Energy and cost optimization in the life cycle of nearly zero energy buildings using parametric calculations

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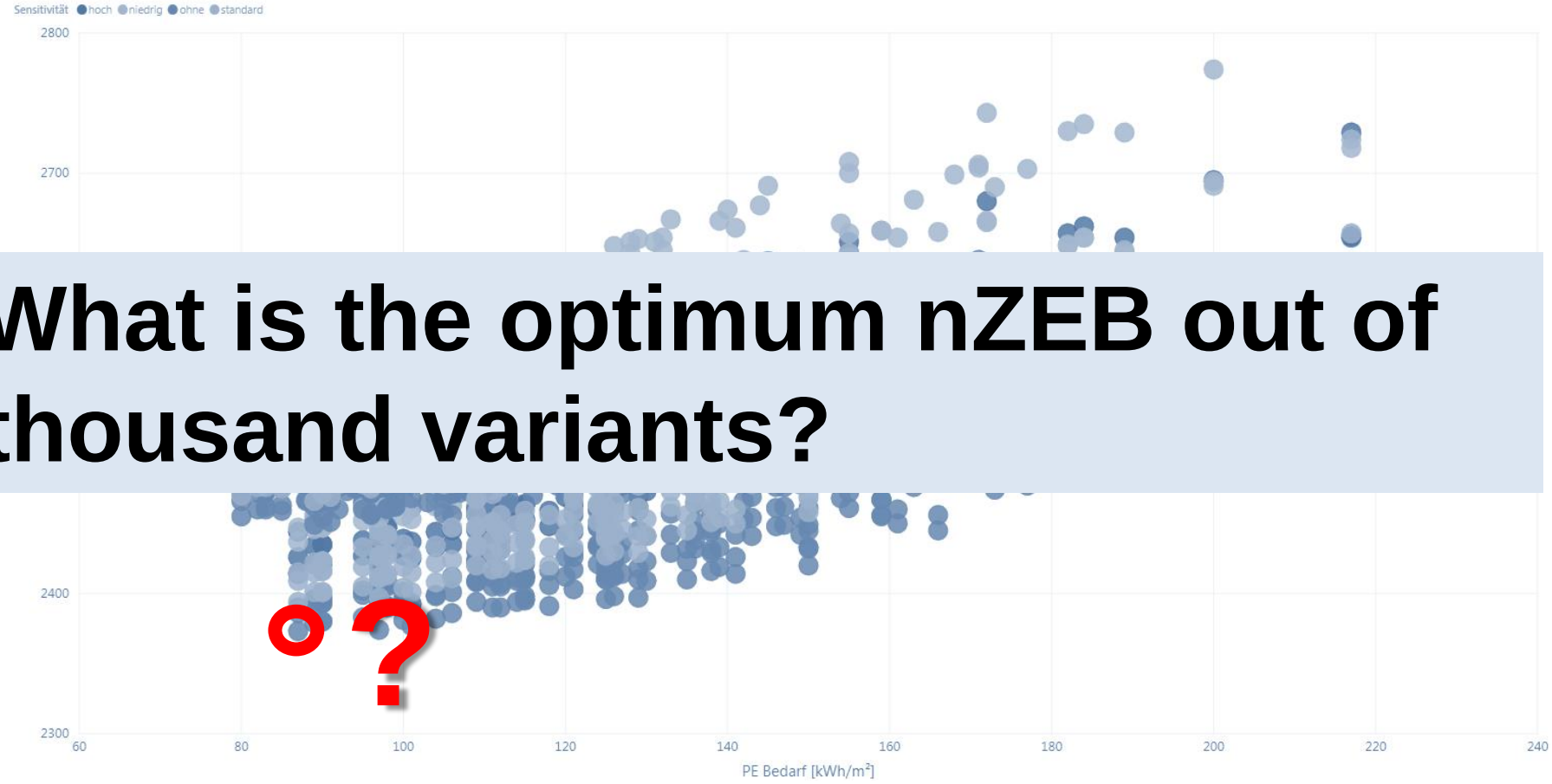


What is the optimum nZEB out of thousand variants?

°?

NZEBs – What do I optimize?
Different actors and their perspectives

Stakeholders	Time expectancy
Tenant / user	3 – 30 years
Real estate agents	1 – 2 years
Builder/ Construction company	1 – 5 years (Guarantee)
Planner	1 years
Property management	1 – 50 years (Contract duration)
Investor	1 – 5 years
Building owner / landlord	20 - 50 years
Building owner (public)	50 – 100 years
Society	> 100 years

NZEBs – What do I optimize?
Different actors and their perspectives

☐ Indirect relationship

☑ Direct relationship

Stakeholders	Benefits					Co-benefits						
	Marketability	Lettability	Value development	Rental income	Comfort	Durability	Arch. quality	Image	Energy Savings	User satisfaction	Climate protection	Energy autonomy
Tenant / user		☐			☑	☐	☑	☑	☑	☑	☐	☐
Real estate agents	☑	☑	☑	☑	☐		☐	☑	☐	☐		
Builder/ Construction company						☑	☐			☐		
Planner		☐	☐		☑	☑	☑	☑	☑	☑		
Property management		☑	☑			☑			☑	☑		
Investor	☑	☑	☑	☑			☐	☐				
Building owner / landlord	☑	☑	☑	☑	☑	☑	☐	☑	☑	☑		☐
Building owner (public)	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Society	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

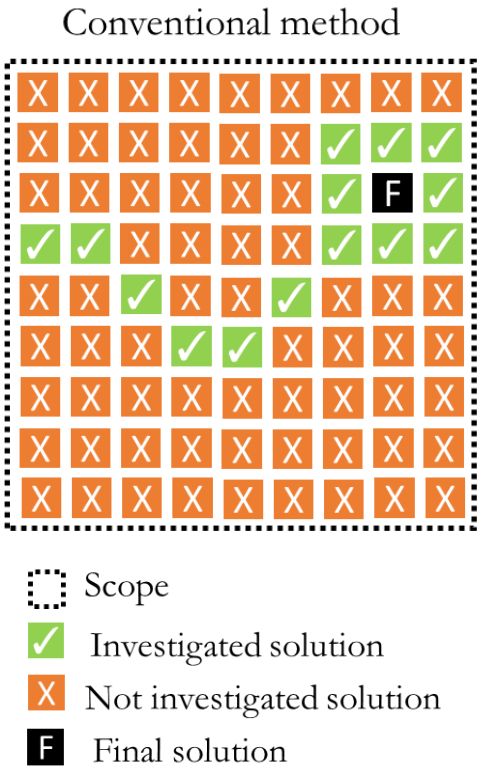
NZEBs – What do I optimize?
Different actors and their perspectives

	Optimization Criteria	
	COSTS	ENERGY
Stakeholders		
Tenant / user	Rental costs, operating costs	final energy demand
Real estate agents	market price	Energy performance certificate
Builder/ Construction company	building costs	
Planner	Planning costs, building costs	Energy performance certificate
Property management	Maintenance costs, renovation costs	final energy demand
Investor	investment cost	
Building owner / landlord	financing costs	final energy demand
Building owner (public)	net present value	Primary energy, final energy, CO2
Society	Life cycle costs, climate protection	Primary energy, CO2

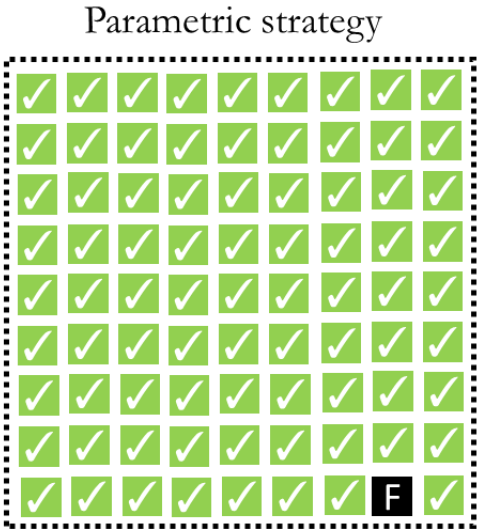
Optimization Strategies
How do I optimize?

- Conventional optimization: “Search“ of possible solutions based on empirical values

- Optimization using “extreme value search algorithms”



Optimization Strategies
How do I optimize?



- “Brute-force method” with a study of all possible solutions (parametric strategy)

Scope
Investigated solution
Not investigated solution
Final solution

Investigation of many variants

- advancement of the calculation method, which was developed in the project “KliNaWo”
- parametric calculations based on:
  - energy calculation with the “passive house planning package - PHPP”
  - life cycle cost calculation with the LCC tool “econ calc”
  - automated calculation using VBA macros in MS Excel

Investigated measures

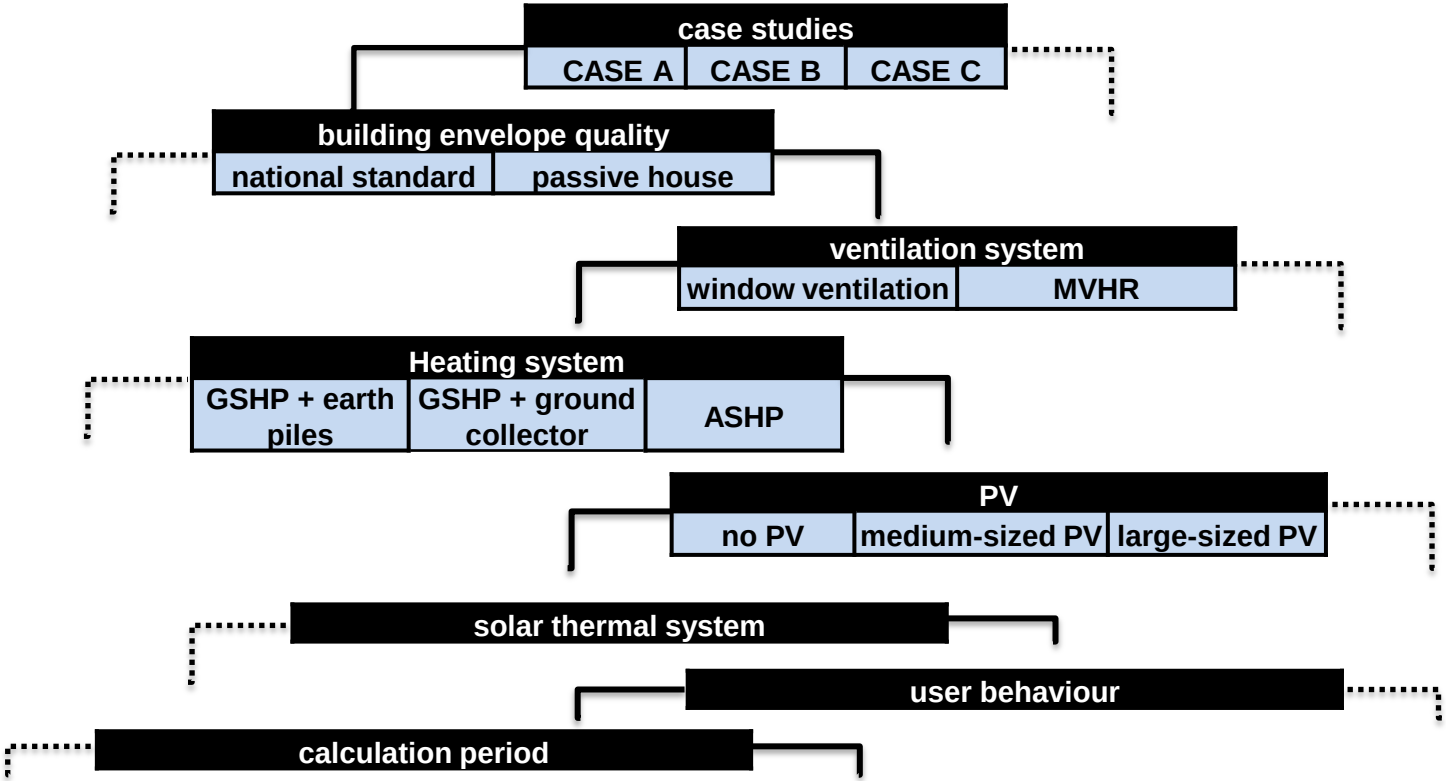
in all case studies

- envelope quality
- ventilation
- heating
- solar thermal
- PV
- interest rate
- energy price
- calculation period

in some case studies

- user behaviour
- heat distribution
- heat emission
- construction
- household electricity
- PV credit
- electric battery
- electricity tariff model
- funding model
- CO_2 follow-up

Optimization Strategies
How do I optimize?



investigated case studies

7 nearly zero energy buildings

renovated school

new constructed office building

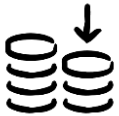
renovated multi-family building

new constructed multi-family buildings

key performance indicators

net present value

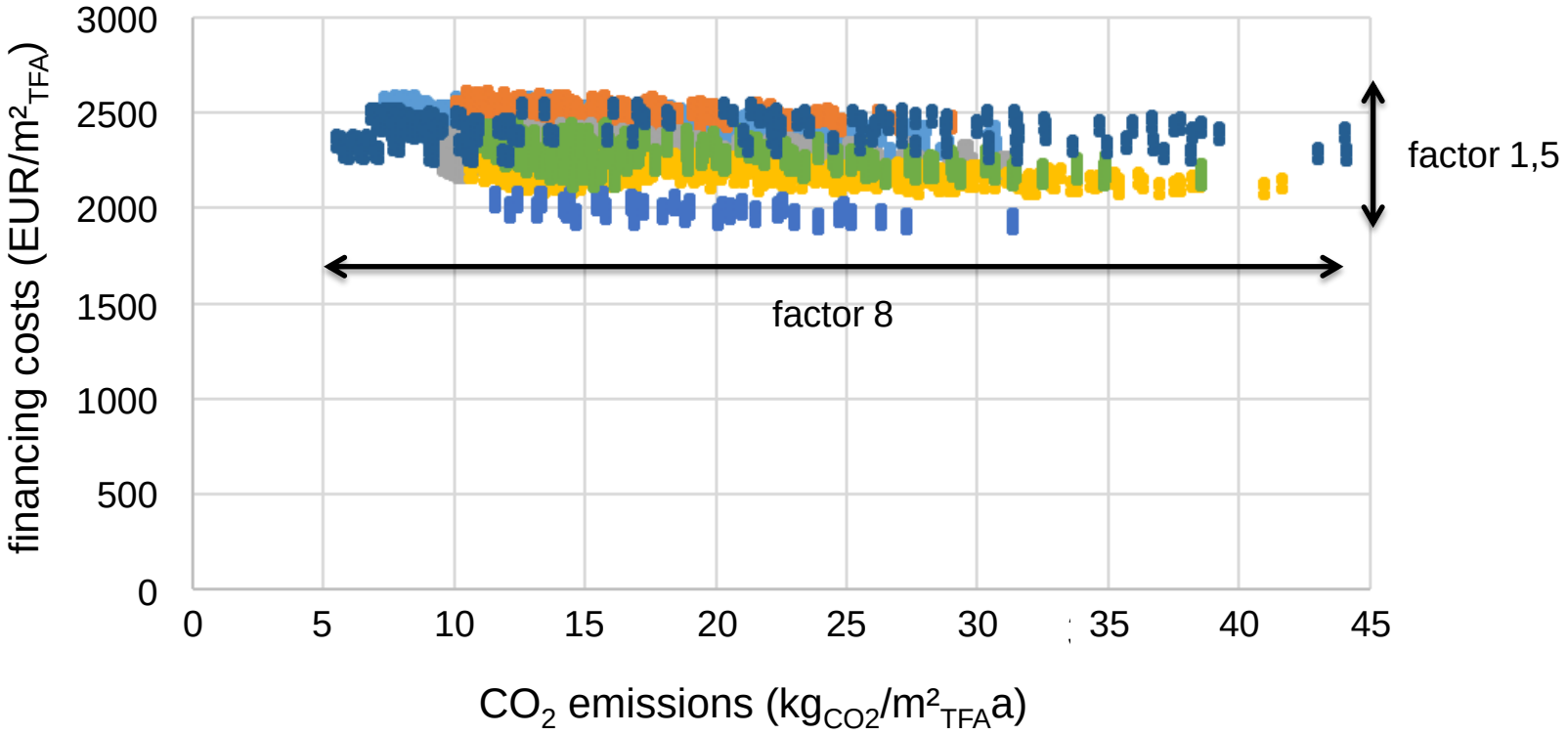
balanced
CO_2 emissions



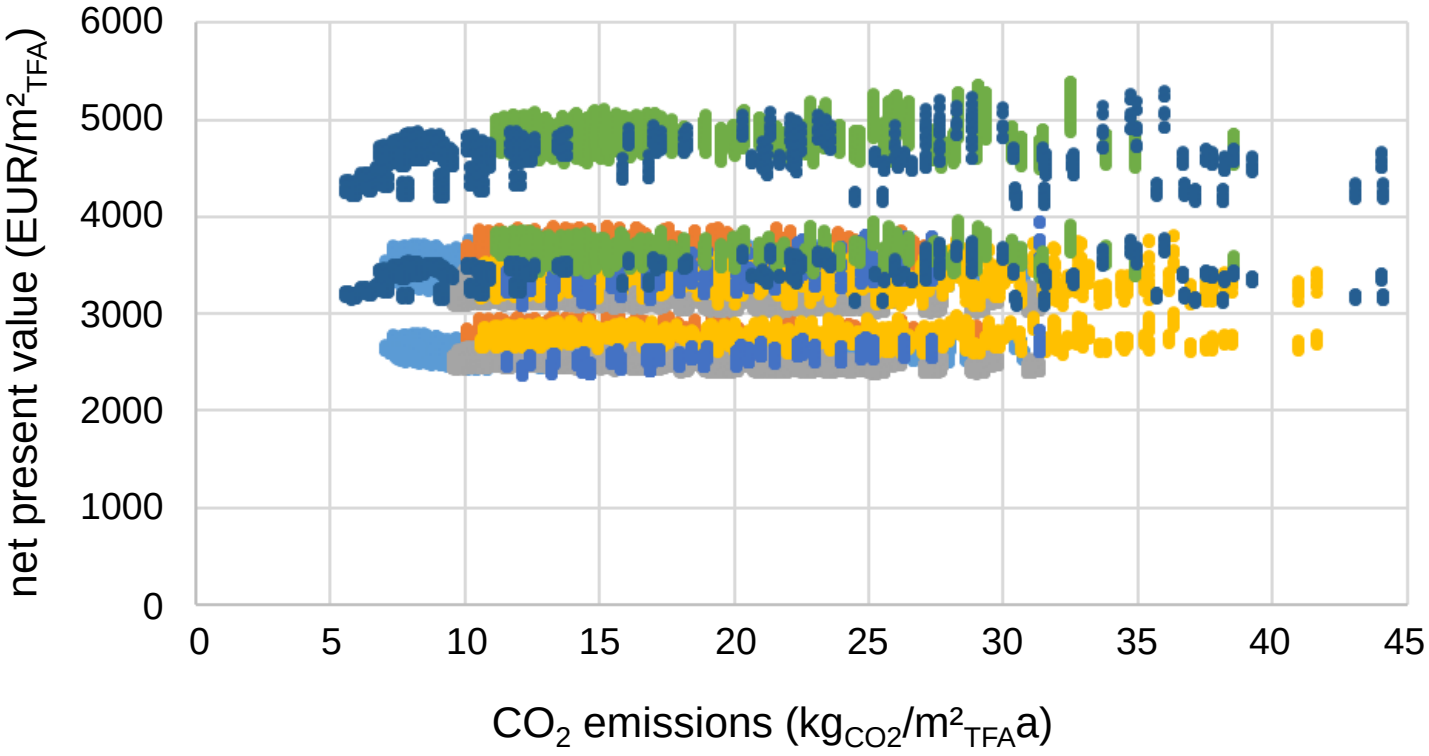
financing costs

balanced
primary energy
demand

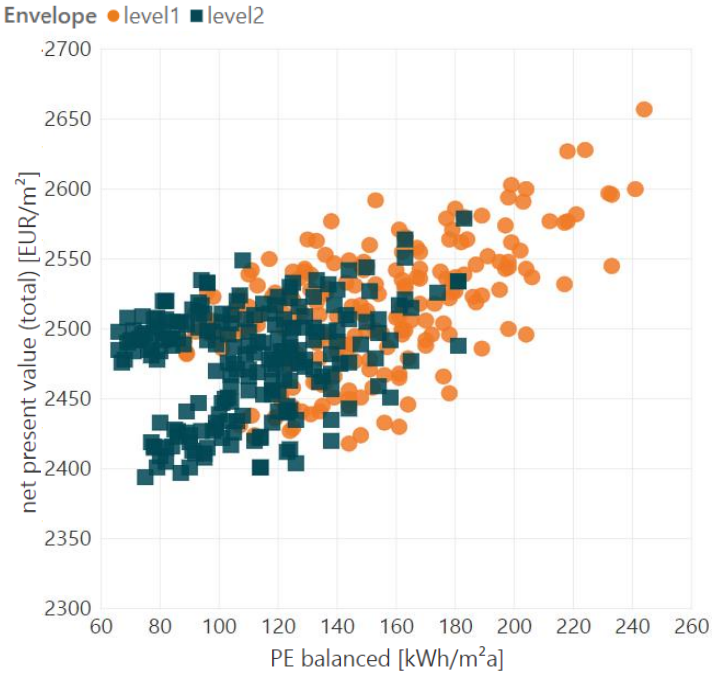
overall results (I)

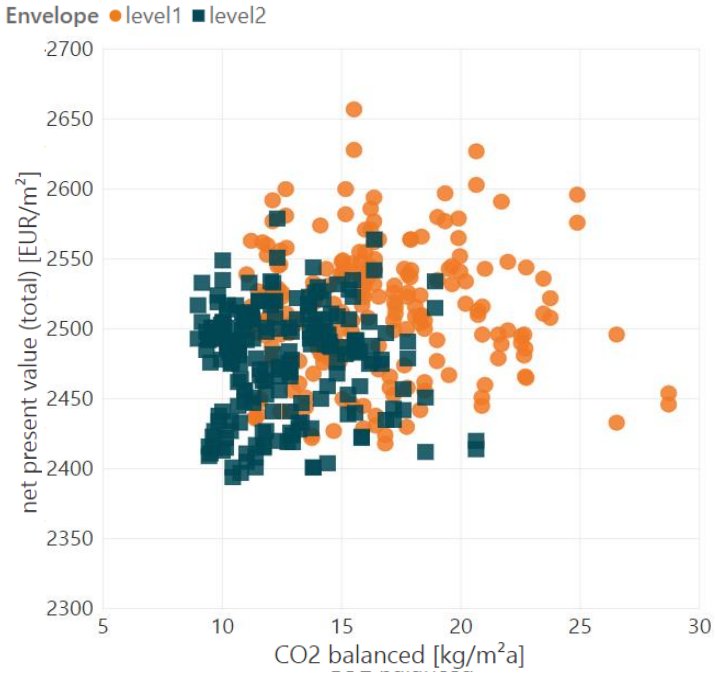


overall results (II)



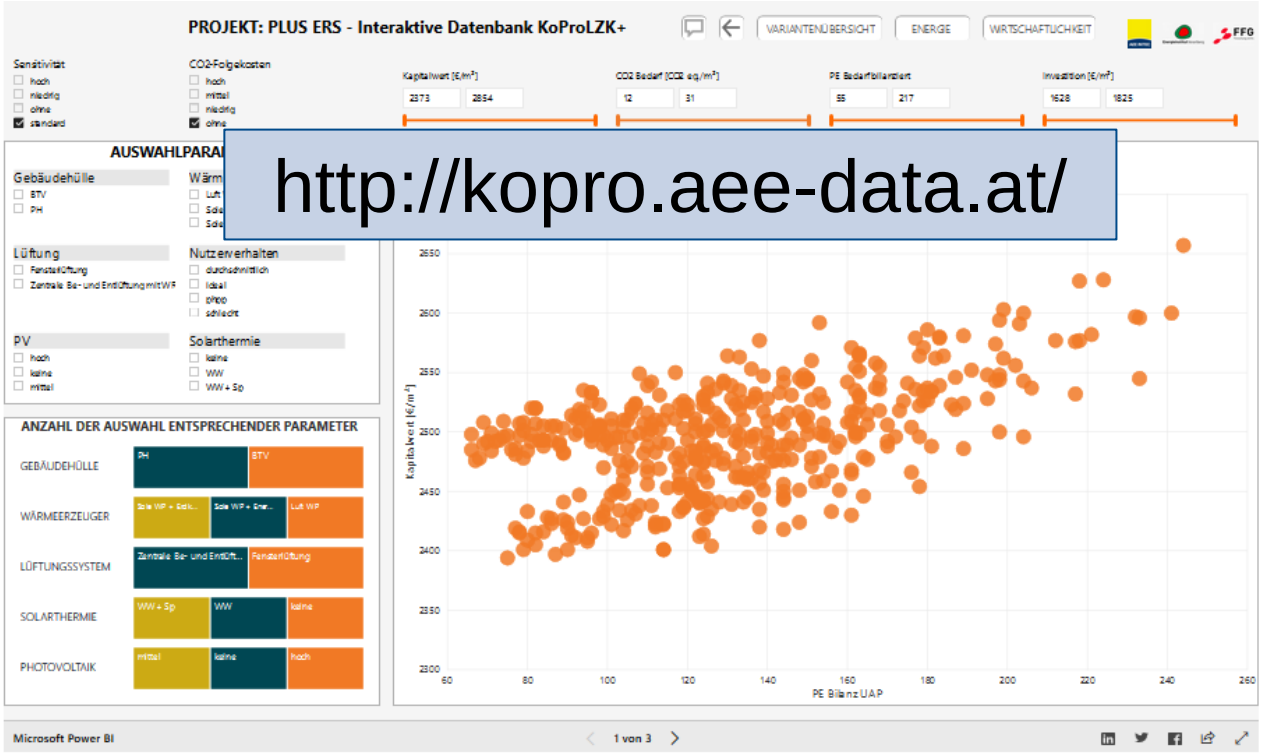
results in detail (I)





results in detail (II)

Interactive web analysis



http://kopro.aee-data.at/

lessons learned (I)

- Processes are often not linear and variables influence each other.
- The optimisation goal of each variable can change significantly based on the optimisation goal and the importance of the key performance indicators.
- Energy efficiency measures have only a small percentage influence on construction costs but can save many times more CO_2 emissions. Energy efficiency is therefore not a significant cost driver.
- Over the whole life cycle of the building, these efficiency measures are then usually cost-neutral or even economical.

lessons learned (II)

- Considering the life cycle costs, the primary energy demand and the CO_2 emissions the optimum is in the range of passive houses.
- Passive house envelopes and highly efficient windows are in most cases economical even without subsidies.
- The optimum for life-cycle costs and CO_2 emissions is very flat. Low emissions and energy consumptions can be achieved with different energy concepts as long as the building envelope is very efficient. This allows creative and conceptual freedom.

For more information visit…

- kopro.aee-data.at
- https://nachhaltigwirtschaften.at/de/sdz/projekte/kopro-lzk-plus.php
- www.aee-intec.at
- www.energieinstitut.at
- http://www.cravezero.eu/

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Please note:

All photos and graphics in this presentation were taken from the final report of the research project "KoPro Lzk+ - Cost and process optimization in the life cycle of nearly zero energy buildings":

Weiß, T.; Moser, C.; Venus, D.; Höfler, R.; Knotzer, A.; Fulterer, A.M.; Hatt, T.; Ploß, M.; Roßkopf, T. (2019): Kosten-. und Prozessoptimierung im Lebenszyklus von Niedrigst- und Plusenergiegebäuden; final report under the programme line of City of Tomorrow; BMVIT; Vienna

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IDEA TO ACTION

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