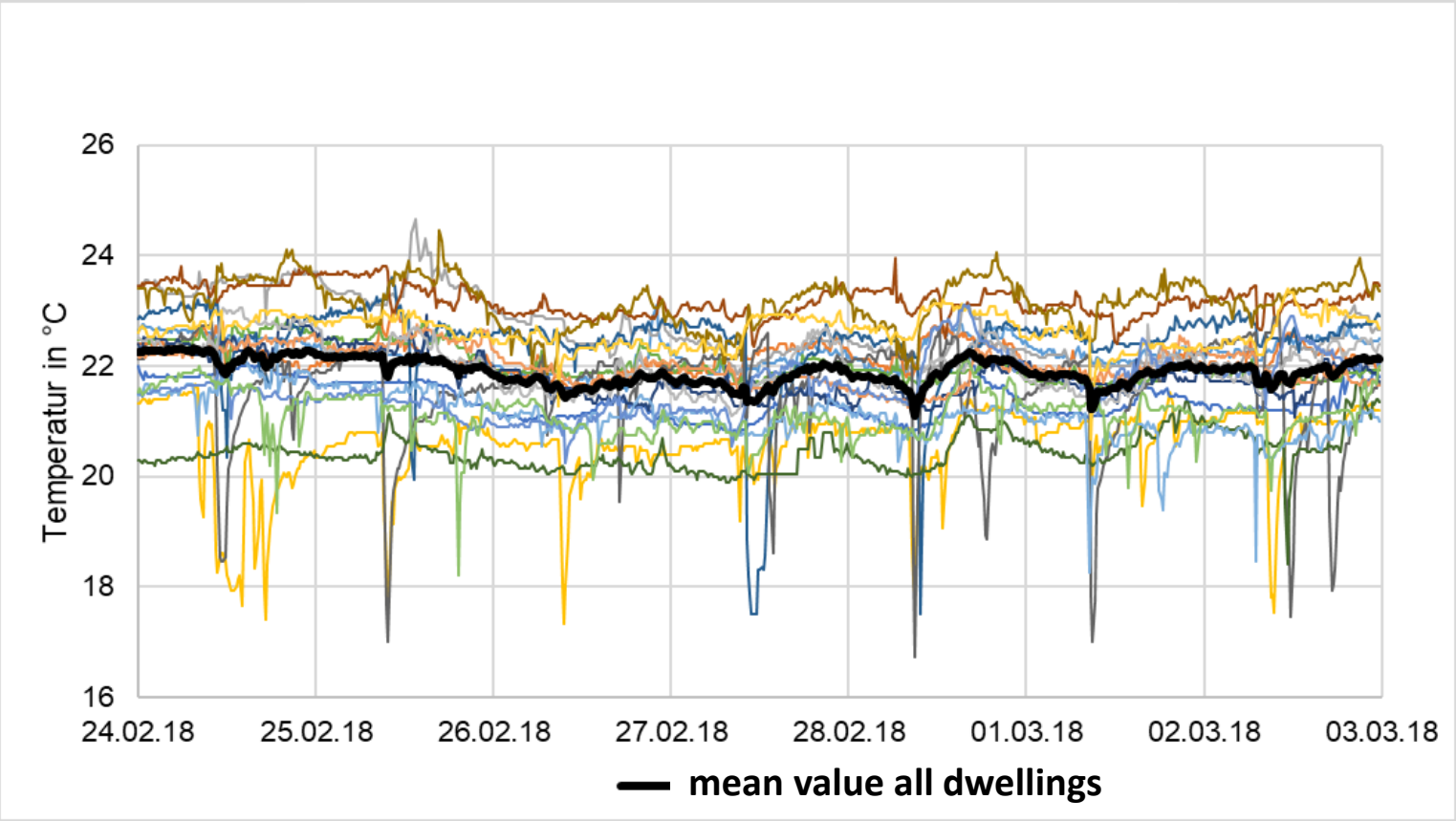
measured air temperatures – coldest winter week (outdoor temperatures down to -13°C)



- mean measured indoor temperature coldest week: 21,9°C
- mean measured indoor temperature heating periode 23,1°C

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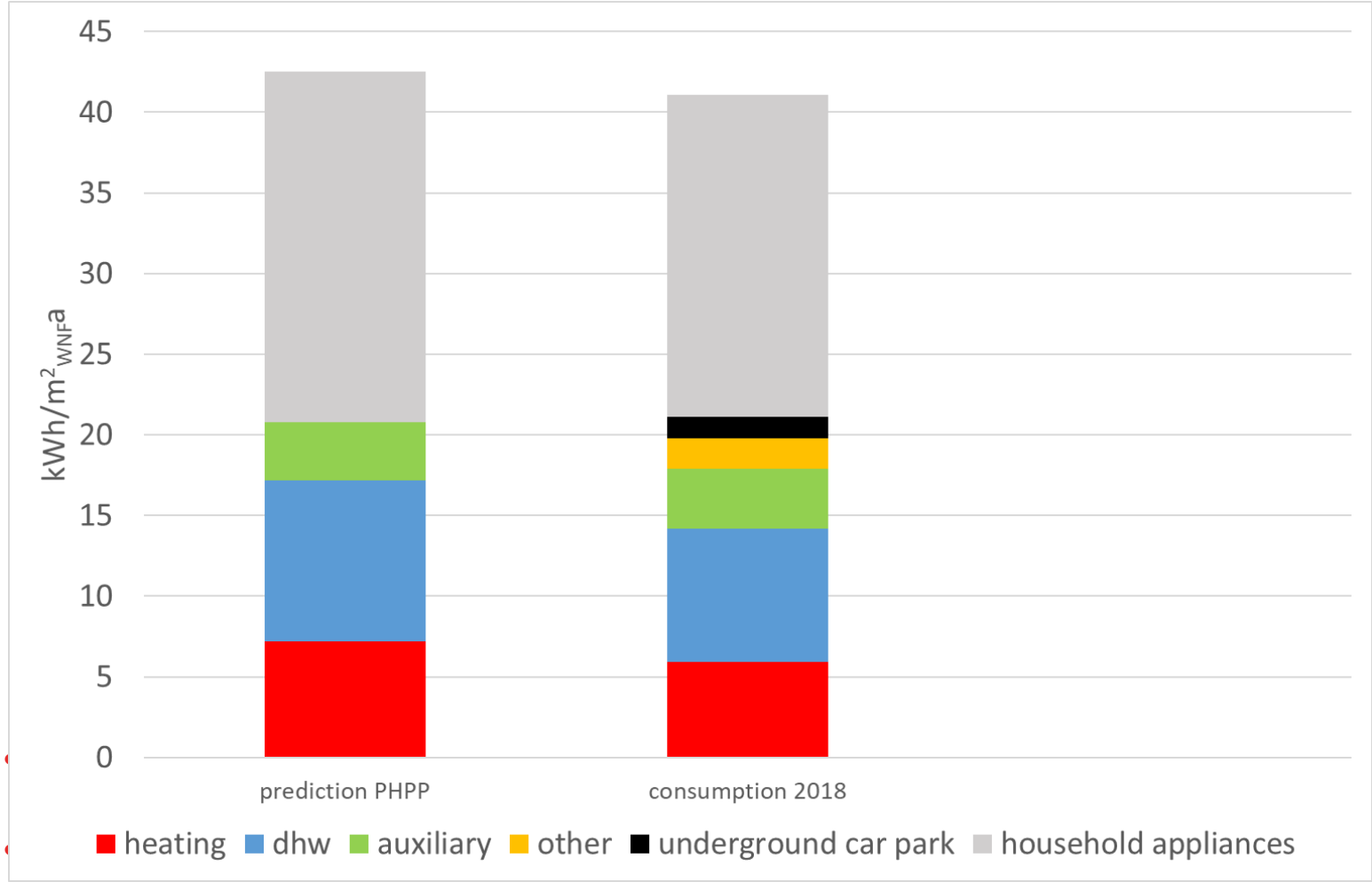
measured consumtion vs. calculated demand



- final energy consumtion$_{heating+dhw}$

  14,2 kWh/m$^2_{net\ dwelling\ area}$a
- monthly costs for heating and dhw of 76m^2-dwelling:

  10,60 EUR/dwelling
- low consumption for auxiliary as well as for household appliances
- low consumtion for lighting of underground car park and others (elevator…)
- PHPP-prediction close to consumption

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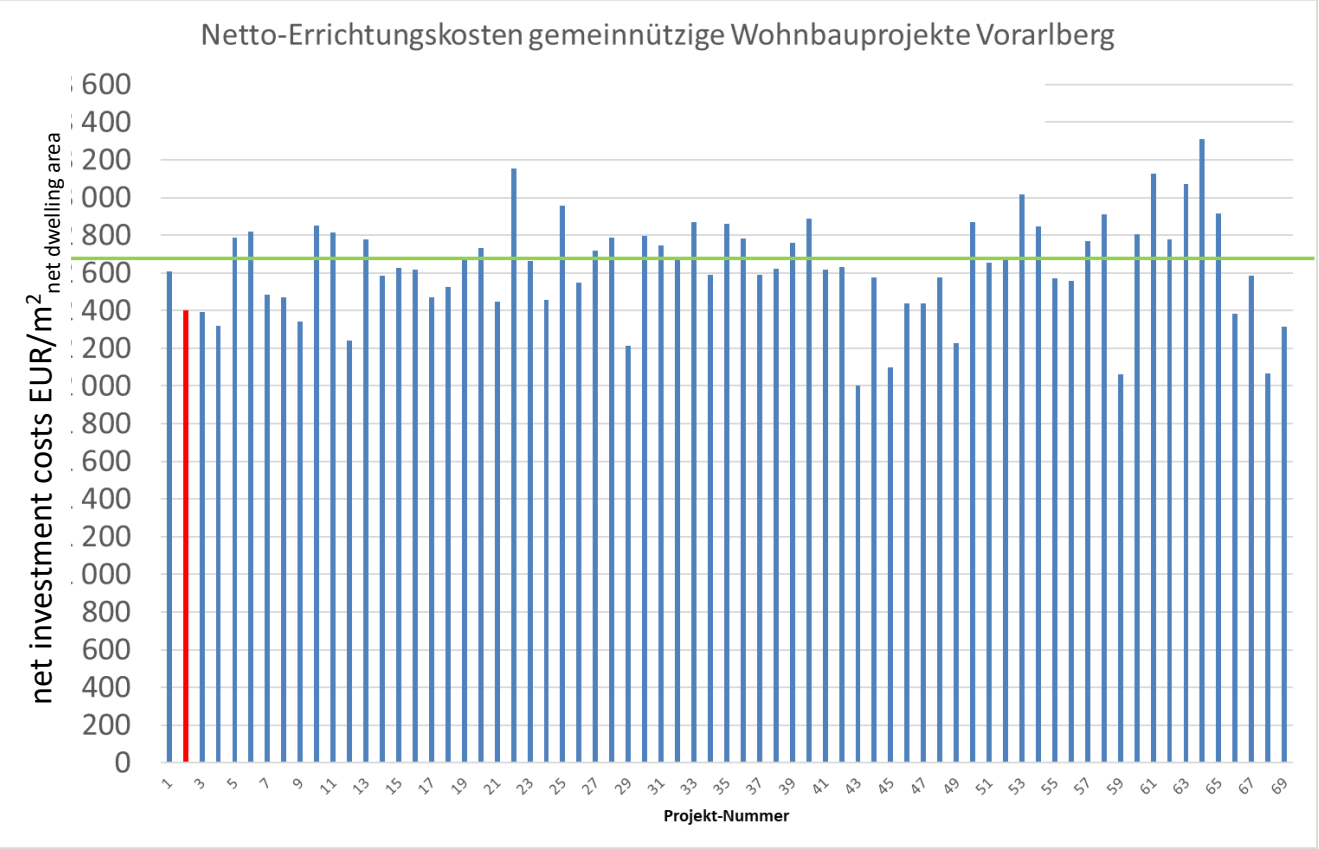
net investment costs - comparison to all other social housing projects in the region



- total net investment costs KliNaWo without ground (ÖNORM 1801-KG 1-9): 2.400 EUR/$m^2_{\text{net dwelling area}}$
- KliNaWo-Projekt has net investment costs 230 EUR/$m^2_{\text{net dwelling area}}$ lower than average of all social housing projects in the region

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2. lessons learned

transfer of findings to subsequent projects

- in a subsequent project with AEE intec, life cycle costs of 7 Austrian buildings were analysed
- methodes and tools developed in „KliNaWo“ projects have been futher-developed
- for each building, 3.500 to 75.000 variants were compared
- energetic quality of building envelope was diferenciated as well as heat distribution, ventilation- and solar systems
- results show, that findings from „KliNaWo“-project can be transfered to other projects
- energy demand calculations presented are calculated using PHPP

project funded by Austrian federal ministery bmvit within project line „Stadt der Zukunft“ ; funding managed by FFG, Vienna

STADT der Zukunft

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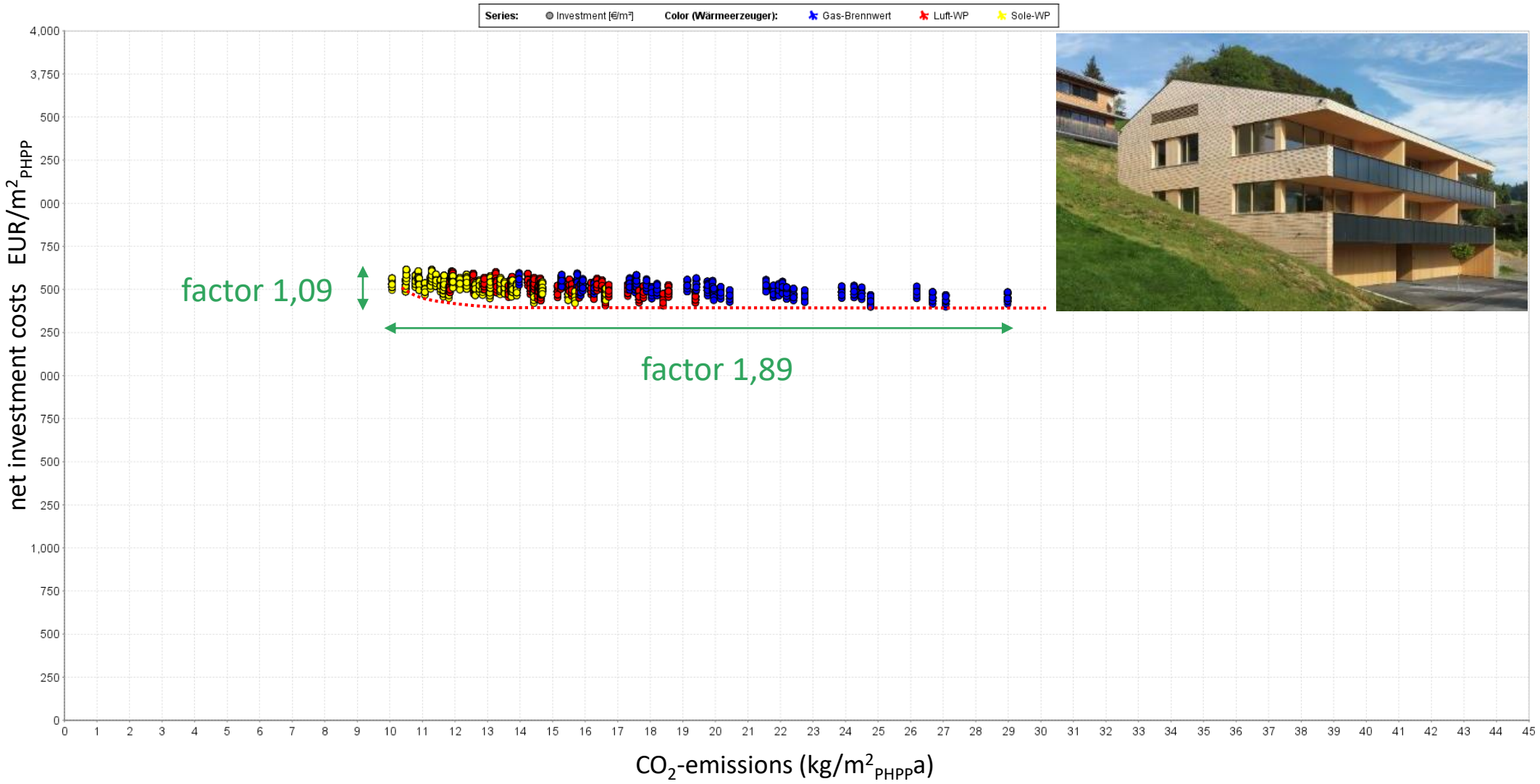
2. lessons learned

transfer of findings to subsequent projects – net investment costs and CO_2-emissions Langenegg



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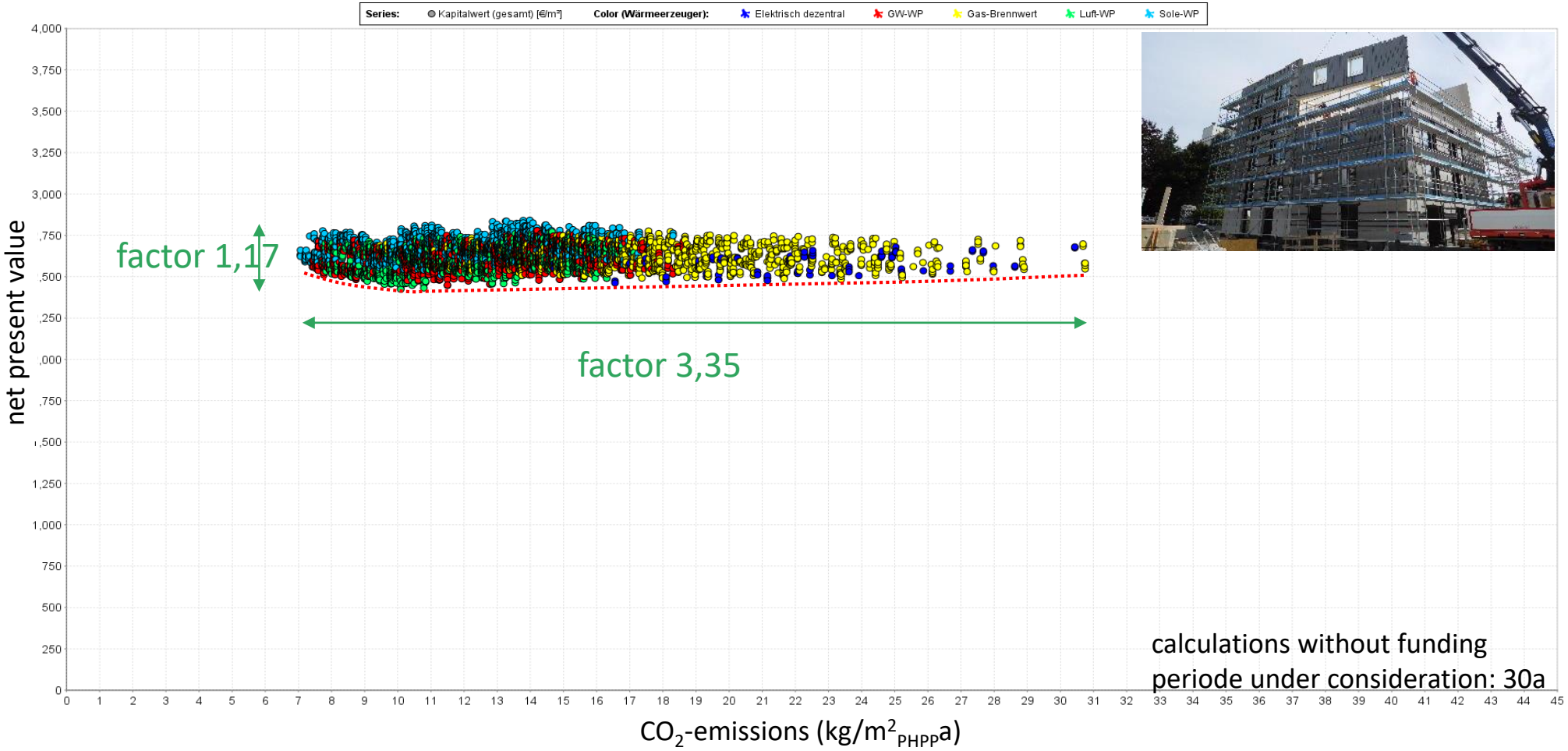
2. lessons learned

transfer of findings to subsequent projects – life cycle costs and CO_2-emissions Wolfurt



calculations without funding
periode under consideration: 30a

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2. lessons learned

main findings KliNaWo and subsequent projects

- energetic quality of buildings causes very little extra investment costs
- lowest life cycle costs achieved in buildings that need 2/3 less energy compared to Austrian min. requirements
- savings of 2/3 in primary energy and CO_2-emissions cause extra investment costs of about 3-5%
- passive house envelope causes least life cycle costs
- method of energetic-economic optimisation developed in project is suitable for every buidling
- final energy consumptions$_{heating+dhw}$ of 9,9 (Langenegg) to 14,2 kWh/m$^2_{dwelling\ area}$ measured in 4 heat pump projects

3. further information

on „KliNaWo“-project

https://www.energieinstitut.at/pdfviewer/economicum_themenband-5

https://www.energieinstitut.at/alle-ziele-uebertroffen-klinawo-bleibt-erfolgsmodell/

on project Wolfurt

https://www.energieinstitut.at/pdfviewer/economicum_themenband-6/

Measuring report:

- Short version: https://www.energieinstitut.at/wp-content/uploads/2019/08/20190729_KliNaWo_Monitoringbericht_kurz_EIV-Layout.pdf
- Long version: https://www.energieinstitut.at/wp-content/uploads/2019/08/20190729_KliNaWo_Monitoringbericht.pdf