universität innsbruck

Phase Out

Techno-ökonomischer Vergleich verschiedener Wärmepumpensysteme im Mehrfamilienhaus

2026-05-06

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Samuel Breuss, Mara Magni, Elisa Venturi,
William Monteleone, Alice Tosatto, Georgios Dermentzis

EU-Life KnowHowHP
FFG PhaseOut

KNOW HOW HP

Co-funded by the European Union

INHALT

- Fallstudie
- WP-Systemvergleich - Performance (Simulationsstudie)
- Techno-ökonomische Bewertung
- Thermische Sanierung und Wärmepumpenkapazität (Platz, Schall)
- Makro-öknomische (Vorkswirtschaftliche Betrachtung)

FALLSTUDIE

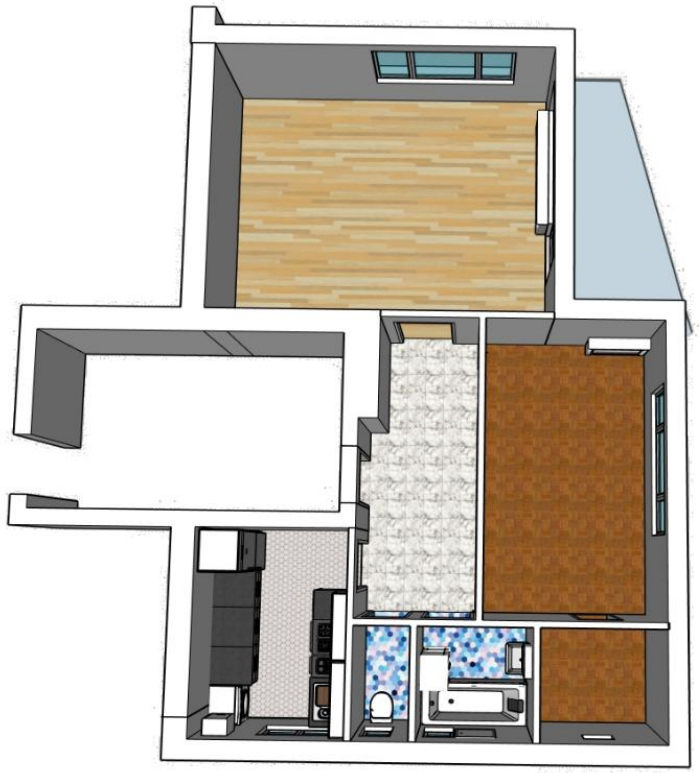
Fläche: 364.5 m^2
Wohnungen: 6
Etagen: 3
Innentemperatur: 20°C (22°C)
Bestand:

- Gasetagenheizung, Wohnungsweise
- Heizkörper

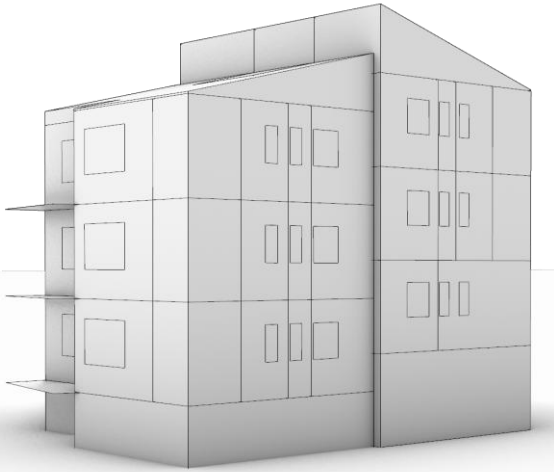




FALLSTUDIE







FFG PROJEKT PHASEOUT

Thermische Sanierung und Wärmepumpenbasierte Wärmeversorgung

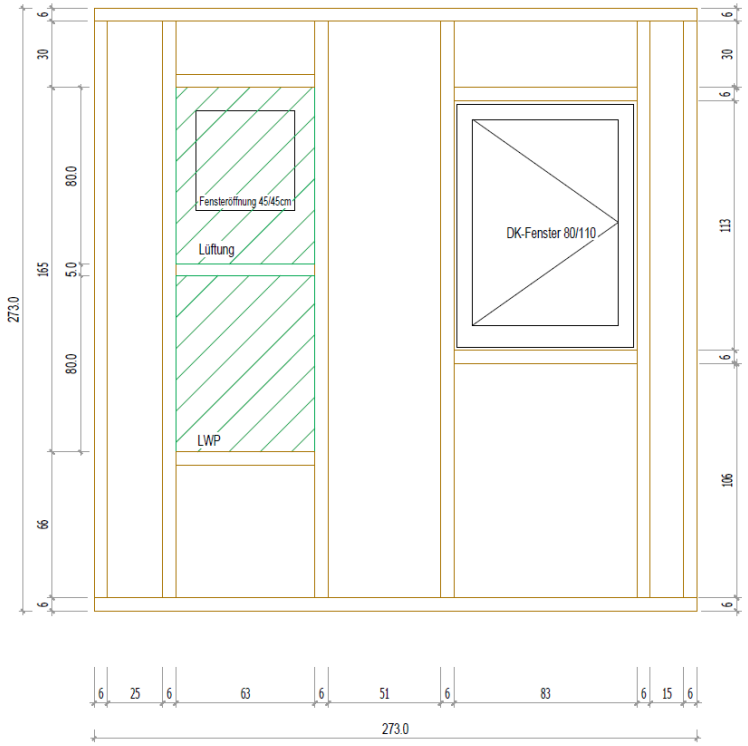
- Hocheffiziente thermische Sanierung (Vorfertigung)
- Effiziente Wärmepumpen-
- Systeme
- PV-Dach und -Fassade

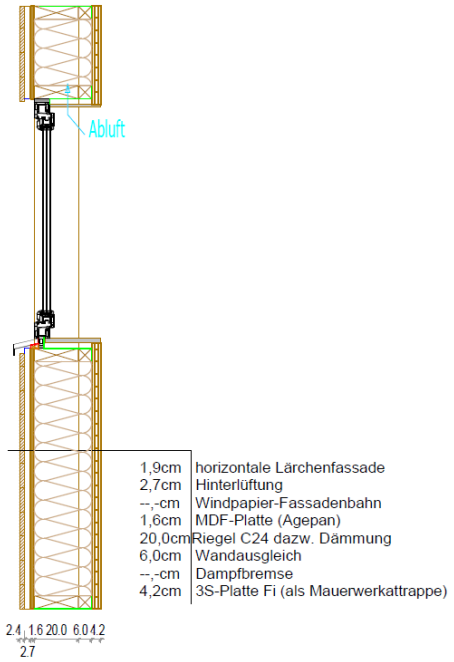


W. Nussmüller

FFG PROJEKT PHASEOUT

Thermische Sanierung und Wärmepumpenbasierte Wärmeversorgung





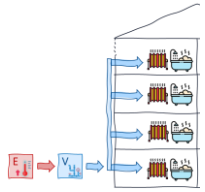
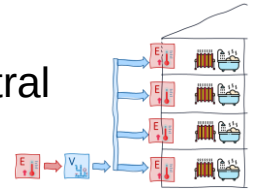
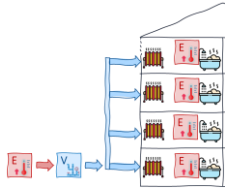
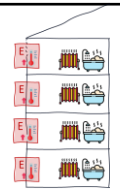


PASSYS Testzelle (UIBK)
Mock-up (Kulmer, DuW)

FRAGESTELLEUNG

- Welches Wärmepumpensystem?
- Heizungstausch notwendig/sinnvoll?
- Thermische Sanierung notwendig/sinnvoll?
- Optimale Lösung (CO_2, EUR)?

Wärmepumpenkonzepte für MFH

Kategorie	WP – System	Puffer-Speicher	WÜ	Betriebs-weise	T_{VL} (RH) / [°C]	T_{VL} (TWW) / [°C]
Zentral 	4P-C (circulation)	c	c(ext, int)	m/(b)	45	65
	2+2P FWS	c	d	m/(b)	45	55
	3 P FWS	c	d	m/(b)	45	55
	2 P HTS	c	d	m/(b)	55	55
	2 P “charging window“	c + d	-	m/(b)	45	60
Semi-zentral 	2 P RF-HP	c + d	-	m/(b)	45	-
	2 P Booster HP	c + d	-	m/(b)	25	-
Gemischt 	2 P E-Boiler/(FTPH)	(c +) d/-	-	b	45	-
	2 P HTS + FTPH	c	d	b	55	55
	2 P d-DHW-HP	(c +) d	-	m/(b)	45	-
	2 P-C E-Heating	c	c(ext, int)	b	-	65
	2 P FWS E-Heating	c	d	b	-	55
Dezentral 	d-HP (SH + DHW)	d	-	m/(b)	-	-
	d-HP (SH) + E-Boiler/(FTPH)	d/-	-	b	-	-
	E-Heating + d DHW-HP	d	-	b	-	-
	E-Heating + E-Boiler/(FTPH)	d	-	-	-	-

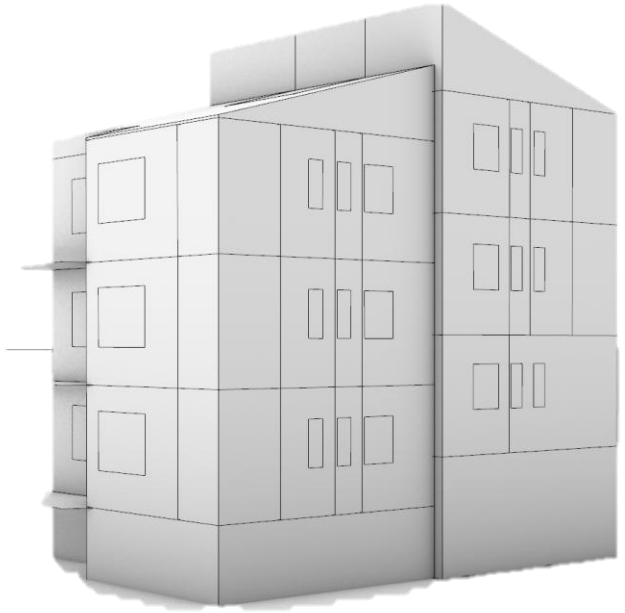
m monovalent / (b) (bivalent)

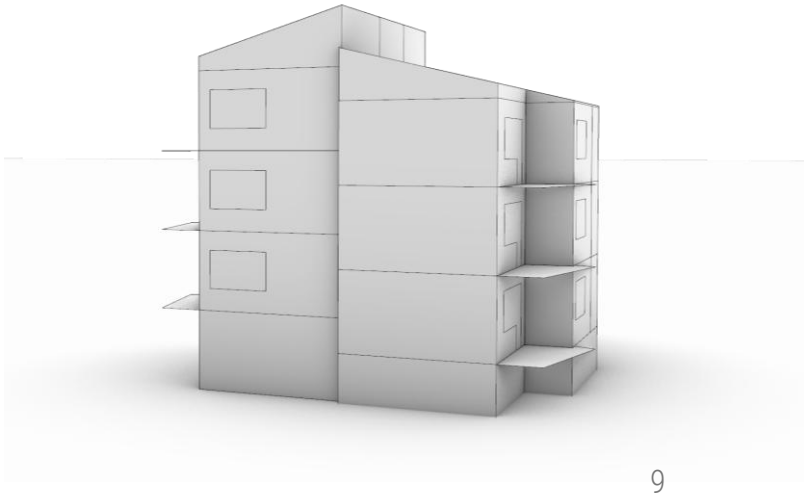
HX: Heat Exchanger, SH space heating, DHW Domestic Hot Water, TF Flow Temperature, FWS: Fresh water station, HTS: Heat Transfer Station, RF: Return Flow, FTPH: Flow Type Post Heater

Co-funded by the European Union

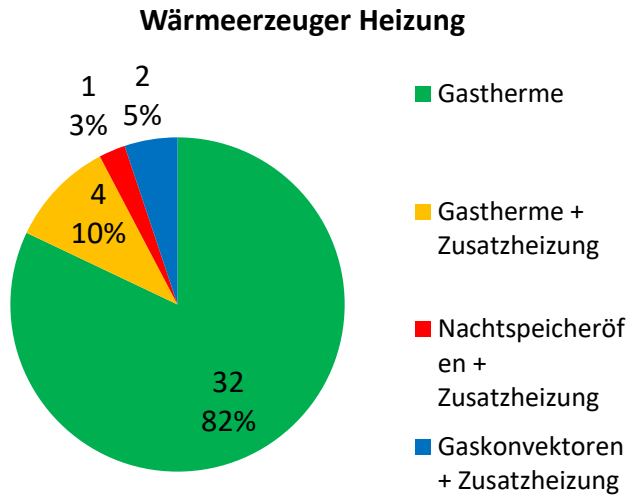
AUSGANGSSITUATION

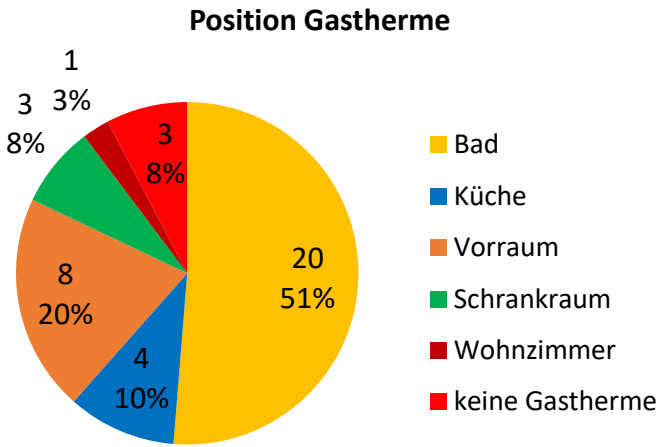
	1963	1990	
Fläche (BGF) – EA	455	455	m_{GFA}^2
Fläche (EBF) – PHPP	365	365	m_{TFA}^2
HWB	247	134	kWh/(m_{EBF}^2a)
TWW	13.7	13.7	kWh/(m_{EBF}^2a)
HL (Tagesmittel)	87	51	W/m_{EBF}^2
Personen	9.9	9.9	-

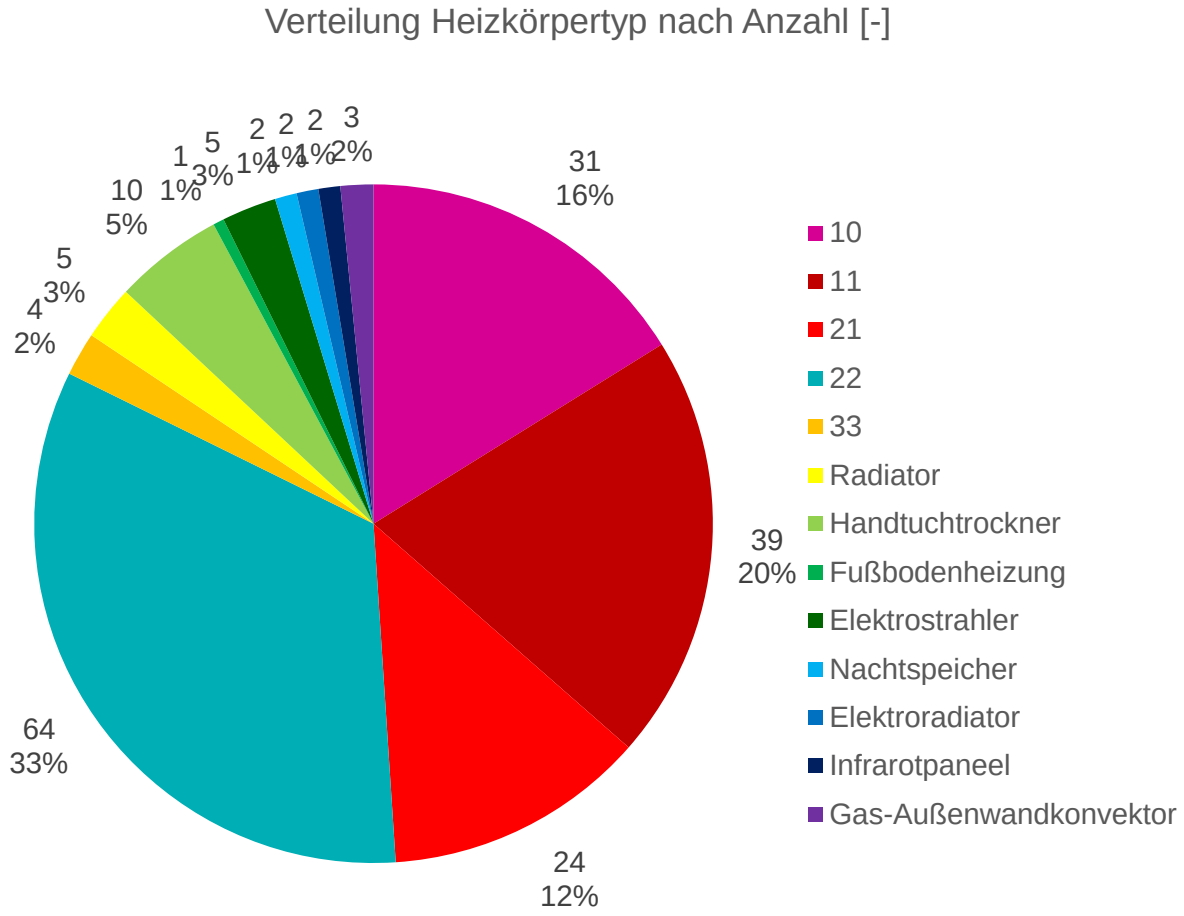




Bestandsaufnahme - Wärmeerzeuger und Heizkörper

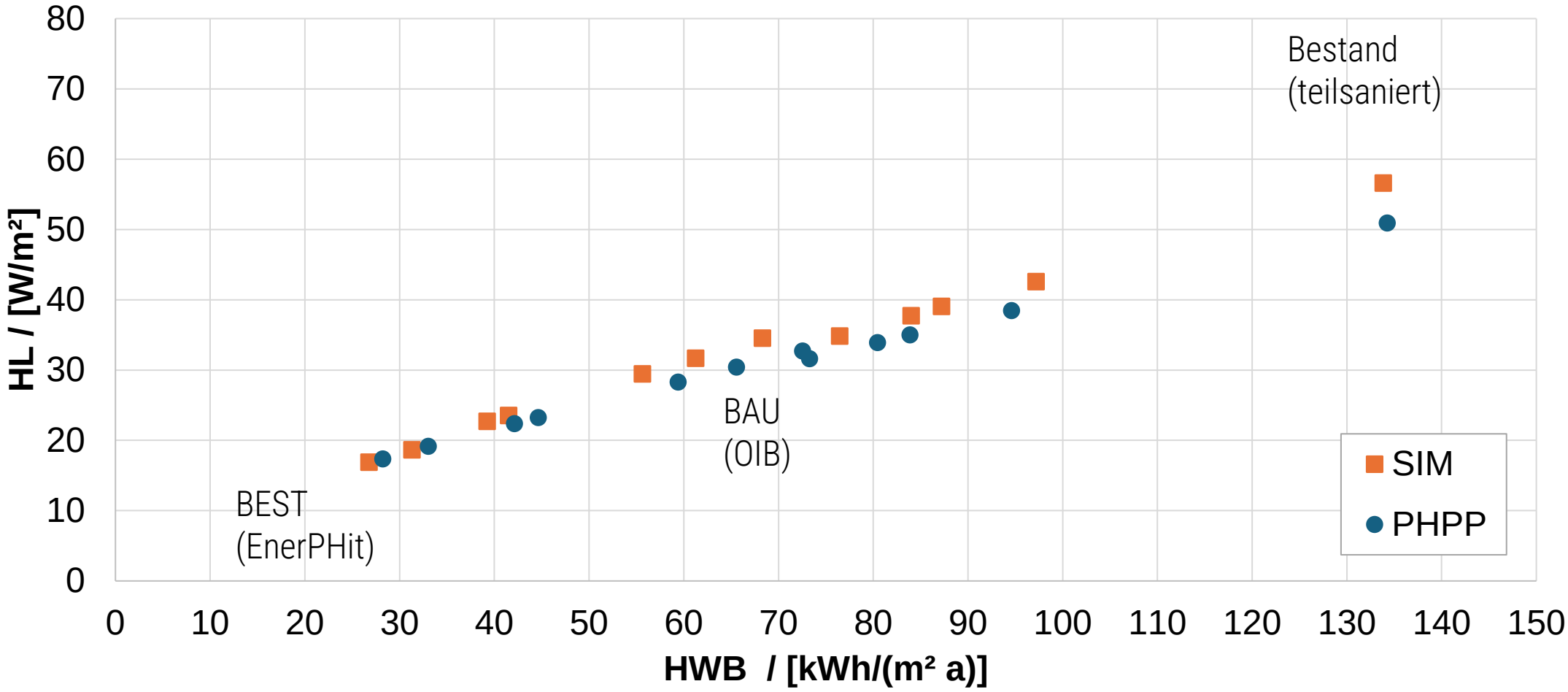




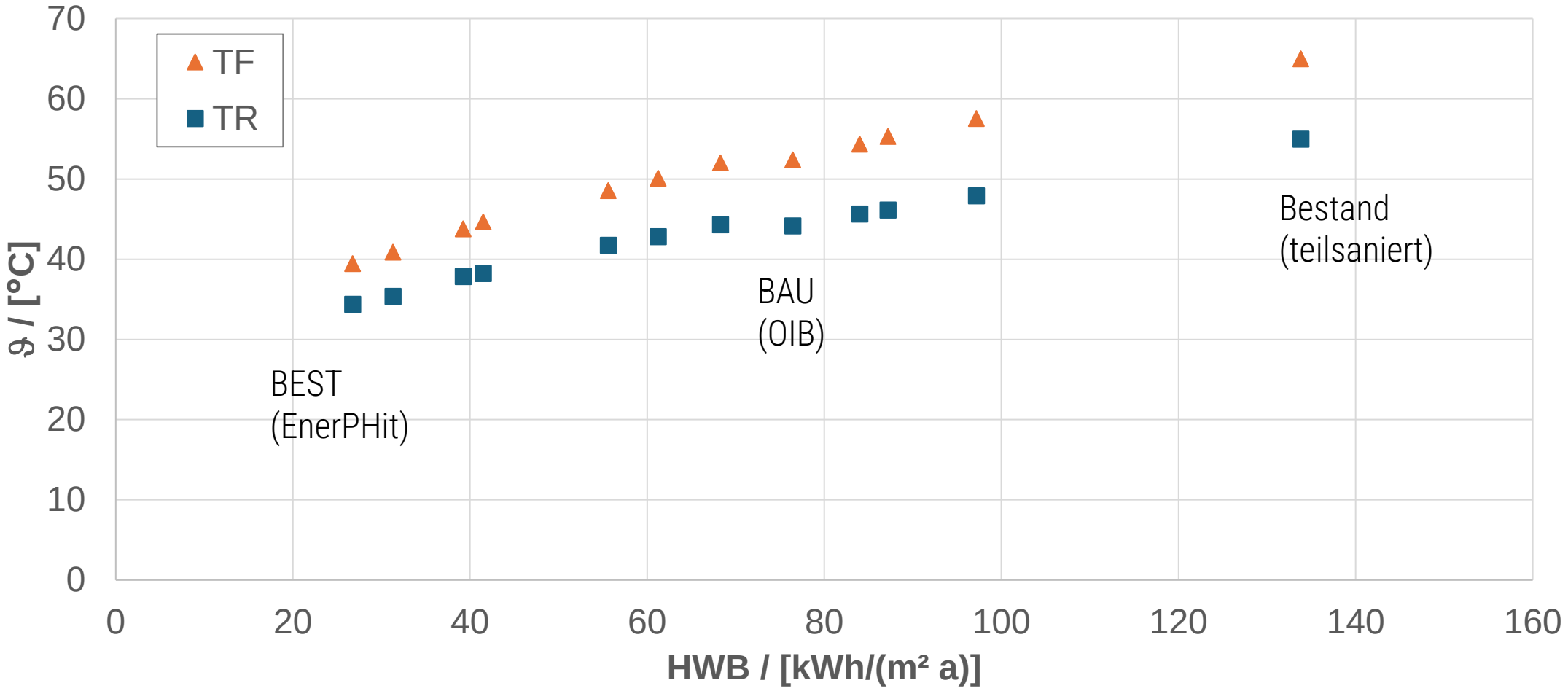


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HEIZWÄRMEBEDARF UND HEIZLAST

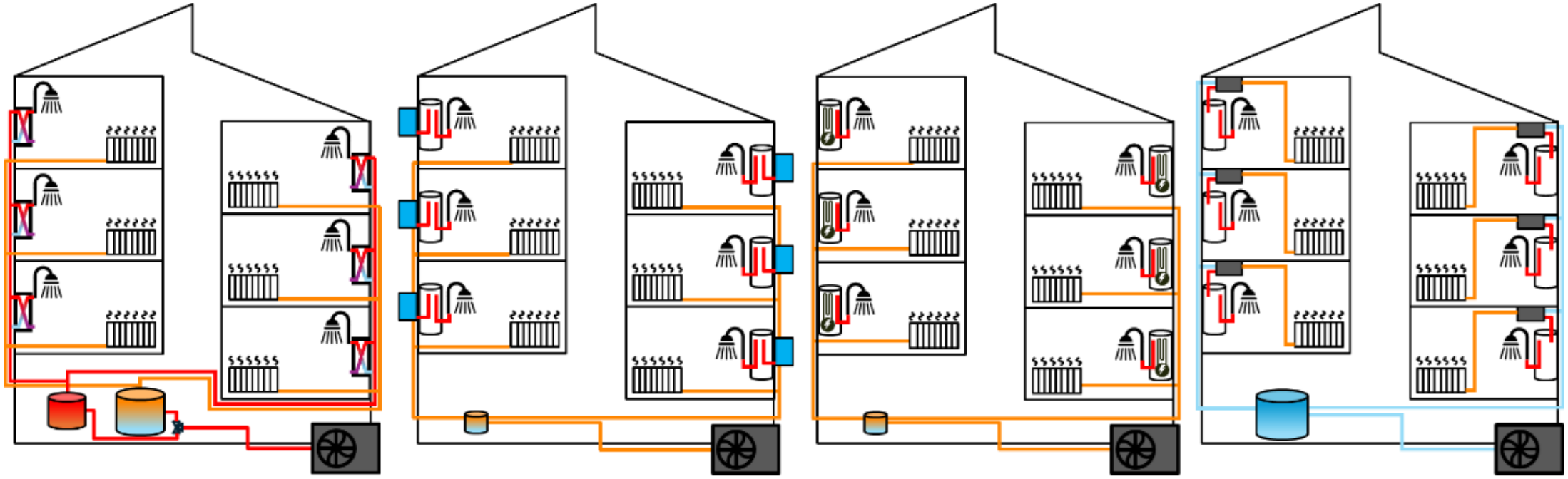


HWB/HL UND VORLAUFTEMPERATUR



WÄRMEPUMPENSYSTEMVERGLEICH

MULTI-APARTMENT BUILDINGS - HP SYSTEMS



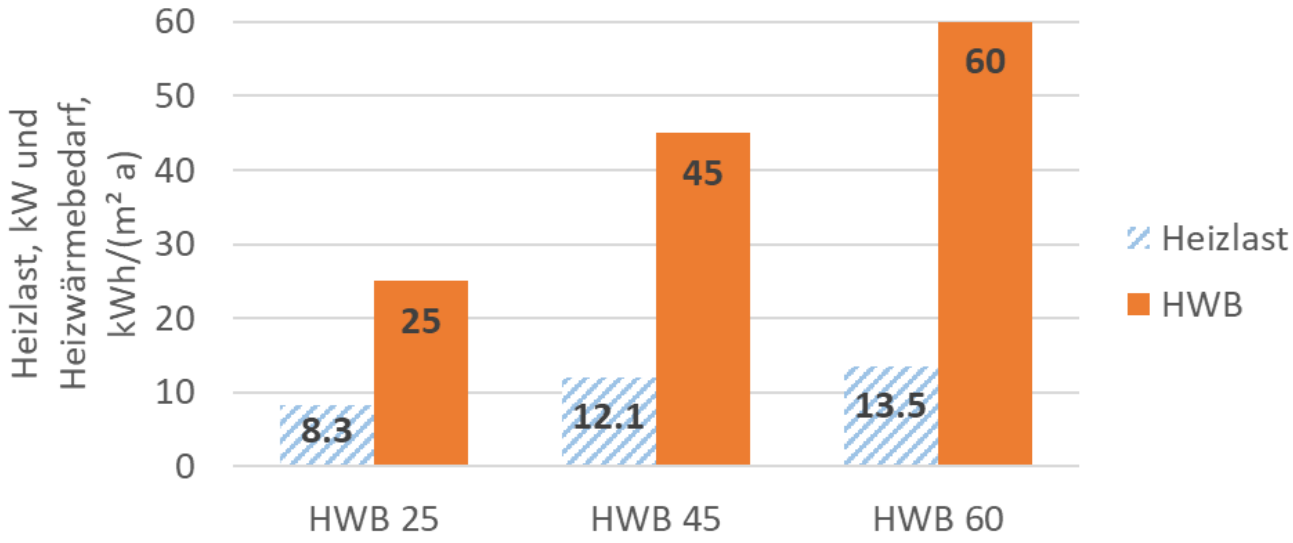
Zentral | Zentral RH, Dezentrale TWW-WP | Zentrale RH, Dezentrale E-Boiler | Semi-Zentral (Booster WP)

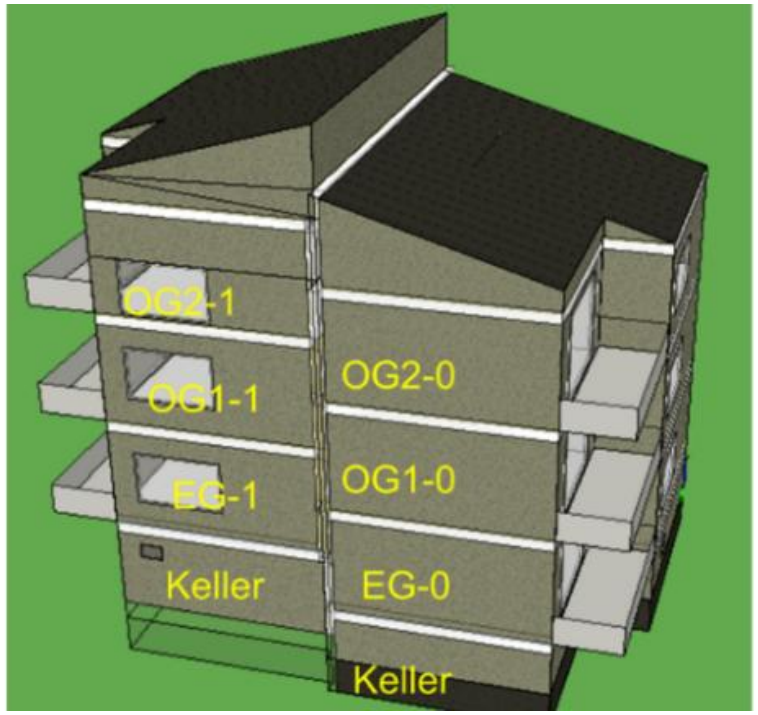
Quelle: iDM

HWB und Heizlast

3 Mustergebäude (ca. 360 m² BGF)

- Geometrie und Wandaufbauten der Demonstrationsgebäude
- aber mit drei verschiedenen Sanierungstiefen



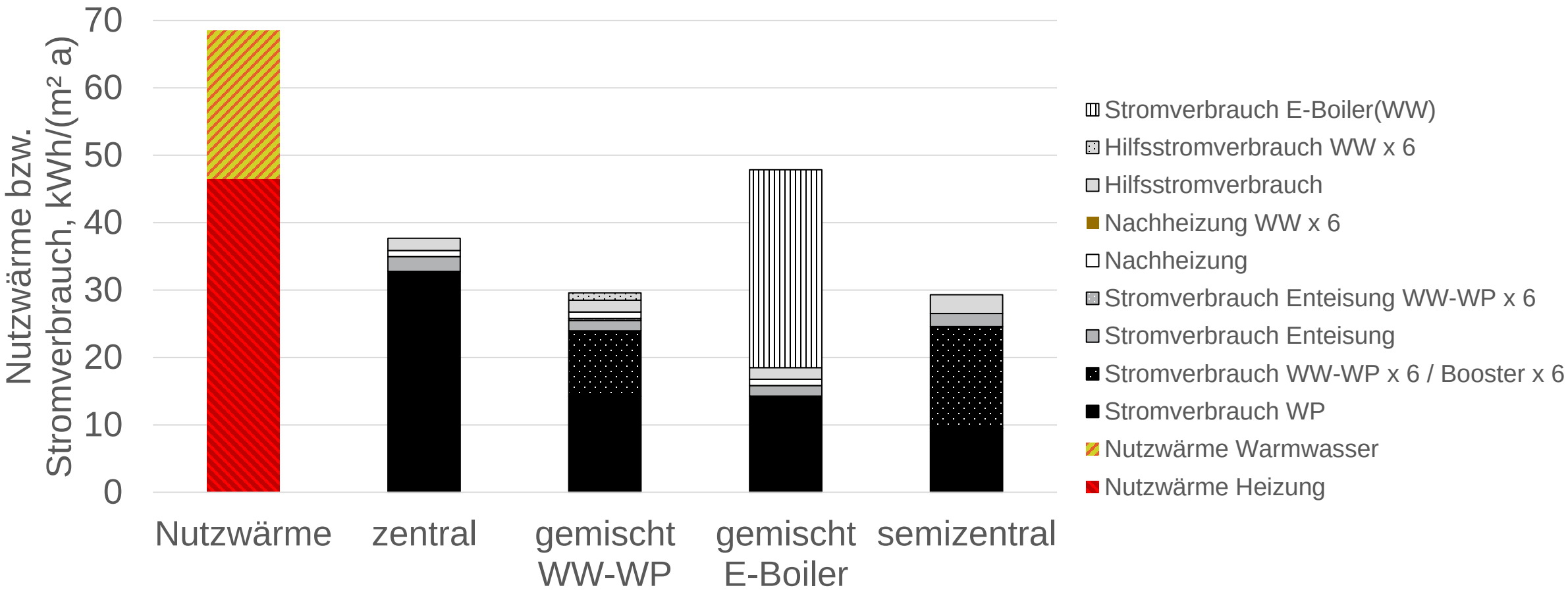


Süd

IDA ICE

Jähnig D., Ochs F., Male, M., **Sanierung mit Wärmepumpen in Mehrfamilienhäusern – eine Simulationsstudie**, Enova 2025

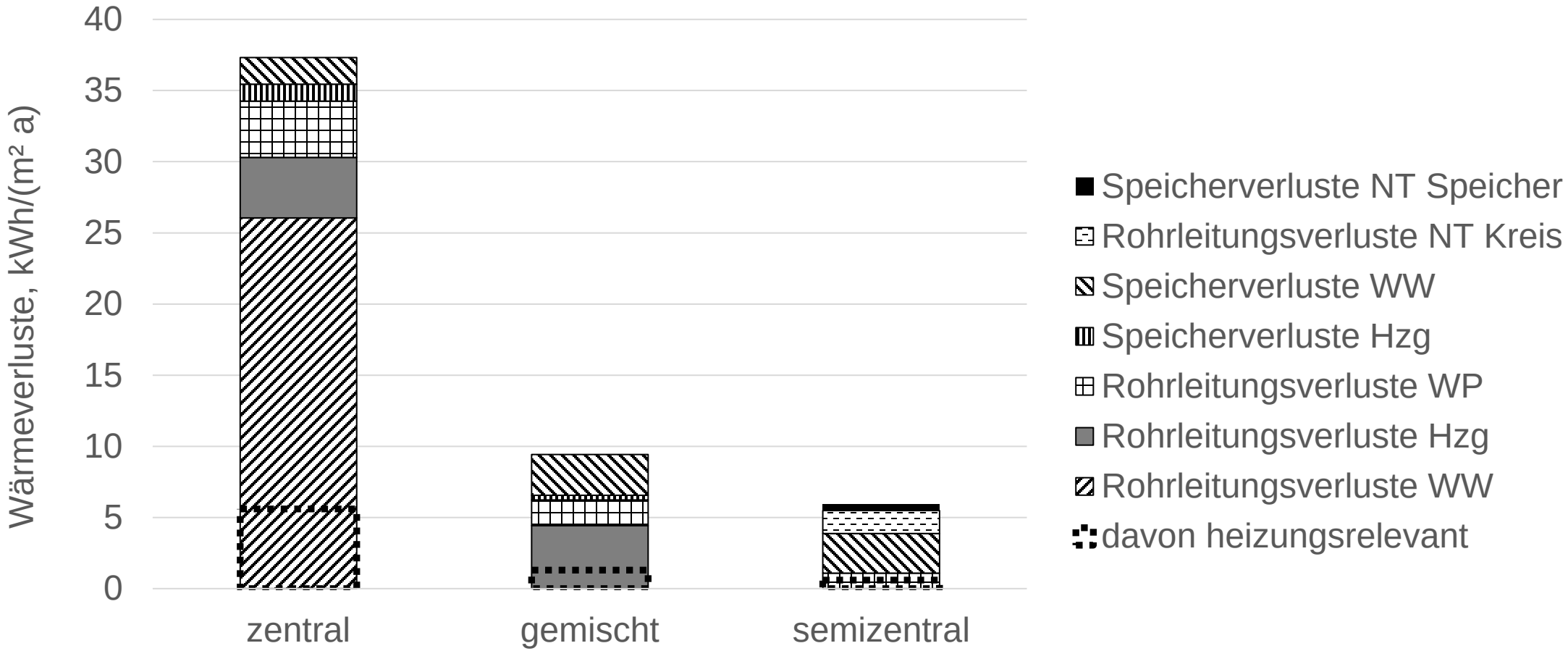
Ergebnisse für HWB 45 – Gesamtstromverbrauch



Jähnig D., Ochs F., Male, M., **Sanierung mit Wärmepumpen in Mehrfamilienhäusern – eine Simulationsstudie**, Enova 2025

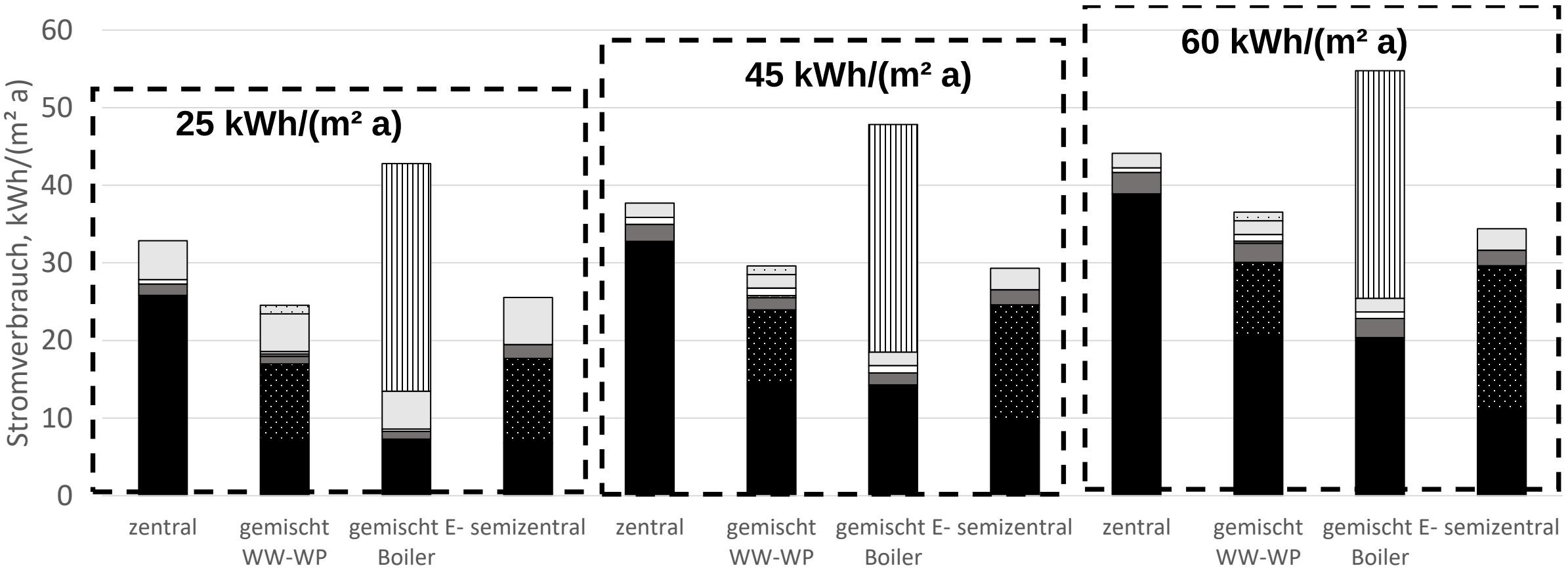
Co-funded by the European Union

Wärmeverluste



Jähnig D., Ochs F., Male, M., **Sanierung mit Wärmepumpen in Mehrfamilienhäusern – eine Simulationsstudie**, Enova 2025

Alle Varianten



Jähnig D., Ochs F., Male, M., **Sanierung mit Wärmepumpen in Mehrfamilienhäusern – eine Simulationsstudie**, Enova 2025

Umsetzung



Co-funded by the European Union

Umsetzung – Vorgefertigte Holzfassade mit Lüftung mit WRG



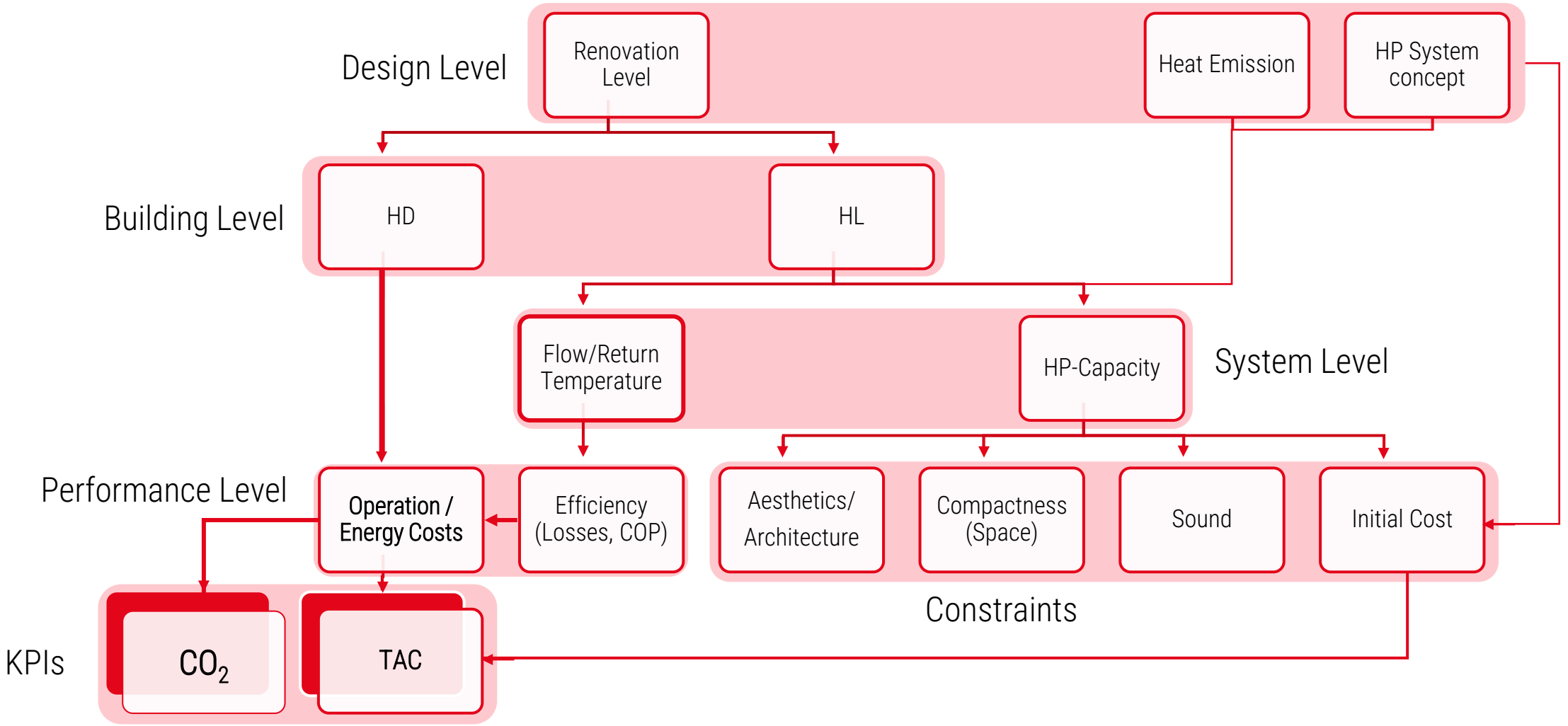


Techno-ökonomische Betrachtung

KNOW HOW HP
Life
Co-funded by the European Union

INTEGRAL PLANNING – WORKFLOW (SIMPLIFIED)

Co-funded by the European Union



Varianten

Wärmepumpensystem

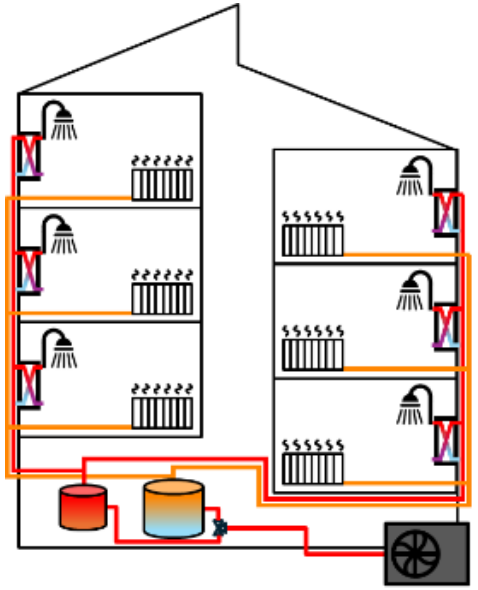
- Zentral
  - 4p-C
  - 2 p HTS
  - 2+2 p FWS
- Gemischt Zentral/Dezentral
- E-Boiler

Wärmeabgabe

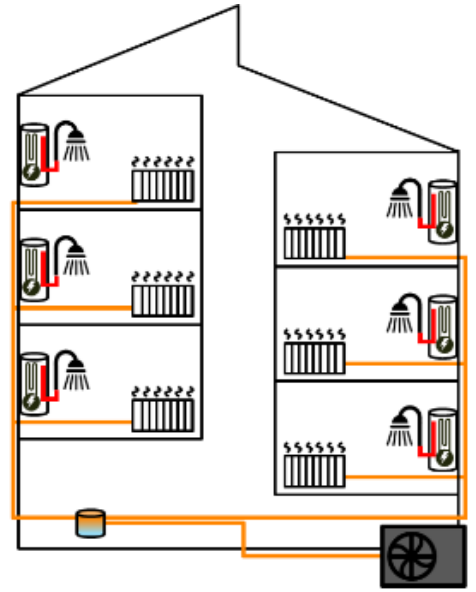
- Bestand
- Neu

Wärmequelle

- Luft
- Sole (optimistisch)



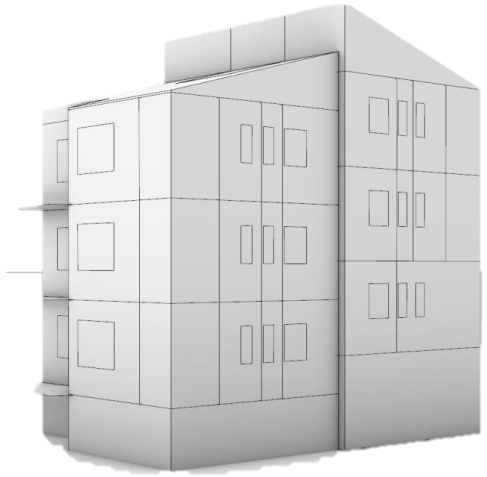
Zentral



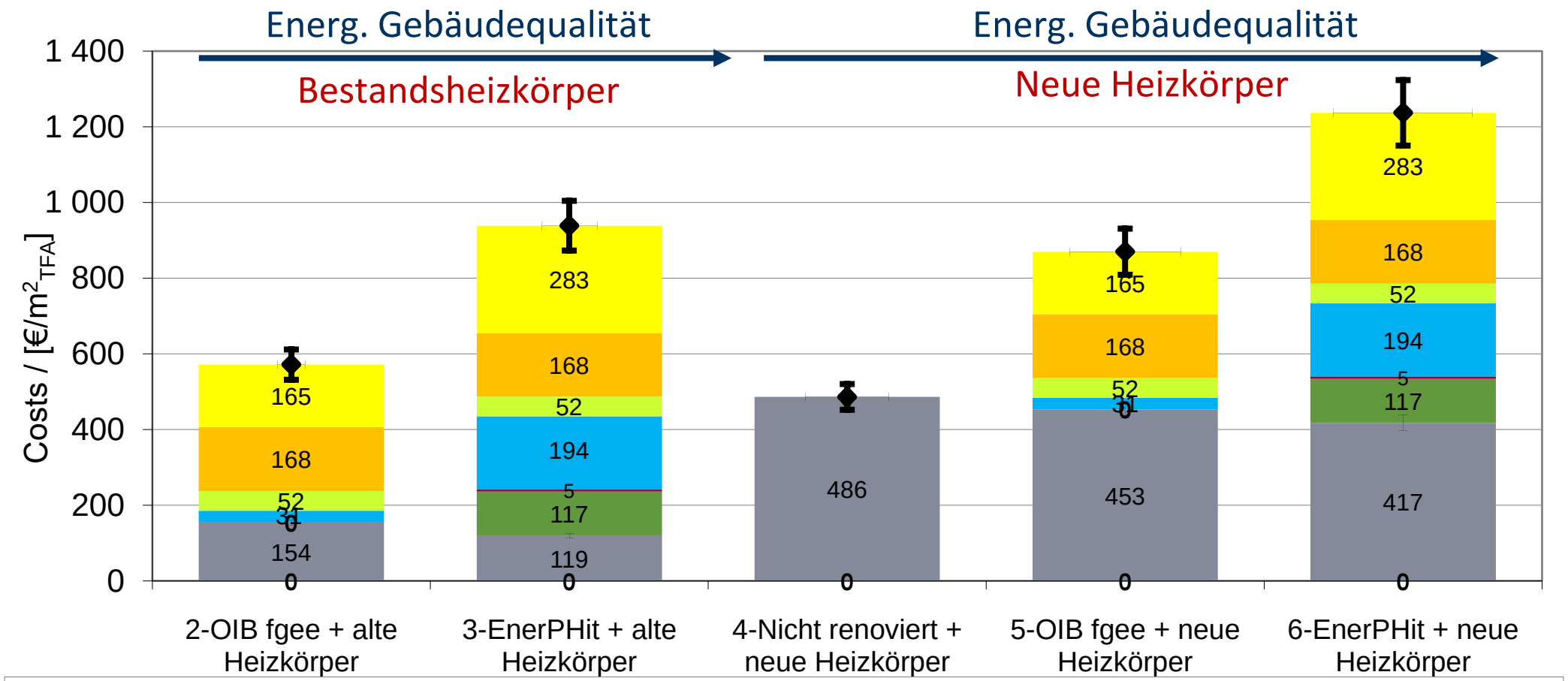
Zentrale RH, Dezentrale E-Boiler

KNOW HOW HP
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SANIERUNGSTIEFE UND VORLAUFTEMPERATUR



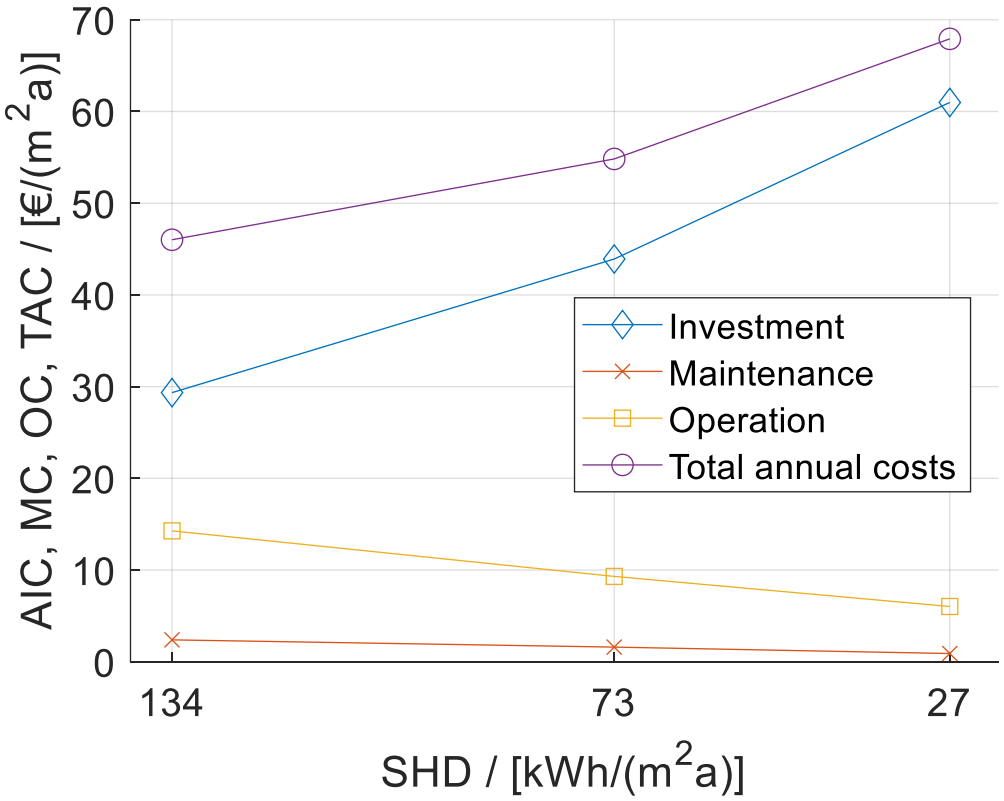
		Bestand	BAU	BEST
HWB [kWh/(m²a)]		134	73	27
Vorlauftemperatur [°C]	Bestandheizkörper Neu	61.6 55	53.5 (55)	41.7 (55)



PhaseOut_4_KnowHowHP 365 m² Energiebezugsfläche,

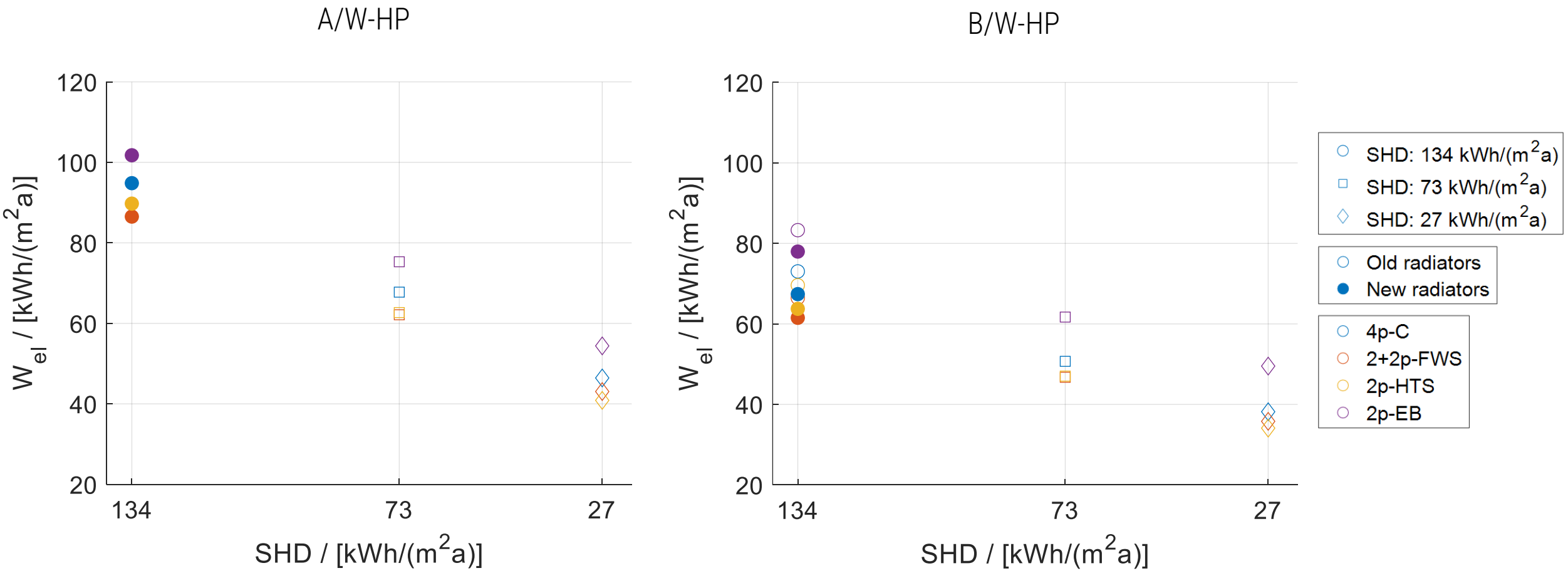
PHPP Passivhaus mit PHPP Version 10.2

GESAMTKOSTEN UND ANTEILE

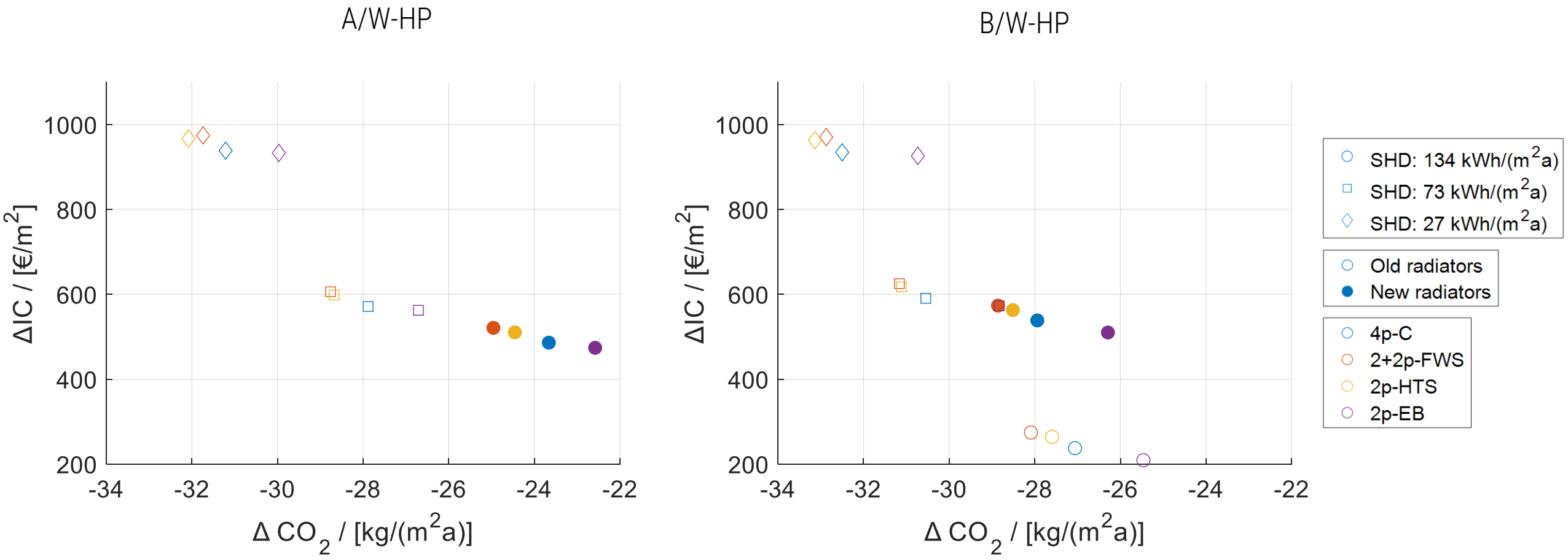


AIC = Annual investment costs
MC = Maintenance costs
OP = Operative costs
TAC = Total annual costs

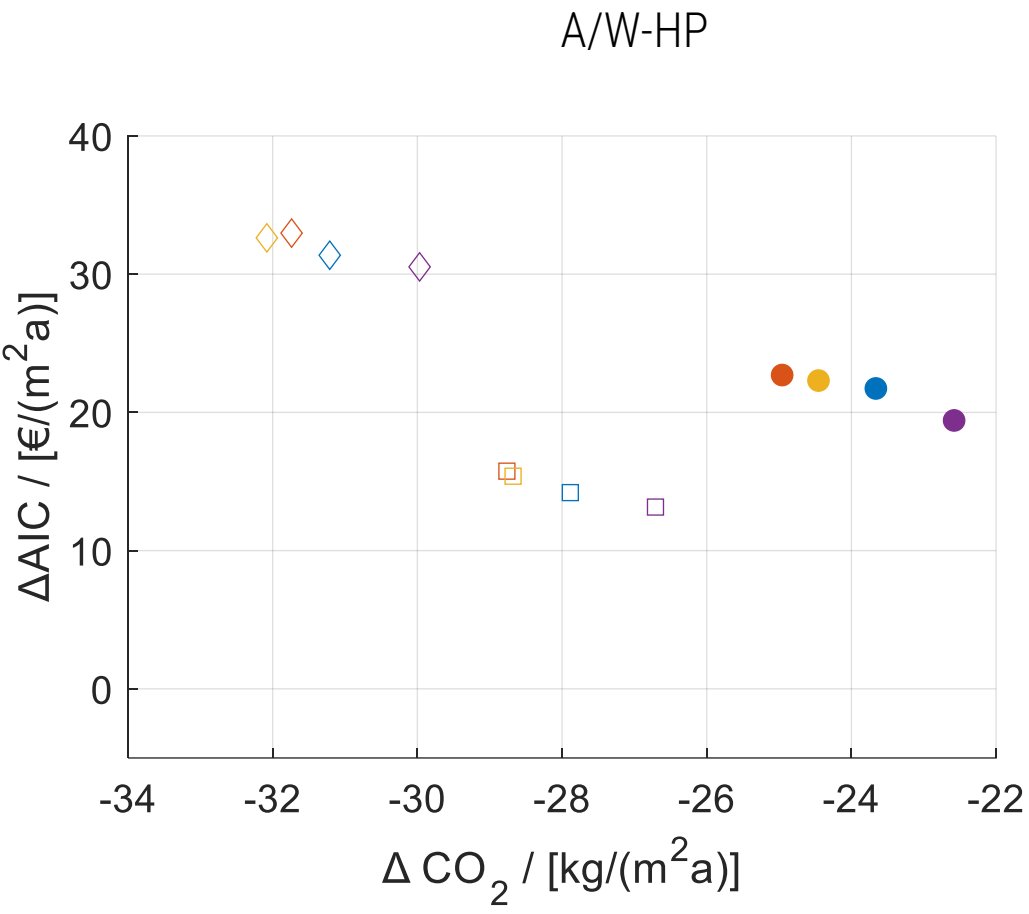
STROMBEDARF

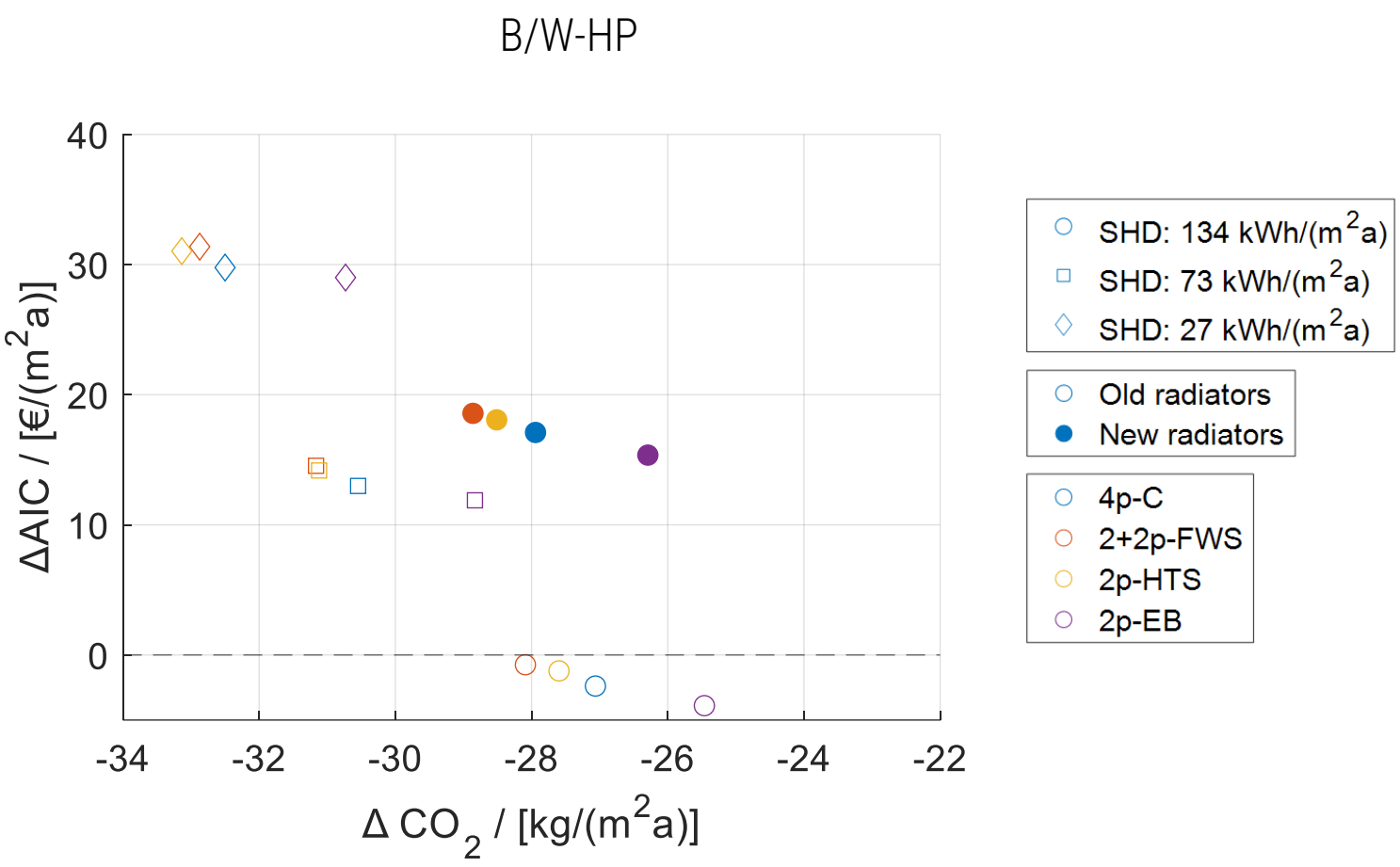


INVESTITIONSKOSTEN



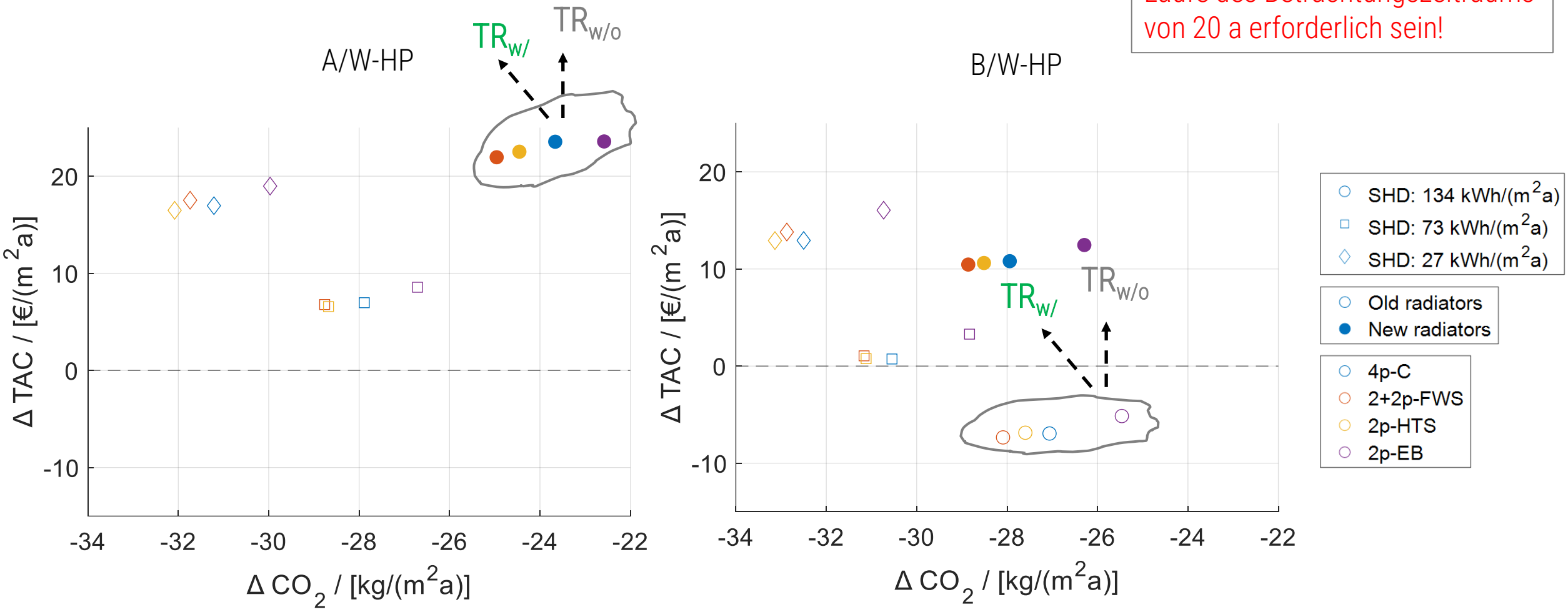
JÄHRLICHE INVEST.-KOSTEN (ANNUITÄT)



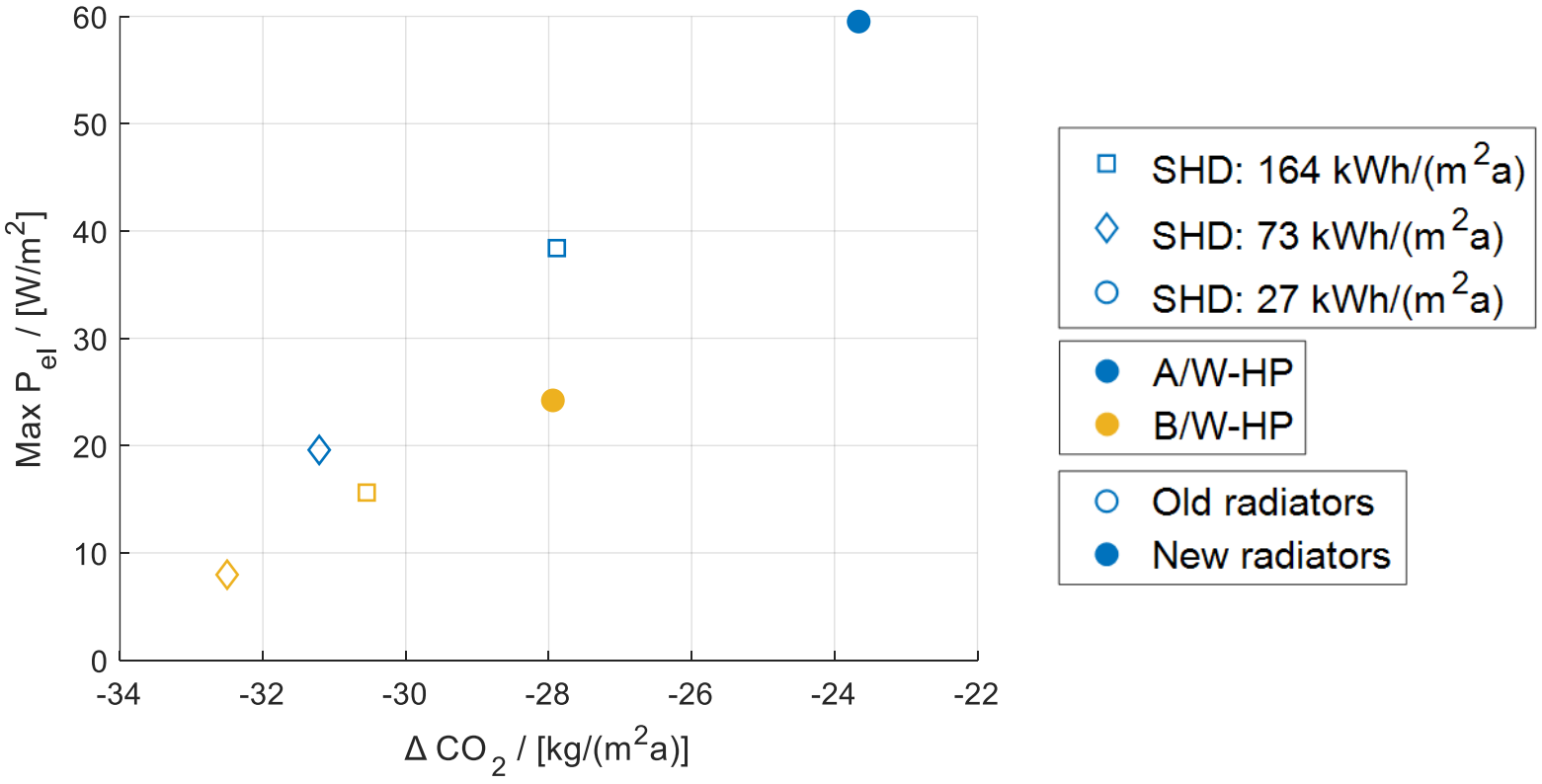


JÄHRLICHE GESAMTKOSTEN

Thermische Sanierung wird im Laufe des Betrachtungszeitraums von 20 a erforderlich sein!



HWB VS. WP-KAPAZITÄT – NETZBELASTUNG

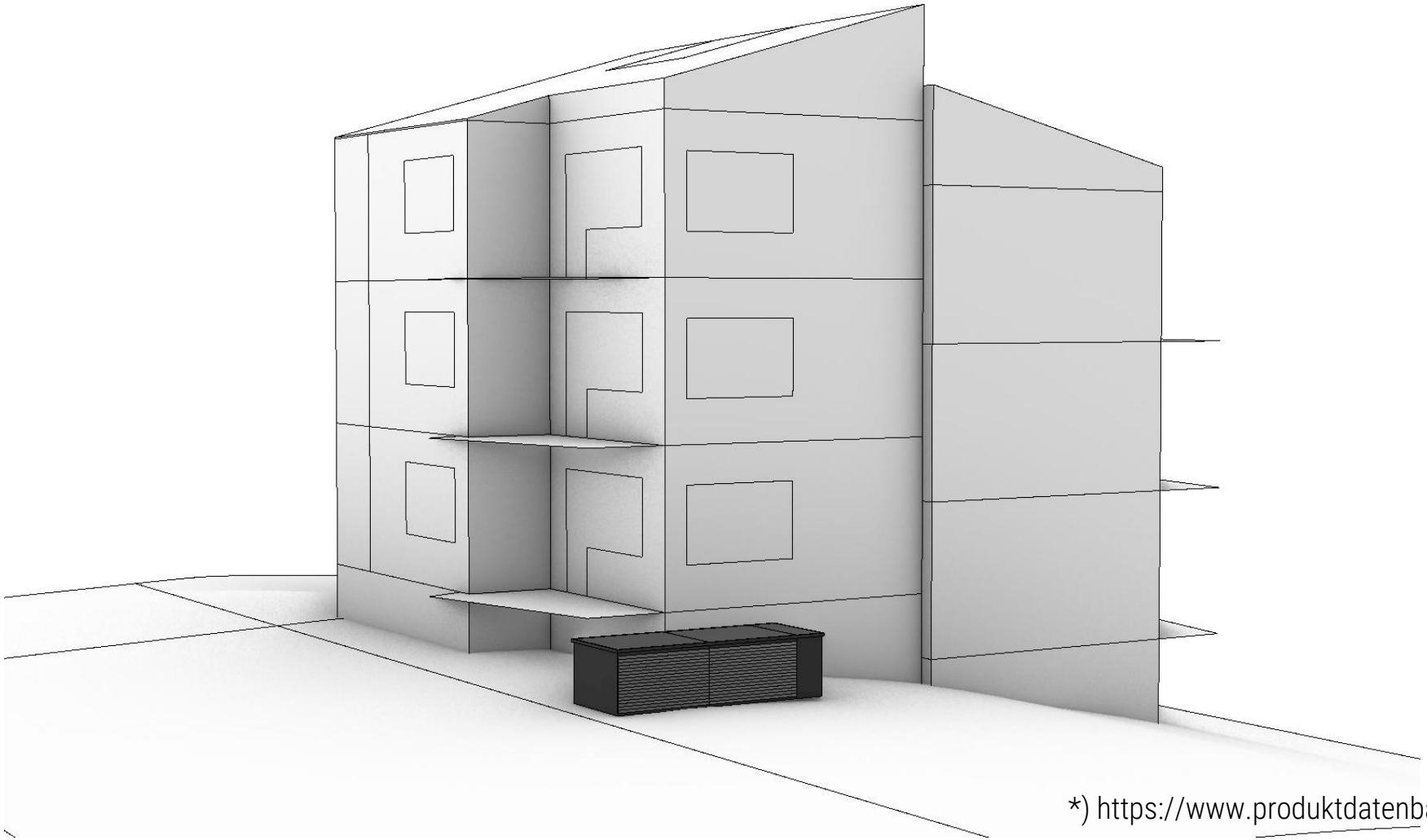


HWB VS. WP-KAPAZITÄT

	None	BAU	BEST
HWB / [kWh/(m² a)]	133.8	68.3	26.7
HL (WP Kapazität ohne TWW) / [kW]	18.6	12.7	6.2
WP Kapazität mit / [kW]	24.8	16.8	8.2
	ALM MAX 10-50	2 ALM 6-15	ALM 6-15 (2 x ALM 2-8)

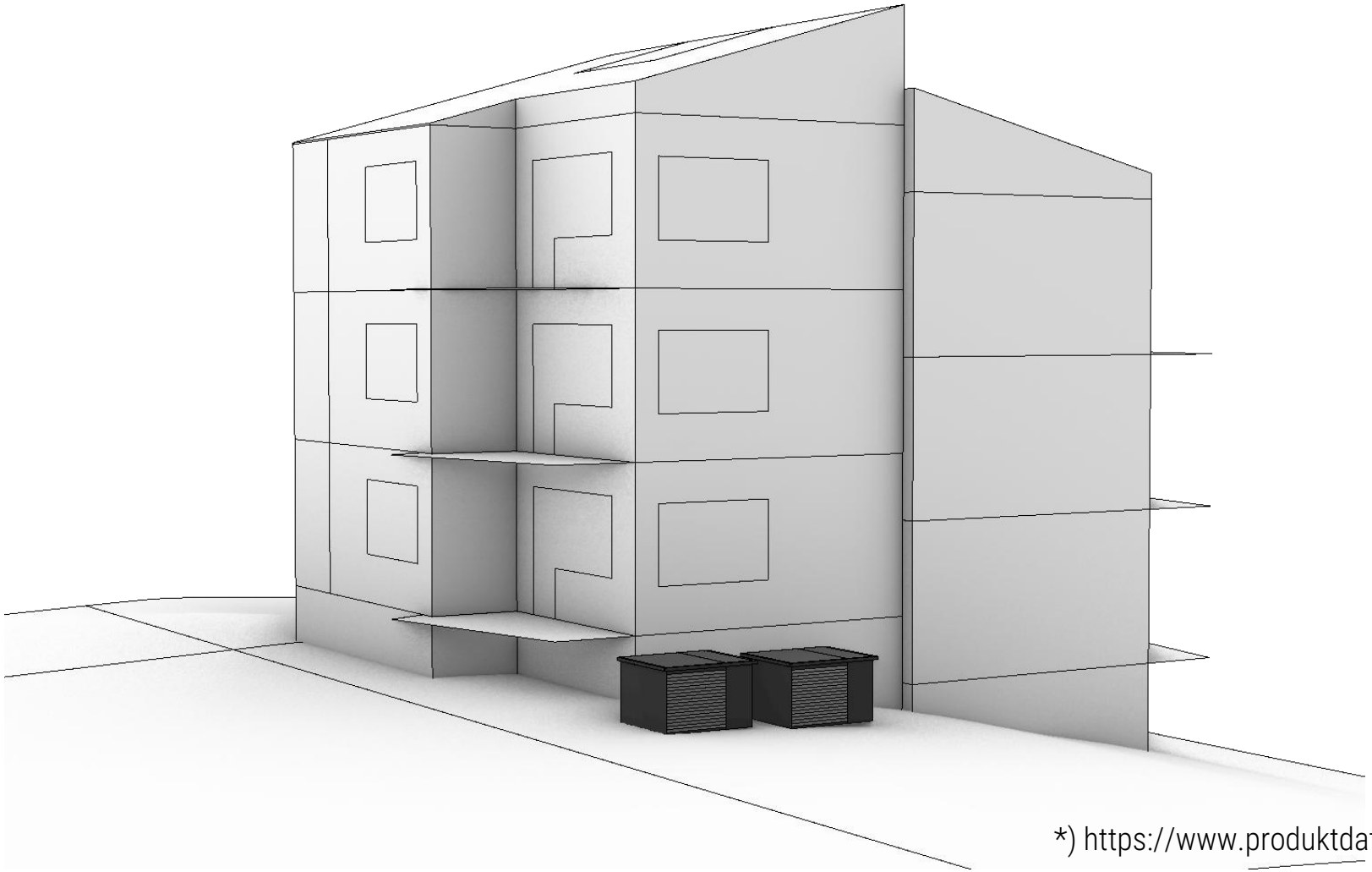
BESTAND

L_{WA} = 57 dB(A) *)



*) https://www.produktdatenbank-get.at/

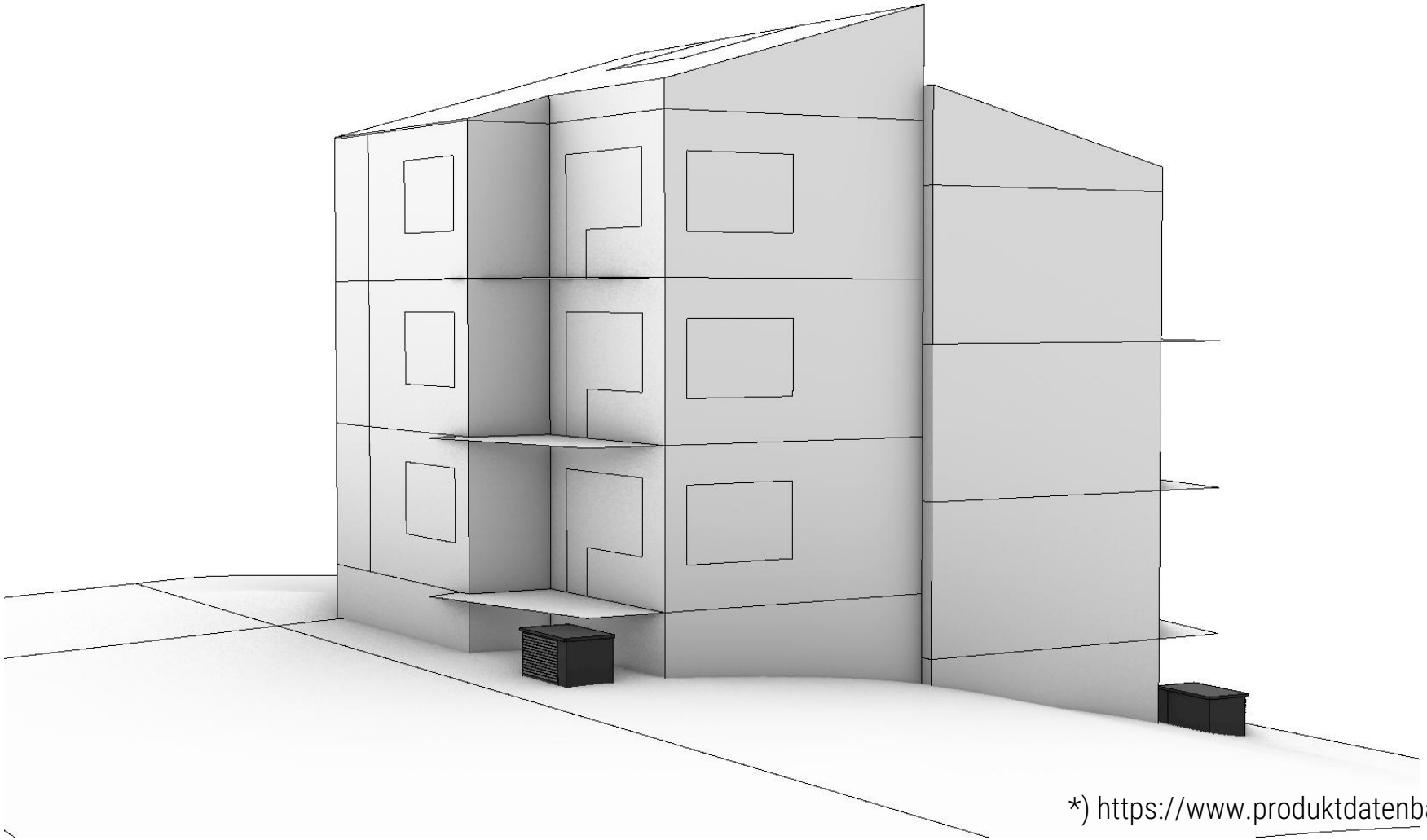
SANIERT (BAU, OIB/GED) L_{WA} = 50 dB(A) per HP *)



*) https://www.produktdatenbank-get.at/

SANIERT (BEST, EnerPHit)

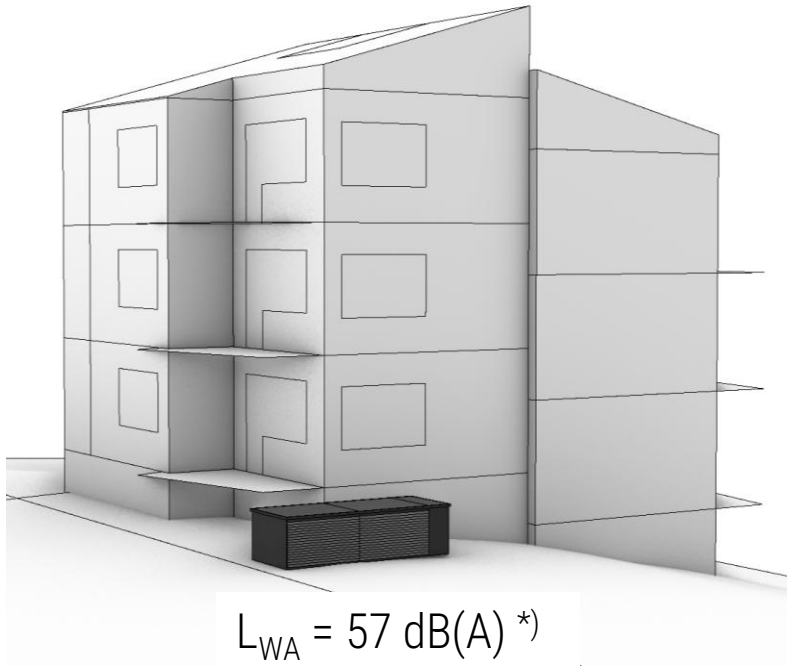
$L_{WA,i}$ = 46 dB(A) per HP *)



*) https://www.produktdatenbank-get.at/

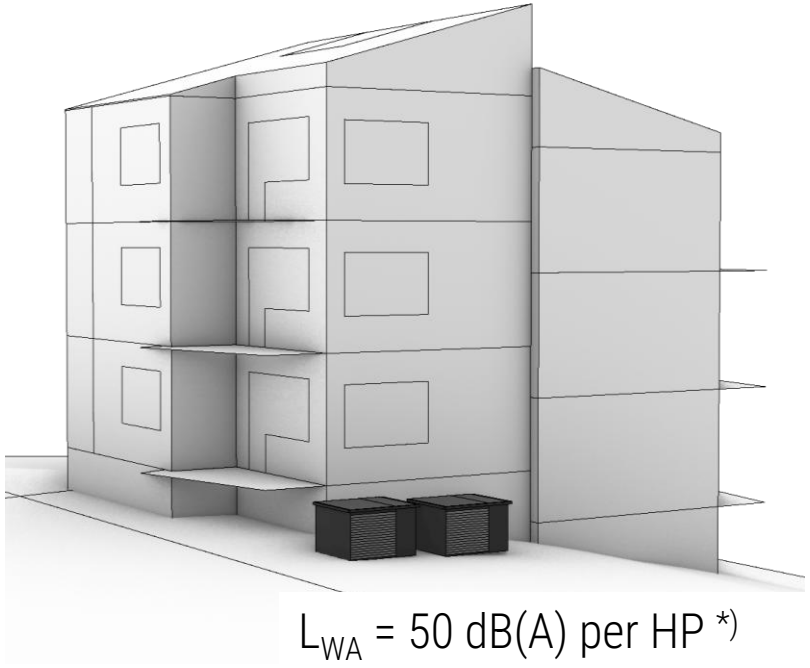
SANIERUNGSTIEFE VS. WP-KAPAZITÄT

Bestand



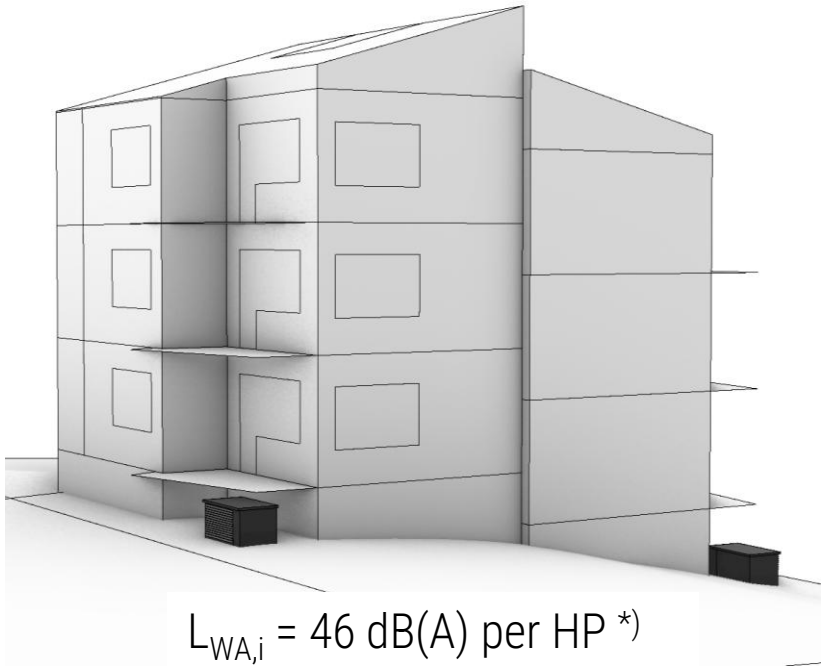
L_{WA} = 57 dB(A) *)

BAU (OIB/GEG)



L_{WA} = 50 dB(A) per HP *)

BEST (EnerPHit)



$L_{WA,i}$ = 46 dB(A) per HP *)

*) https://www.produktdatenbank-get.at/

SCHLUSSFOLERGUNG

- Integrale Planung
  - Hülle
  - Wärmeabgabe
  - WP System
  - WP-Quelle
- Betriebs- und Volkswirtschaftliche Betrachtung
- Wintegap

VORHERSAGE NEKP - WAM

Own representation (simplified)

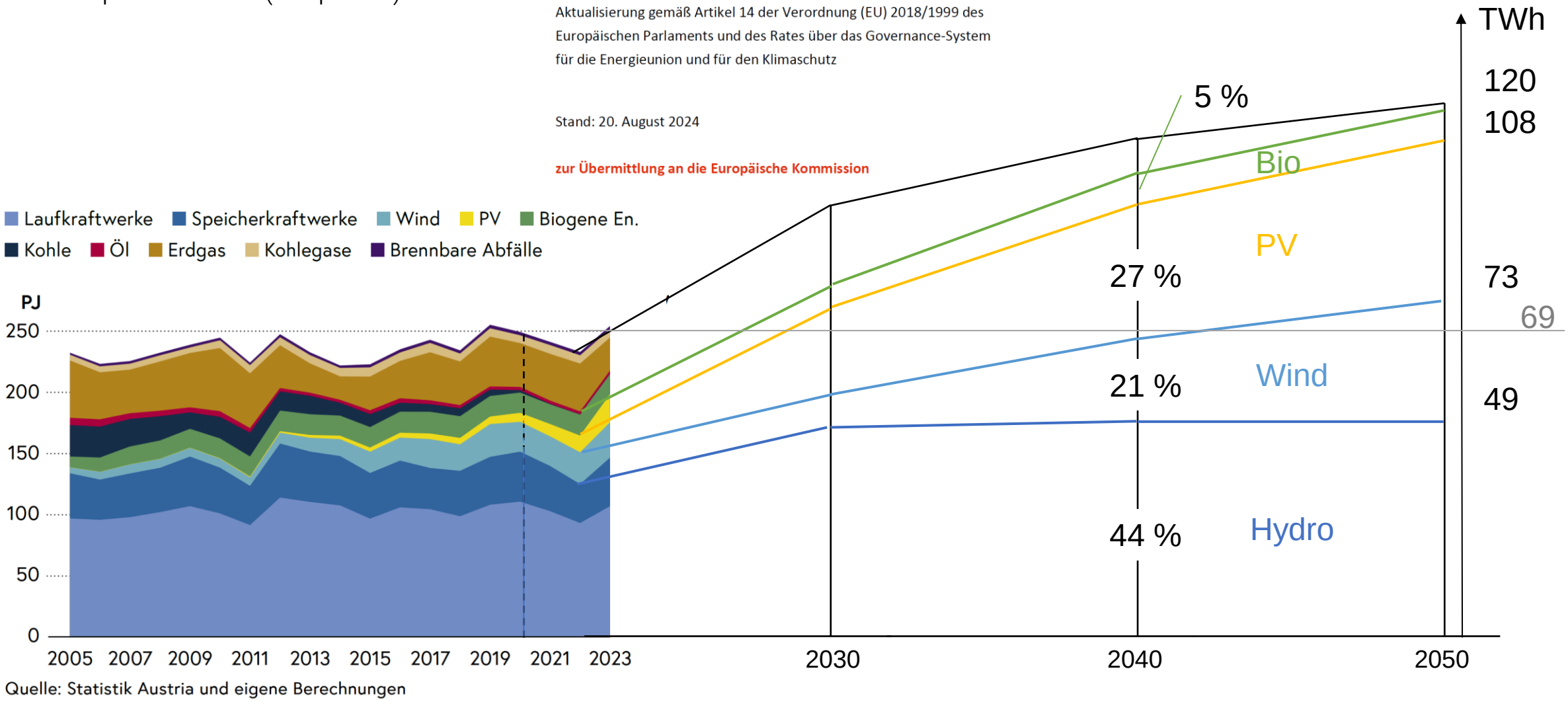
Integrierter nationaler Energie- und Klimaplan für Österreich

Periode 2021-2030

Aktualisierung gemäß Artikel 14 der Verordnung (EU) 2018/1999 des Europäischen Parlaments und des Rates über das Governance-System für die Energieunion und für den Klimaschutz

Stand: 20. August 2024

zur Übermittlung an die Europäische Kommission

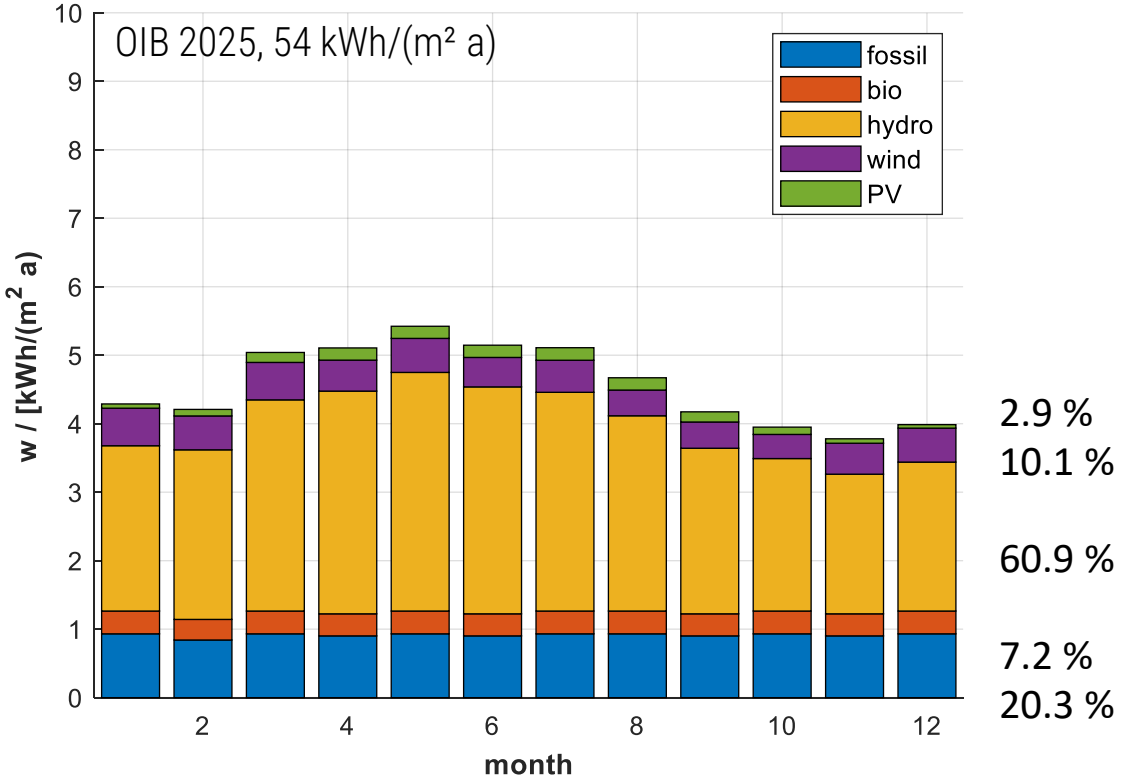


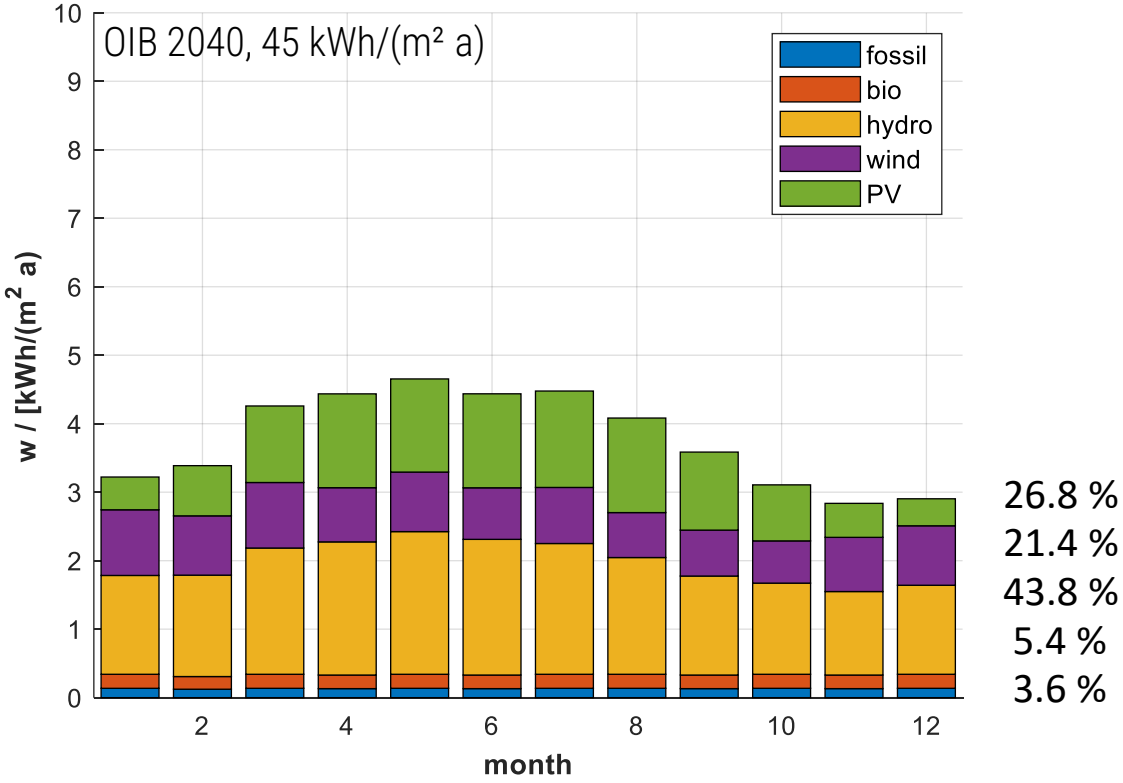
Quelle: Statistik Austria und eigene Berechnungen

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STROMBEDARF UND ERZEUGUNG - OIB

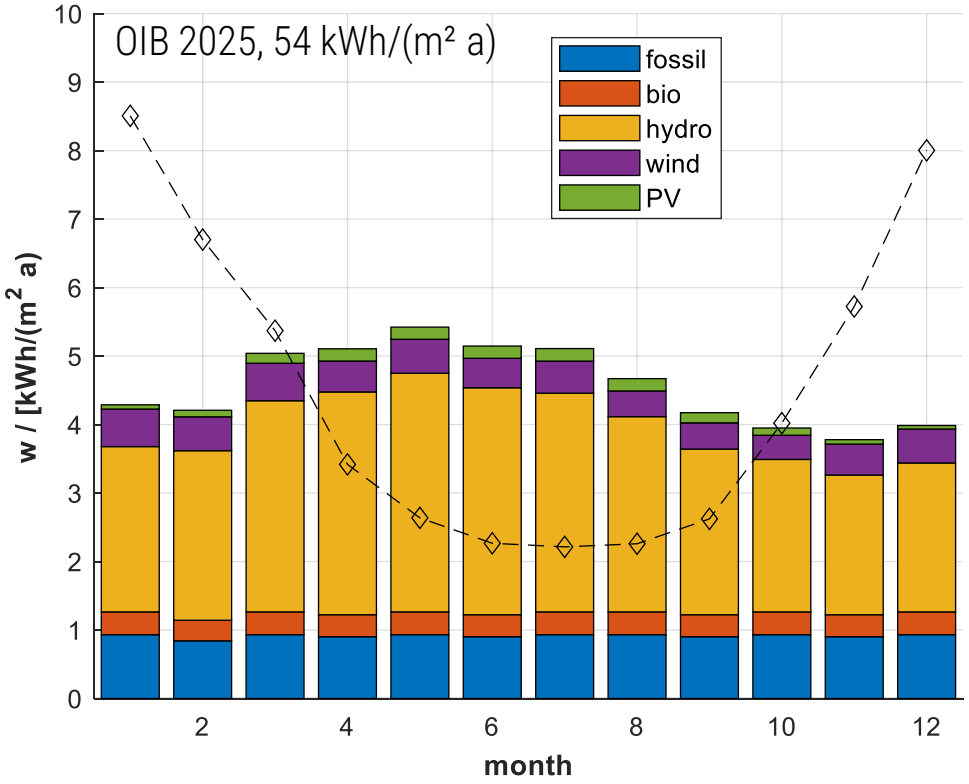




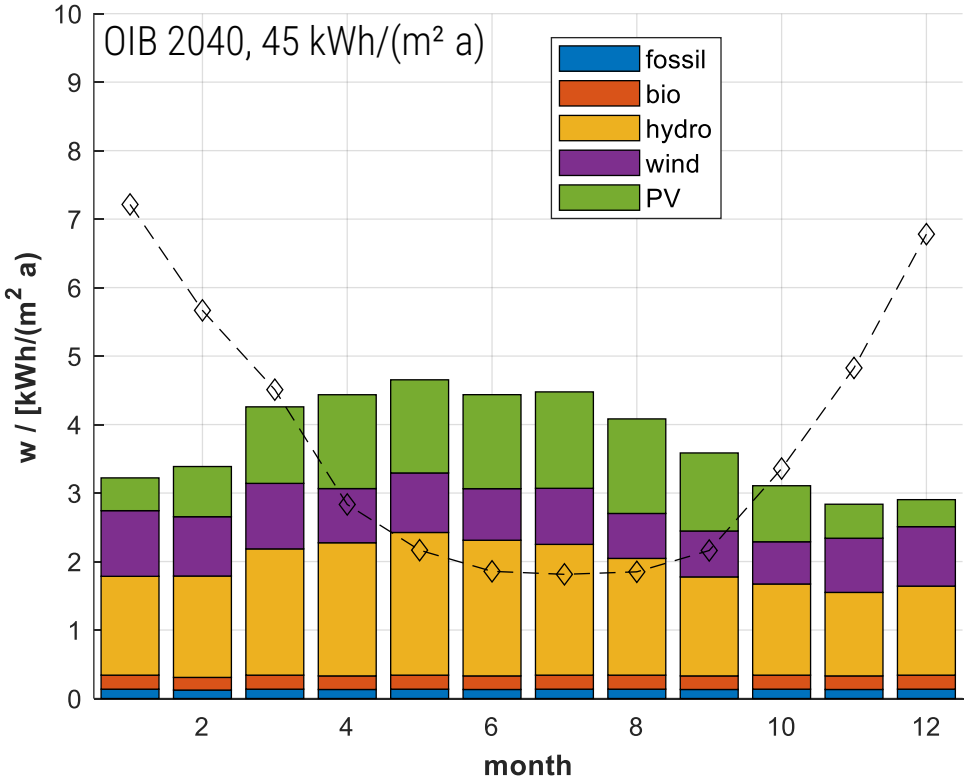
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STROMBEDARF UND ERZEUGUNG - OIB



Mismatch: 26.4 %

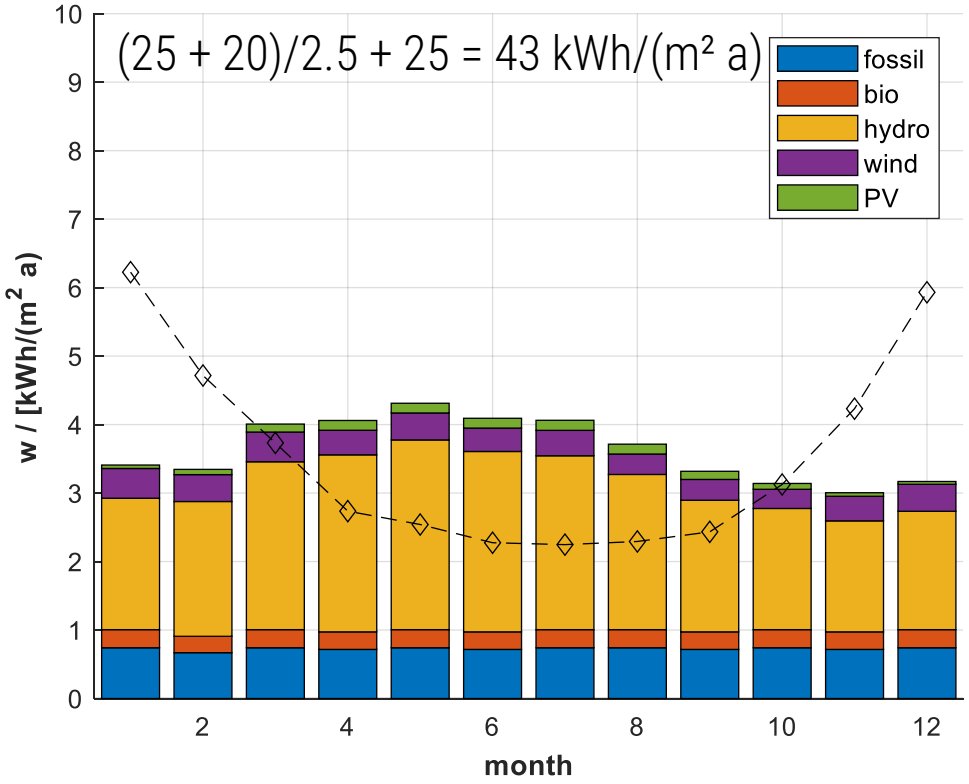


Mismatch: 27.5 %

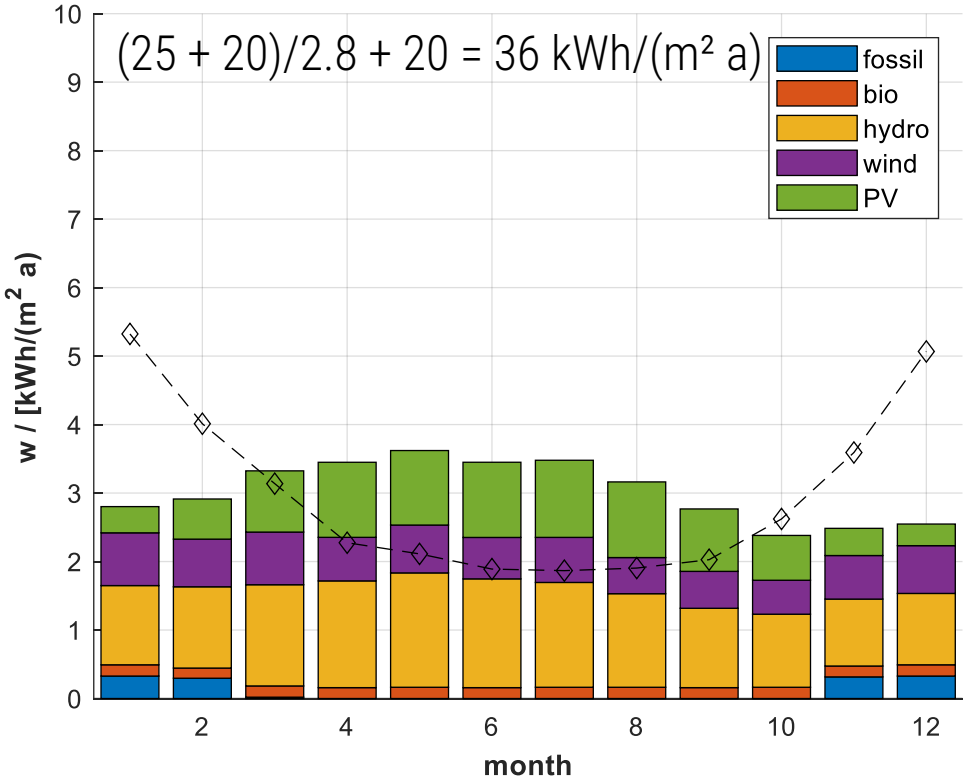
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STROMBEDARF UND ERZEUGUNG - NZEB



Mismatch: 21.1 %



Mismatch: 24.6 %

↳ Mismatch: 22.6 %

PERSPEKTIVE

- Mieter:in
- Eigentümer:in
- Kommune
- Energieversorger
- Gesellschaft
- Klimaschutz

VIELEN DANK!

Fragen?

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raumklima: einfach intelligent

AEE INTEC

Energieinstitut Vorarlberg

iDM WÄRMEPUMPEN

klimatherm

| 44

kulmer
PROFIS AM WERK

Arch Werner
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INGENIEURBÜRO ROTHBACHER

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KONSORTIUM KNOWHOWHP

COORDINATOR:

Energieinstitut Vorarlberg

PARTNERS:

Rosenheim Technical University of Applied Sciences

universität innsbruck

eza! Energie- und Umweltzentrum Allgäu

RENOWAVE.AT

Fraunhofer ITALIA

KlimaHaus CasaClima®

KOSTEN UND NUTZUNGSDAUER (TH. SAN.)

	Cost assumption (investment + installation)	Service Life [y]
Scaffolding	127,03 · TFA $^{(-0,32)}$ €/m$^2_{TFA}$	
Insulation external wall	166,58 €/m$^2_{Exterior\ wall\ surface}$ + 482,90 €/m$_{Insulation}$ /m$^2_{Exterior\ wall\ surface}$ · m$_{Insulation}$	40
Insulation roof	337 €/m$^2_{Roof\ surface}$	40
Replacement windows	Wooden frame IV 88, good triple glazing with argon filling: 795 €/m$^2_{Window\ area}$ Wooden frame IV 88, very good triple glazing with argon filling: 825 €/m$^2_{Window\ area}$ Additionally: Sealing 42 €/window	30 30 10
Improved airtightness	3 €/m$^2_{TFA}$ (not EnerPHit) 5€/m$^2_{TFA}$ (EnerPHit)	30
Ventilation system	Extract air unit : 46 €/m$^2_{TFA}$ MVHR: 117 €/m$^2_{TFA}$ (additionally: 100 €/Apartment/Year for the maintenance)	30

GEBÄUDETECHNIK-KOMPONENTEN

	4p-C	2+2p-FWS	2p-HTS	2p-EB
Radiator (in case of new radiators)	X	X	X	X
Thermal storage	X	X	X	X
Heat pump (HP)	X	X	X	X
Pipes (including insulation)	X	X	X	X
Pumps	X	X	X	X
Fresh water stations (FWS) – decentral		X		
Heat transfer stations (HTS) – decentral			X	
Fresh water module (FWM) – central (circulation)	X			
Electric Boiler				X

KOSTEN UND NUTZUNGSDAUER (TGA)

	Cost assumption (investment + installation)	Maintenance	Service Life [y]
Radiator (in case of new radiators)	80 €/m^2_{TFA}	0	30
Thermal storage	20.5 €/l	0.5€/l/a	30
A/W-HP	4310·P[kW_{th}]$^{0.6177}$ €	14 €/kW	15
B/W-HP	1948.2·P[kW_{th}]$^{1.0138}$ €	14 €/kW	15
Geothermal probes	1000+1667 €/kW_{th}	0	40
Pipes	1.22 €/m/mm	0	30
Pipe insulation	1.06 €/m/mm	0	30
Pumps	0.41 €/l/S	0.006€/l/S/a	15
Fresh water stations (FWS) – decentral	3250 €/System	0	30
Heat transfer stations (HTS) – decentral	3500 €/System	0	30
Fresh water module (FWM) – central (circulation)	10000 €/System	0	30
Electric Boiler	1100 €/System	0	30

KONVERSIONSFAKTOREN CO_2 UND STROMPREIS

		PHPP (Ref. Germany)	OIB2023 (Ref. Austria)	OIB2019 (Ref. Austria)	E-Control (Ref. Austria, 2023)
Conversion factor f_{CO2eq} [g/kWh]	Gas	250	201	247	
	Electricity	363	156	227	
Price [€/kWh]	Gas	0.09			0.20 (update: 06/2023)
	Electricity	0.25			0.31 (update: 12/2023)