HOW AMBITIOUS

Austrian PED certification development within klimaaktiv programme

IS GOOD ENOUGH?

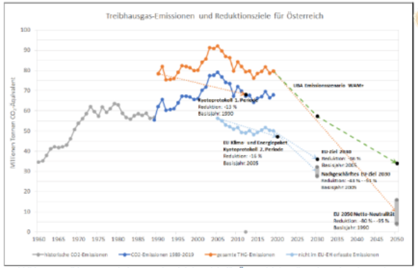


Abbildung 3 Treibhausgasemissionen und Reduktionsziele für Österreich (Quelle: Schwarzl et al., 2021)

THOMAS ZELGER, SIMON SCHNEIDER, PETRA SCHÖFMANN, OSKAR MAIR AM TINKHOF

FH TECHNIKUM WIEN, RENEWABLE ENERGY SYSTEMS – UIV URBAN INNOVATION VIENNA - SIR

10.10.2023 **AUSTRIAN PED CERTIFICATION DEVELOPMENT WITHIN KLIMA:AKTIV PROGRAMME**

PROJEKTE ZUKUNFTSQUARTIER 2.0, ZQ SYNERGY, ANDERE

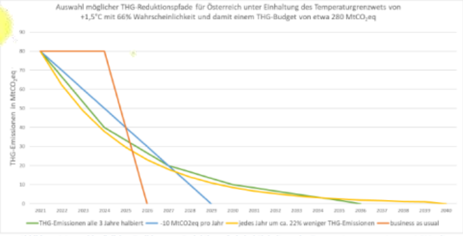


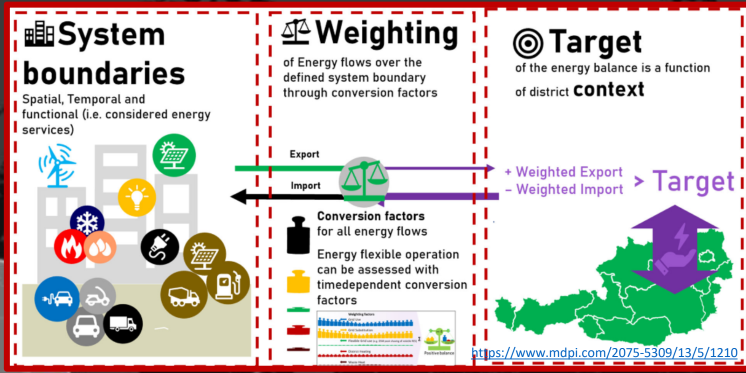
Abbildung 4 Auswahl möglicher Treibhausgas-Reduktionspfade bei Einhaltung des Temperaturgrenzwerts von +1,5°C mit 66% Wahrscheinlichkeit ohne zwischenzeitliche Überschreitung der Temperatur

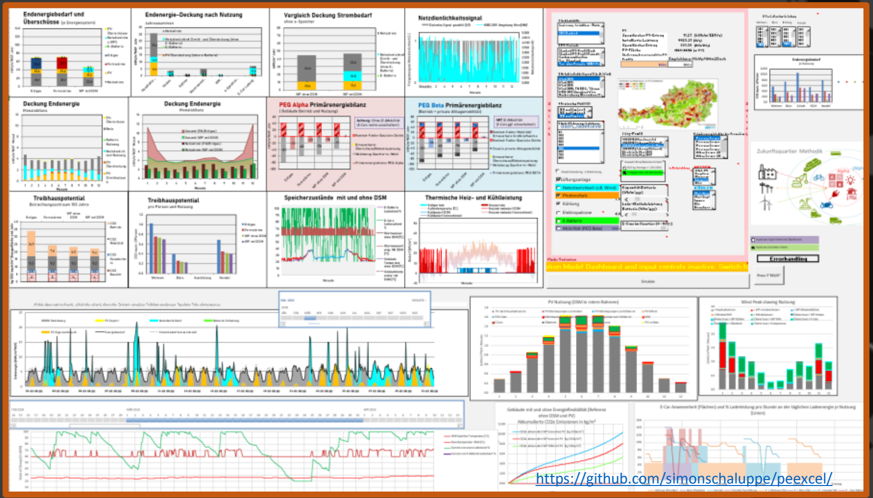
Simon Schneider

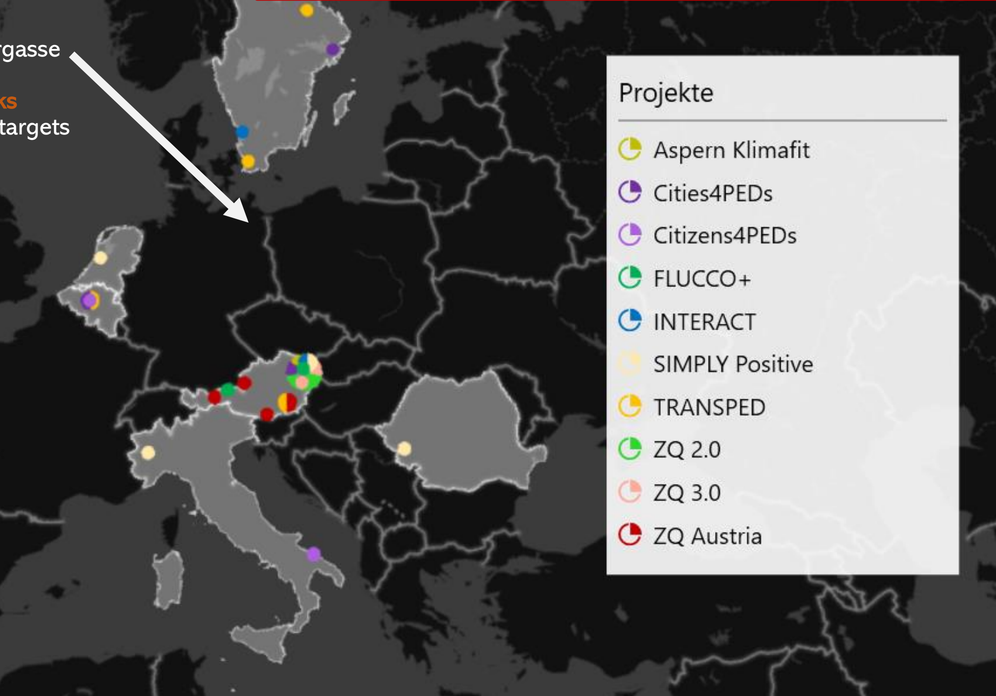
Senior Researcher, Lecturer @ Research group Climate-fit buildings and districts @ Fachhochschule Technikum Wien

Simon.schneider@technikum-wien.at
Physicist, Energy and Environmental Engineer
Member of the IEA EBC Annex 83 PEDs working group
Member of the JPI UE Task force on Positive Energy District definition

- A decade of research and 7 years of teaching in climate-neutral Positive Energy Districts
- Development of an Austrian PED definition as preparation for a klima:aktiv PED certification
- Implementation support for over a dozen PED projects (e.g. Pilzgasse21, Geblergasse – Staatspreis Nachhaltige Architektur)
- Development and Maintenance of PED assessment methods, tools and frameworks
- Development of localization frameworks for allocating national decarbonization targets







Agenda

- **PED defintion and assessment Design goals**
  - Why another klima**aktiv** Certification? Differences to the klimaaktiv Siedlungen und Quartiere not enough?

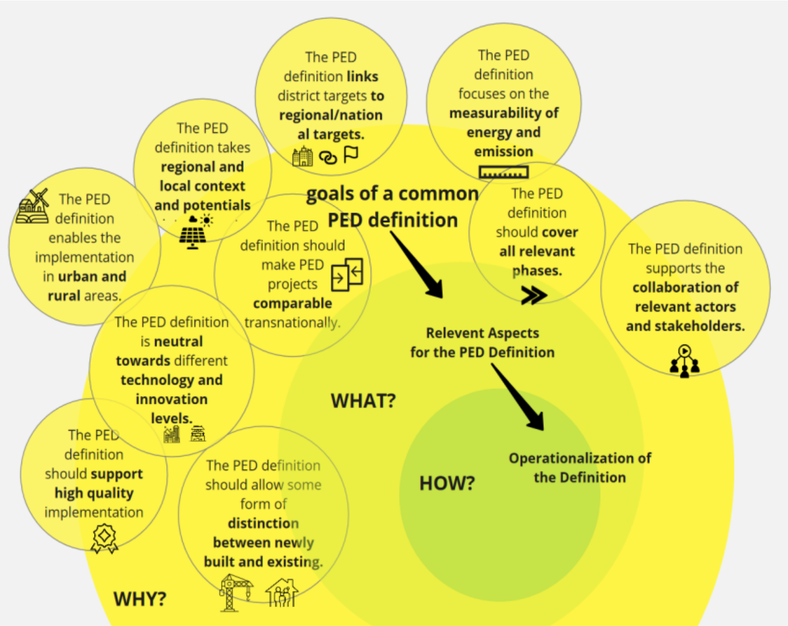
- **How it works: Contextual positive Energy & Emission Balance**
  - System Boundaries: (((Operation& Plugloads (Alpha)), Mobility (Beta)), Embodied Emissions (Omega))
  - Contexts: Density, Flexibility, Surrounding Energy System, Vintage

- **Does it actually work? Examples**

PED Definition as a design problem
Goals

***Categorical Imperative** (freely adepted from Kant):*
"Build and refurbish districts in such a way that if all districts were built and refurbished in this way, the entire building stock would be sufficiently decarbonized within the envisaged future energy system"

- Positive Primary Energy Balance as a Certifiable System, quantitative Targets and Assessments
- **Links EU and national climate goals** of carbon neutrality by 2050 **to local** district targets, that are "sufficient for a future 100% renewable energy system"
- **Feasibility and comparability** of PEDs **in all EU MS**, not individual project definitions
- **Urban** feasibility (Technical/legal/economic)
- Definition **operationalization is multi-layered** and can take regional and local contexts and potentials into account

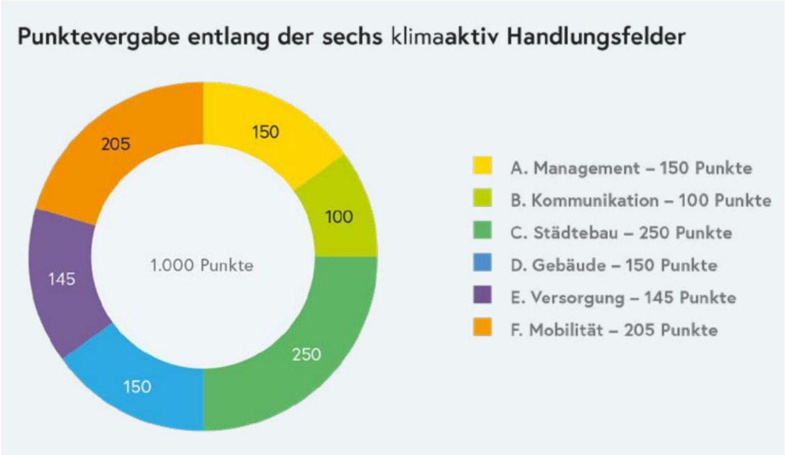


Preliminary results of Cities4PEDs JPI UE PED Project: Brussels, Stockholm, Vienna

A (KPI) Bouquet AND A single KPI: Balance

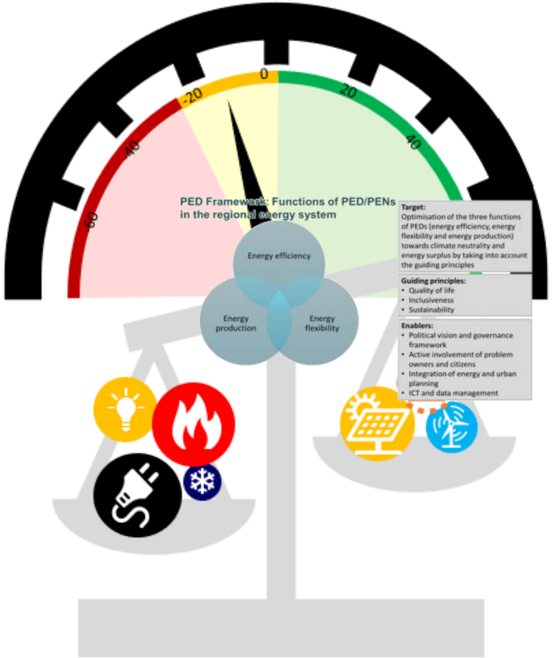
klimaaktiv Settlements and Neighborhoods

- Improvement Maximization
- Process oriented
- Many incomparable approaches and labels



klimaaktiv Plusenergiequartiere

- Ambition Sufficiency
- Performance
- Flexible
- Comparable



Whats in it? System boundary considerations

Functional

Considered energy services: ->

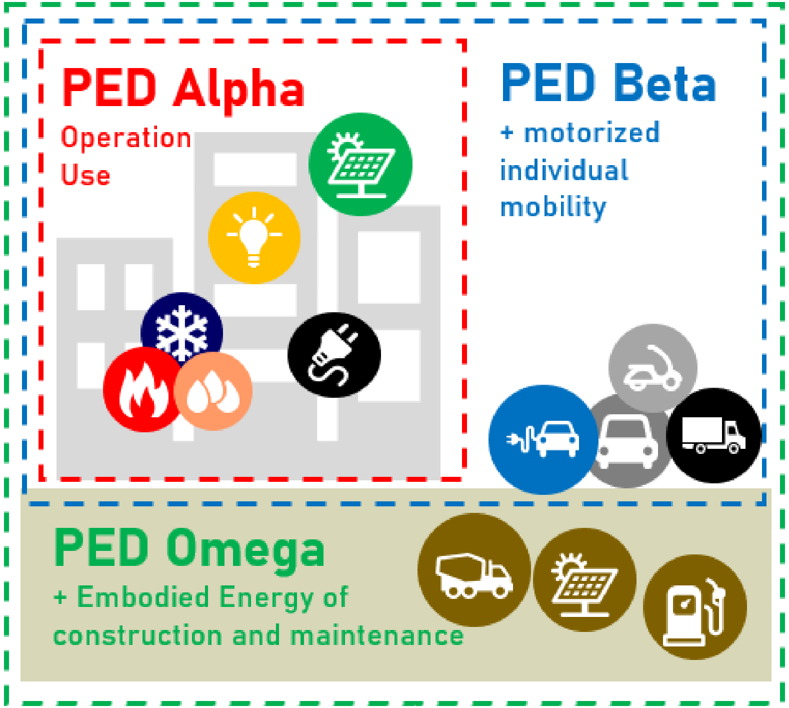
Spatial

No “Gerry mandering”!

Temporal

Balance period: Annual

Resolution: Hourly



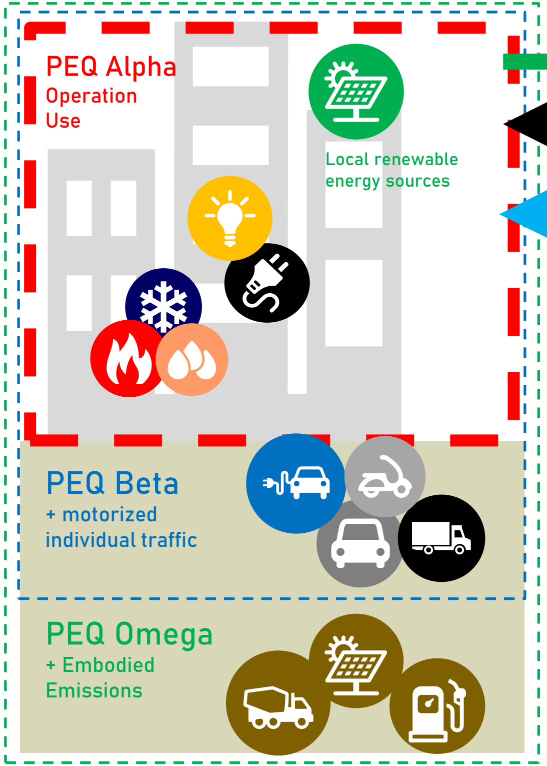
Advantages of Layered Approach:

- Varying data availability
- w/ increasing effort
  Inclusion of all aspects is possible
- NOT considering Mobility or LC Emissions is still possible, but not easier

Single KPI for sufficient efficiency, flexibility and onsite RES

District

System boundaries and considered energy services



Balance

Energy flows over the system boundary,
Flexible energy exchange of renewable EXCESS is free

Grid feed in (PV,Heat)

Grid use (Electricity, District heating, gas, etc.)

flexible use of renewable Excess in the system

Faktor 0

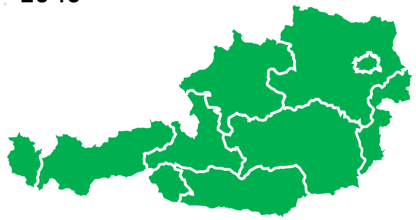
PEQ Alpha
Total Primary Energy

PEQ Beta
Total Primary Energy

PEQ Omega
GHG-Emissions

Target

Allocation method linking to national decarbonization targets 2040



District balance + “context factor” > 0

\+ Context factor Building density > 0

\+ Mobility Budget Per service reference unit > 0

\+ GHG Emission Budget Per Person > 0

Assessment Method:
Efficiency, Flexibility and onsite RES in a single KPI

System boundaries

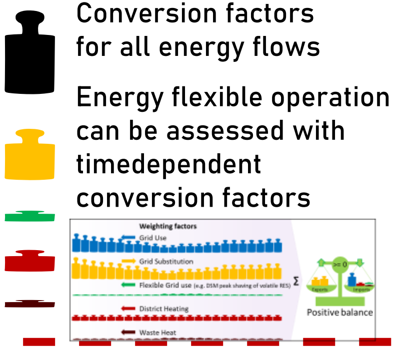
Spatial, Temporal and functional (i.e. considered energy services)

Weighting

of Energy flows over the defined system boundary through conversion factors

Conversion factors for all energy flows

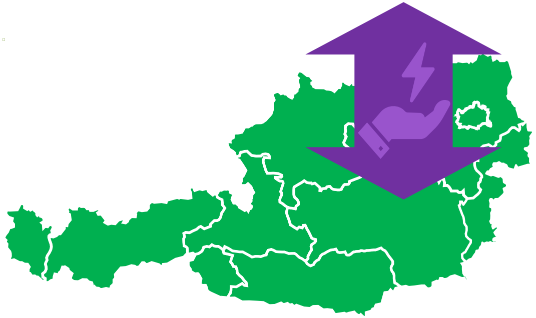
Energy flexible operation can be assessed with timedependent conversion factors



Target

of the energy balance is a function of district **context**

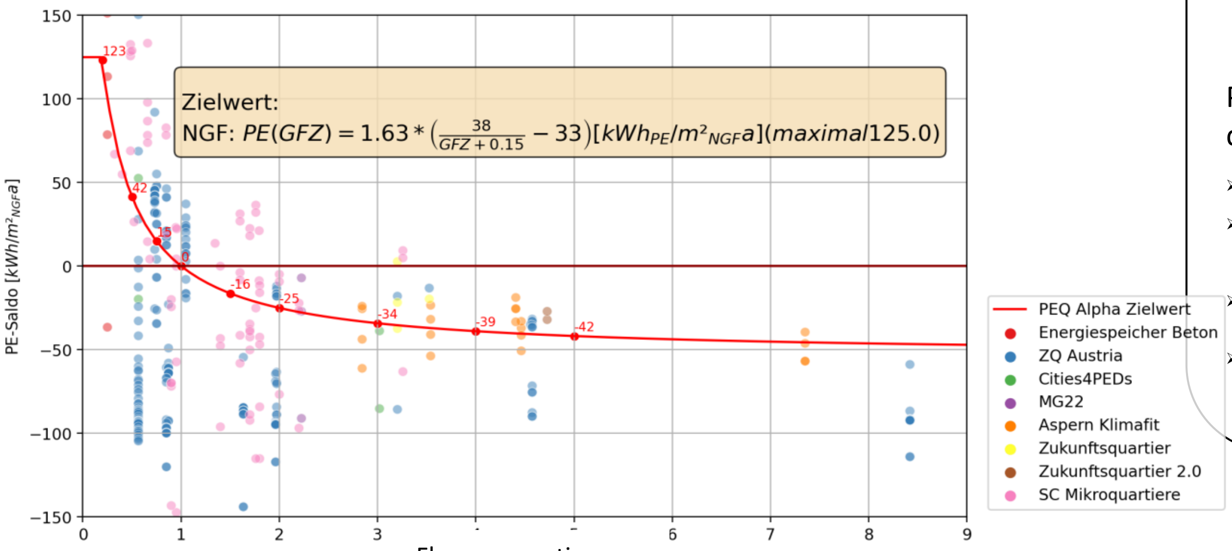
+ Weighted Export − Weighted Import −ContextFactor > 0



Context 1 for Operation: Density

Examination of approach incl. adaptation for very dense districts (up to FAR= 7.5) and very soparse built settlements (FAR <= 0.5).
Approx. 40 districts were evaluated in detail in the last 5 years (Hourly sim based on PHPP, Energy Performance Certificate, partly more complex simulations with Trnsys etc.).
Conclusion: economically feasible PED can be presented with relatively low effort.
Obstacles: Fixed maximum investment costs, innovative business models only common for some utilities, energy communities not yet implemented.

PE-Balances of example districts over Floor Area Ratio (Gross Floor Area / Plot Area)

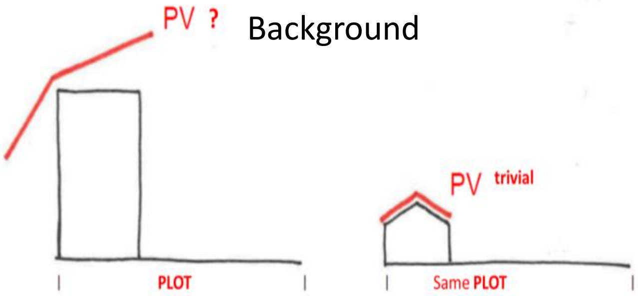


Detached SF Homes

Floor area ratio (Density)

Skyscrapers

Background

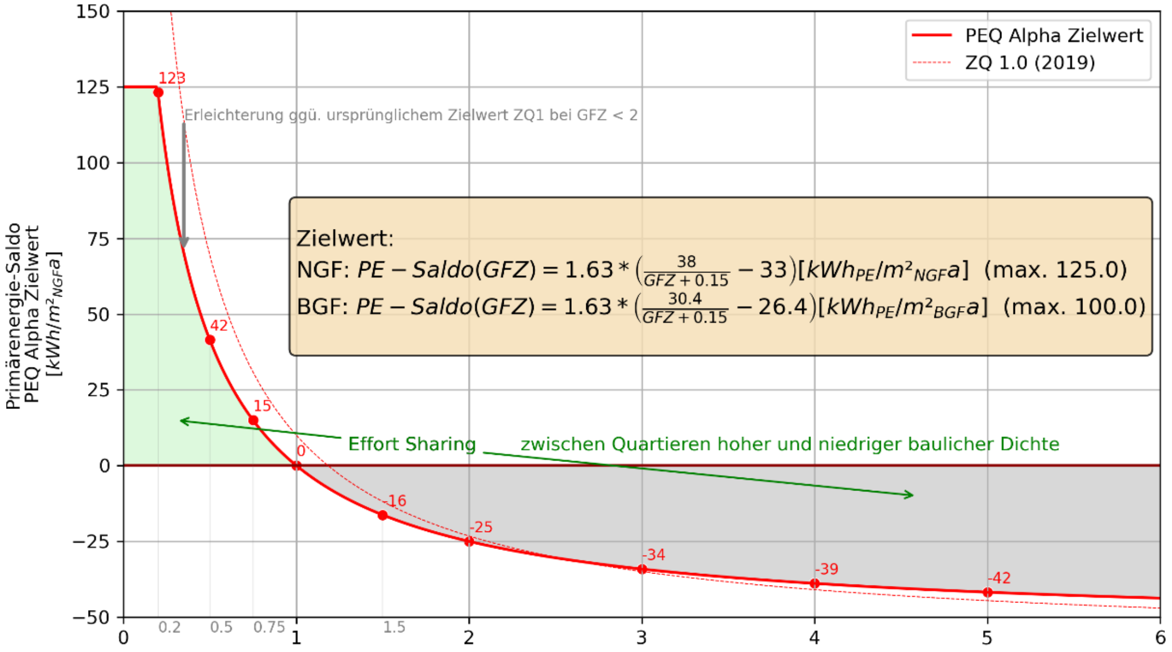


Positive energy balance feasibility self-evidently depends on density, studies unsurprisingly show:

- A. Blumberga *u. a.*, „Transition from traditional historic urban block to positive energy block", *Energy*, Bd. 202, S. 117485, Juli 2020, doi: 10.1016/j.energy.2020.117485.
- H.-M. Neumann, A. Hainoun, R. Stollnberger, G. Etminan, und V. Schaffler, „Analysis and Evaluation of the Feasibility of Positive Energy Districts in Selected Urban Typologies in Vienna Using a Bottom-Up District Energy Modelling Approach", *Energies*, Bd. 14, Nr. 15, Art. Nr. 15, Jan. 2021, doi: 10.3390/en14154449.
- A. Bruck, S. Díaz Ruano, und H. Auer, „A Critical Perspective on Positive Energy Districts in Climatically Favoured Regions: An Open-Source Modelling Approach Disclosing Implications and Possibilities", *Energies*, Bd. 14, Nr. 16, Art. Nr. 16, Aug. 2021, doi: 10.3390/en14164864.
- S. Schneider, N. Bartlmä, J. Leibold, P. Schöfman, M. Tabakovic, und T. Zelger, „New Assessment Method for Buildings and Districts towards "Net Zero Energy Buildings" Compatible with the Energy Scenario 2050", gehalten auf der REAL CORP, Karlsruhe, 2019. [Online]. Verfügbar unter: http://repository.corp.at/id/eprint/487

Context 1 for Operation: Density

Solution -> Make target depend on density



Detached SF Homes

Floor area ratio (Density)

Skyscrapers

by either:

- achieve a balance depending on the density (red line)

or

- Add the virtual density context to your balance

Curve-Parametrization of the Density Context

Top Down Approach

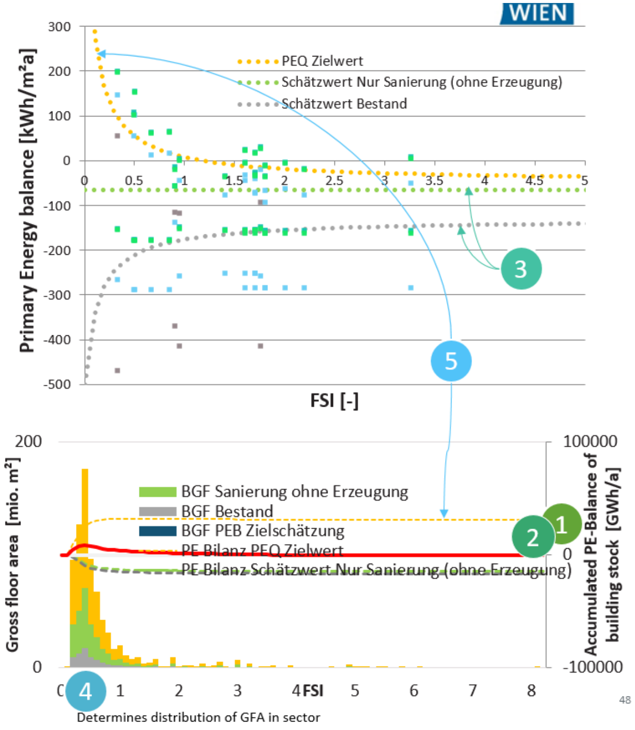
1 Sectoral Targets
- Sectoral Targets (PE, Emissions,)
- Sectoral size (growth)

2 Average Building
- Average target for all buildings in Sector

3 Other Buildings
- Define feasible targets for NON-PEDs
- Depending on density, vintage, etc…

4 Classify
- Building stock by above variables (density, vintage,)

5 PEDs
- Define Target function parameters such that (1) is reached



- Parameterization is **not a direct representation** of the technical potential of a neighborhood as a function of density.
- The parameterization is only motivated by the technical potential, but the actual CF is significantly lower than the technical potentials and needs and ensures that over the entire building stock, the future energy balance requirements according to scenarios are met

Context 1 for Operation: Density
From Zero to Hero:

System boundaries

Spatial, Temporal and functional (i.e. considered energy services)

Weighting

of Energy flows over the defined system boundary through conversion factors

Export

Import

Conversion factors for all energy flows

Energy flexible operation can be assessed with timedependent conversion factors

Target

of the energy balance is a function of district context, not just positive:

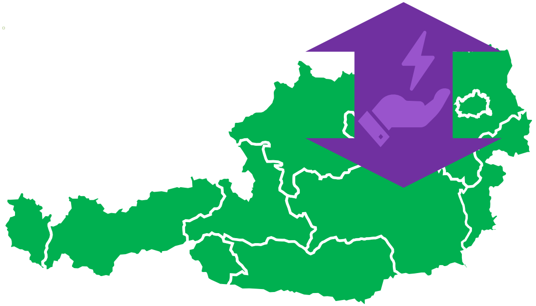
+ Weighted Export
− Weighted Import

~~> 0~~

> Target

or equivalently

−ContextFactor > 0



Context 2 for Operation: Flexibilty

Assess Efficiency, Flexibility and onsite RES in a single KPI with weighting

System boundaries

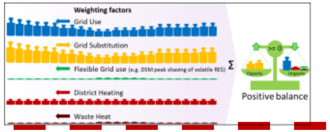
Spatial, Temporal and functional (i.e. considered energy services)

Weighting

of Energy flows over the defined system boundary through conversion factors

Conversion factors for all energy flows

Energy flexible operation can be assessed with timedependent conversion factors



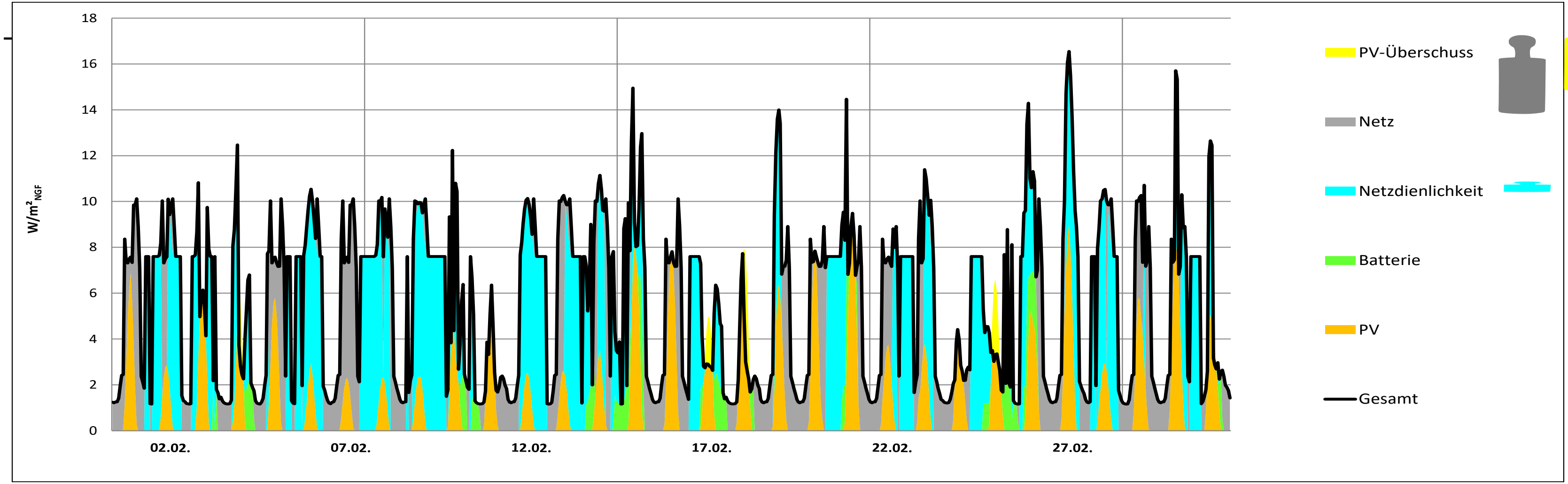
Target

of the energy balance is a function of district context

+ Weighted Export
– Weighted Import

–ContextFactor > 0

Example of dynamic PED weighting

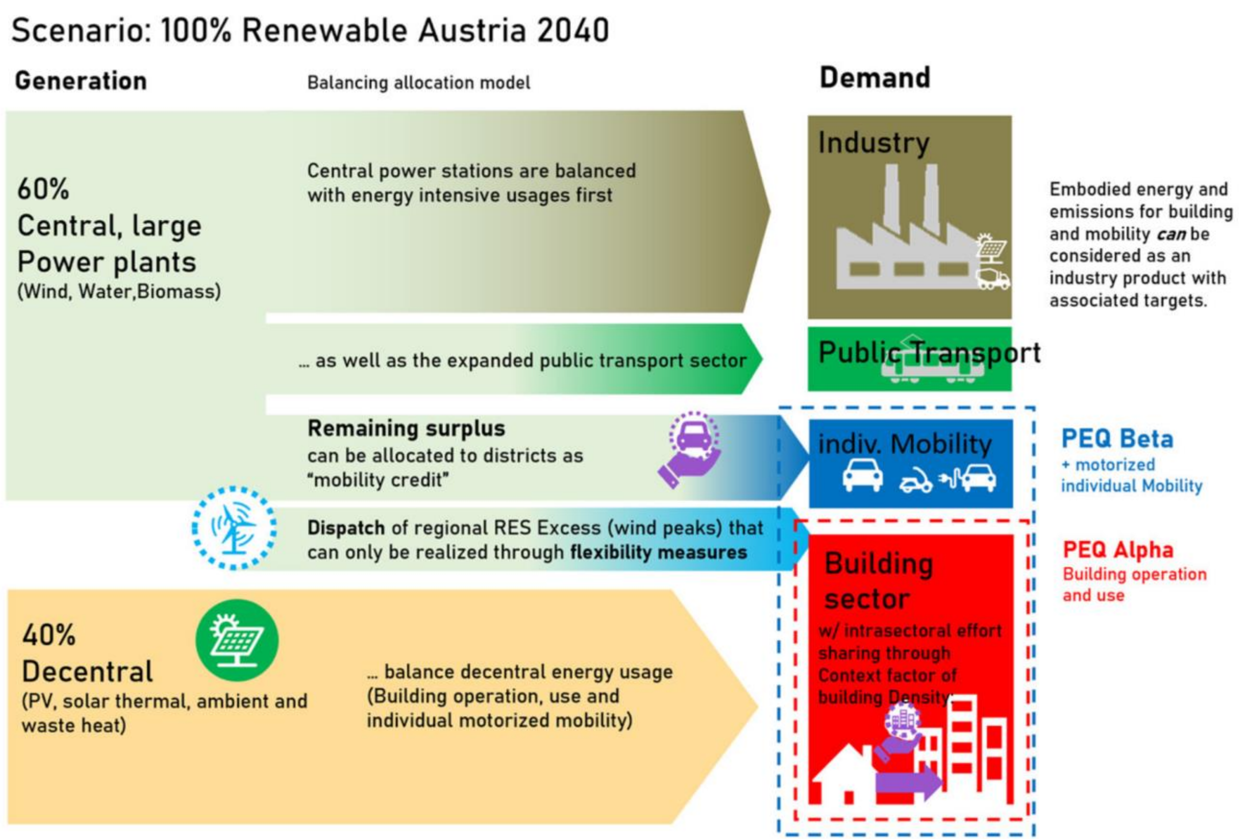


- **Control**: In case of oversupply of solar power or wind peak shaving, the enabled storage tanks are charged: Component activation for heating/cooling, buffer storage, battery, bicycle/car batteries in each case if available and depending on the enable signal (e.g. MaxTemperatures etc.). Variant alfa+mobil grid-serving
- **Simplified dynamic simulation**: The temporal exchange between the services/sectors (conditioning buildings, eMobility, etc.) and the storage can be precisely balanced with little effort (especially important for economic efficiency depending on the business models!). For quality assurance, the use over the entire planning and operation process is useful.

PED Beta – (individual motorized) Mobility

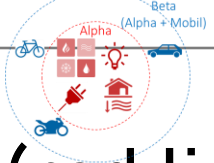
- Why bother? Future **Emobility loads** will substantially be covered by onsite RES (in climateneutral scenarios) -> consideration can **optimize RES self-utilization, grid support, usage of E-Storage**
- Allocation of offsite ressources follows Statistics (similar to klimaaktiv – Siedlung) -> **fair and independent**
- Demand calculation is dynamic -> **dependant on location and usage of the district**
- Method can be used for all Austrian districts without additional data or effort.
- Groundwork for future dynamic models with price signals

Context for Mobility: Surrounding Energy System



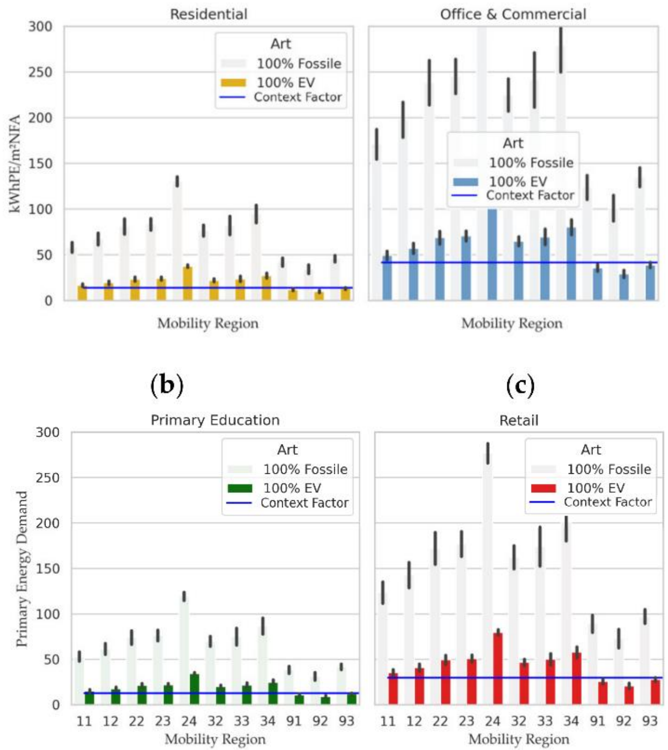
Problem: Except for rich, detached SFH with Teslas, no District can additionally supply its own mobility energy

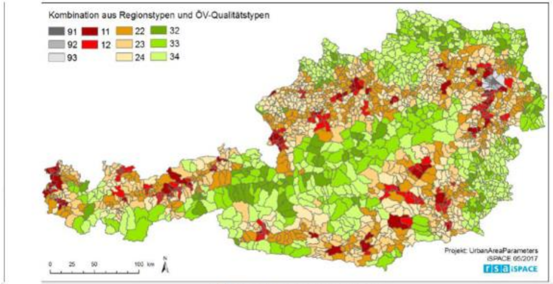
Solution: Districts get a virtual balance credit based on the surrounding energy system



Mobility Energy demand (cols) vs. „Credit“ (red line)

Comparison between energy demand with 100% fossil (gray) and 100% electric (colored by usage). The mobility credit is shown as a blue line and is proportionally the same for all uses.





Traffic performance [km/person]										
Regiontype	Walking	Cycling	Motorbike	Car-Driver	Car-Passenger	City-Bus	Metro	Train	Inter-Bus	**Total**
11	310	383	225	5.527	2.666	379	232	1.366	176	11264
12	276	351	66	6.456	2.903	415	286	867	422	12042
22	243	223	74	7.810	2.950	404	88	1.996	309	14097
23	211	188	65	7.846	2.734	566	200	940	173	12923
24	165	73	133	11.831	3.363	380	99	482	90	16616
32	333	181	76	7.204	4.220	535	287	1.444	31	14311
33	247	195	153	8.038	2.954	626	91	1.181	147	13632
34	215	150	88	9.125	3.744	961	258	949	72	15562
91	363	257	78	4.062	1.855	337	1.808	3.588	44	12392
92	339	114	78	3.414	1.803	326	2.031	1.394	33	9532
93	235	116	146	4.291	2.035	165	1.978	1.463	67	10496
Austria 2013/2014	269	235	121	6.696	2.773	444	555	1.417	169	**12679**

Calculation method in detail: In addition to PED Alpha, two components are added:

- **(dynamic) energy demand of the private everyday mobility** induced by the neighborhood (statistically projected). This depends on the public transport connection of the location, as well as the mix of uses in the neighborhood, resulting in a neighborhood-specific mobility profile and associated energy demand.
- **Mobility energy budget** as a balance credit from the surrounding renewable energy system ("surplus" from central renewable large-scale power plants, which is allocated to the neighborhood per created floor space.

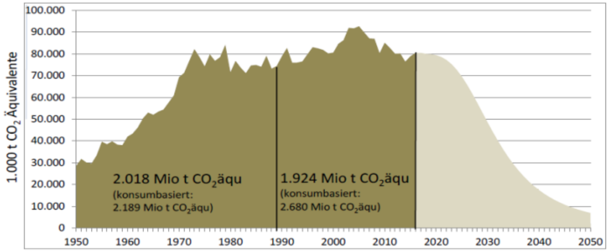
PED Omega: Scope 3 and climate neutrality 2040

Basis target maximum CO2 equiv per human 2040: All human-caused activities are included, all greenhouse gases are included: energy services, "material" services, sinks, etc.

Basis: treaty under international law, global warming to be limited to 1.5, but no more than 2 K compared to pre-industrial times according to Paris 2015 climate conference, i.e. maximum CO2 equiv budget per human by 2050 [Schellnhuber 2015]. With the same distribution over all people in 2017 according to [Meyer, Steininger 2017], this results approximately in 96 t CO2 equiv per person.

Reference to neighborhoods: All measures that can be influenced in neighborhoods and buildings

-> Budget Allocation approach (WIP)



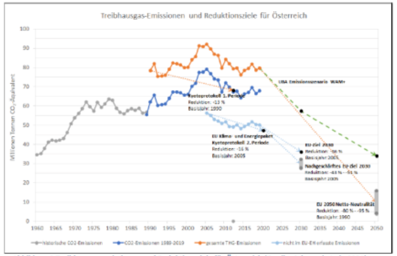
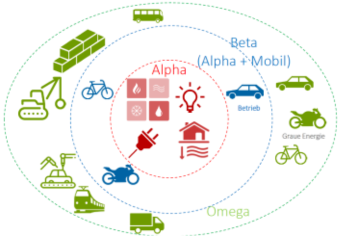


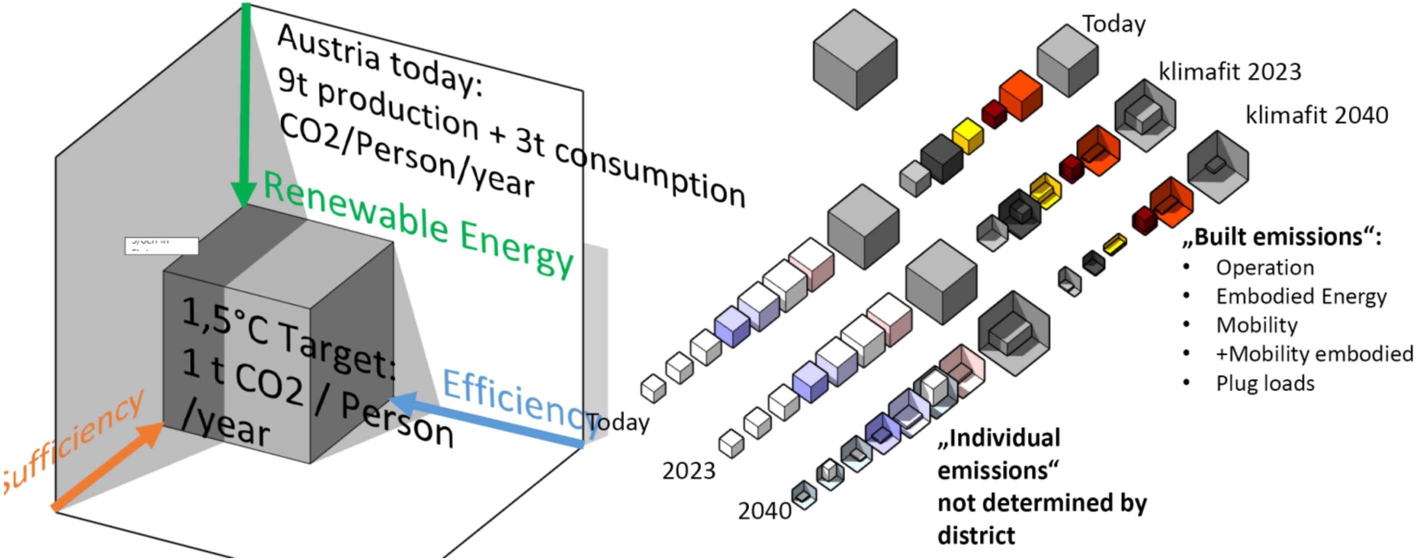
Abbildung 3 Treibhausgasemissionen und Reduktionsziele für Österreich (Quelle: Schwarzl et al., 2021)



„**aspern** klimafit" – the new building standard of the SeeStadt Aspern

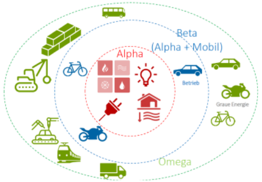
What is a „climate fit" and „future proof" building or district?

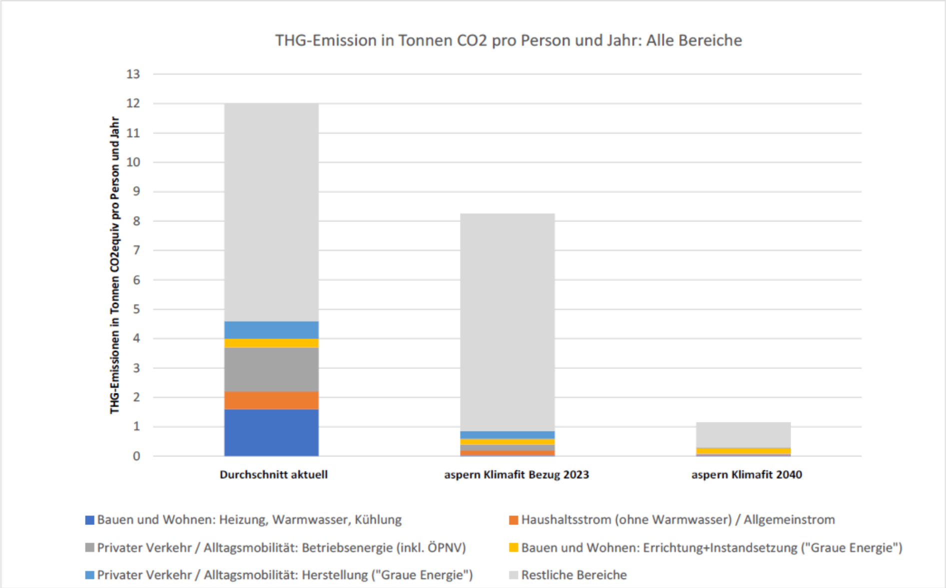
Connect personal and „built" emission **targets**



https://www.aspern-seestadt.at/wirtschaftsstandort/innovation__qualitaet/nachhaltigkeit

PED Omega Emission Target derivation





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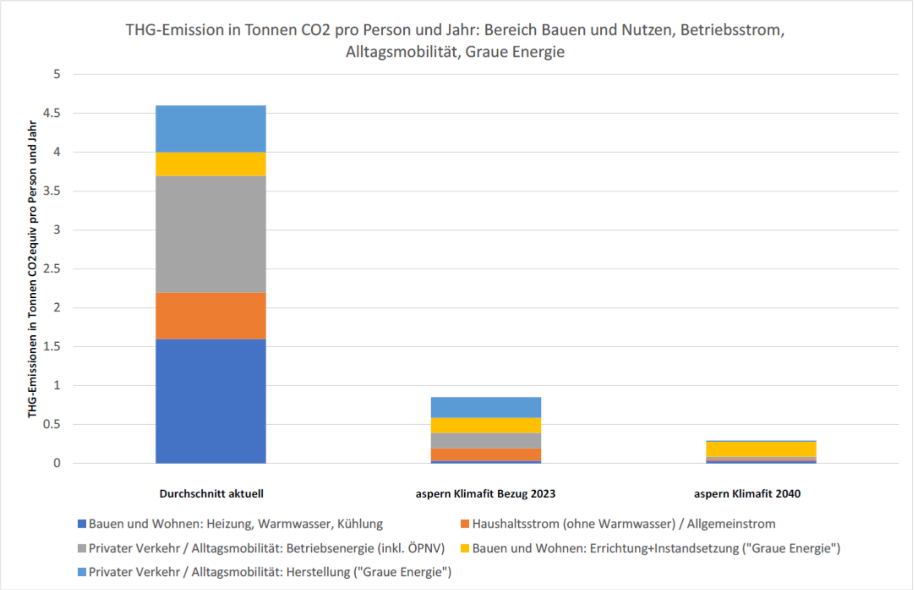
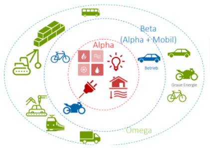


Total CO2 footprint Austria (consumption-related) CO2 footprint that can be influenced by neighborhoods/buildings

On this basis, the maximum CO2 footprint currently (current conversion factors) is 0.8 t CO2 equiv/person a.



PED Omega: Targets

Methodik Zukunftsquartier

The Emisison credit for PED Omega 2023 is 0.8 t CO2equiv/EW a! This must cover all services according to system boundary PED Omega:

- Space conditioning, ventilation, regulation, domestic and operational electricity, etc. (system boundary PEQ Alpha).
- In addition to PED Alpha coverage of motorized individual mobility (system boundary PEQ Beta)
- In addition to PED Beta, coverage of operating energy for everyday public mobility, plus gray energy for buildings over their life cycle and for everyday mobility (PED Omega).

For Austria as a whole (assumption simplified 9,000,000 PE), this results in 7,200,000 t CO2 equiv a, which a total "climate-neutral" building/everyday mobility sector should emit in 2023, or must achieve in the next 17 years (incl. adjustments according to the transformation of the overall energy system, mapped in OIB conversion factors).

The following guidelines are applied for a "fair" allocation:

- Neighborhoods with high space efficiency (FAR) get a credit in terms of CO2 emission budget. (Allocation factor density_PEQ_Omega).
- New development neighborhoods provide at least some of the residential, employment, educational, or commercial needs. Therefore, at least some of the existing CO2equiv budget is shifted from redevelopment to new construction. (Allocation Factor Redevelopment/New Construction_PEQ_Omega).
- Uses away from housing must cope with a significantly higher volume of everyday mobility. (Allocation Factor Destinations Everyday Mobility_PEQ_Omegao

PEQ Omega – Ansatz CO2 Budget

Tabelle 3: CO_2-Global-Budgets ab 2020 für verschiedene Klimaschutzziele und Eintrittswahrscheinlichkeiten. Zuordnung der Pro-Kopf-CO_2-Budgets für Österreich durch Zuweisung des 0,00115 %-Anteils an der Weltbevölkerung. Für die Wohnnutzung wird ein in etwa gleichbleibender Anteil von einem Fünftel angesetzt (aktueller Wert AT: 17 %, siehe Kapitel 1.1). Quellen: (IPCC 2021, SfP S. 41) und eigene Berechnungen. Nähere Angaben finden sich in (Vallentin 2021).

Pfad	Klimaschutzziel (Wahrscheinlichkeit)	CO_2-Global-Budget ab 2020 (IPCC 2021)	Pro-Kopf-CO_2-Budget Österreich	Pro-Kopf-CO_2-Budget Österreich - Wohnen
A	2-Grad (50 %)	1.350 Gt	174 t/P	34,8 t/P (118 %)
B	2-Grad (67 %)	1.150 Gt	148 t/P	29,6 t/P (100 %)
C	1,75 Grad (67 %)	700 Gt	103 t/P	20,6 t/P (61 %)
D	1,5 Grad (67 %)	400 Gt	52 t/P	10,4 t/P (35 %)

Quelle: Ploß, Ochs, Sigg et al: Low-Cost nZEB. Paris-kompatible Mehrfamilienhäuser. Dornbirn 2022

- Aktualisierung auf Basis 2023 erforderlich

PEQ Omega – Ansatz CO2 Budget

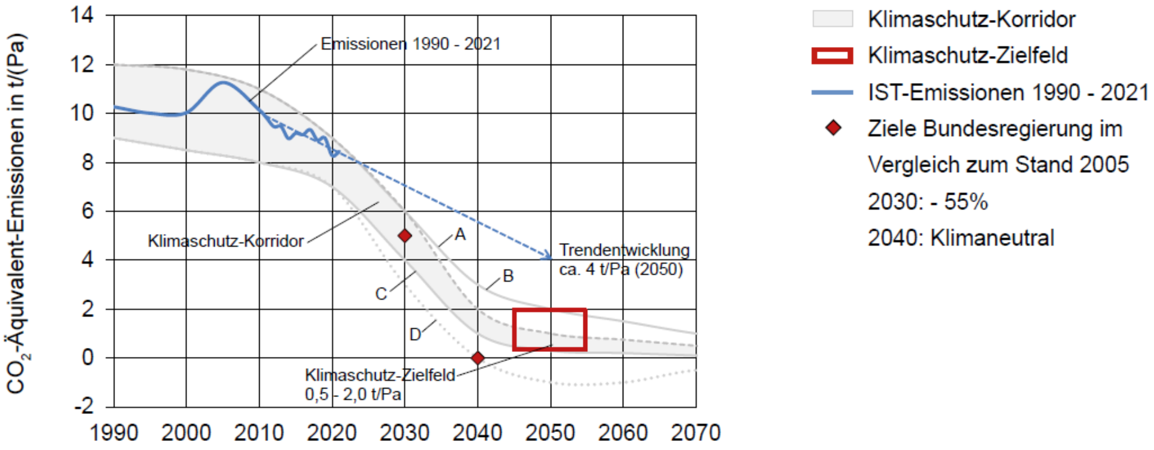


Abbildung 6: Entwicklung der Pro-Kopf-CO_2-Äquivalent-Emissionen in Österreich 1990 – 2021. Zur besseren Einordnung sind die o.g. 4 Pfade A – D sowie der daraus gebildete Klimaschutz-Korridor (grau hinterlegter Bereich) und das Zielfeld (rotes Rechteck) eingetragen. Darüber hinaus sind eine Trendentwicklung und die Klimaschutzziele der österreichischen Bundesregierung eingetragen.

Quelle: Ploß, Ochs, Sigg et al: Low-Cost nZEB. Paris-kompatible Mehrfamilienhäuser. Dornbirn 2022

- Aktualisierung auf Basis 2023 erforderlich

PEQ Omega – CO2 Budget versus CO2 2050

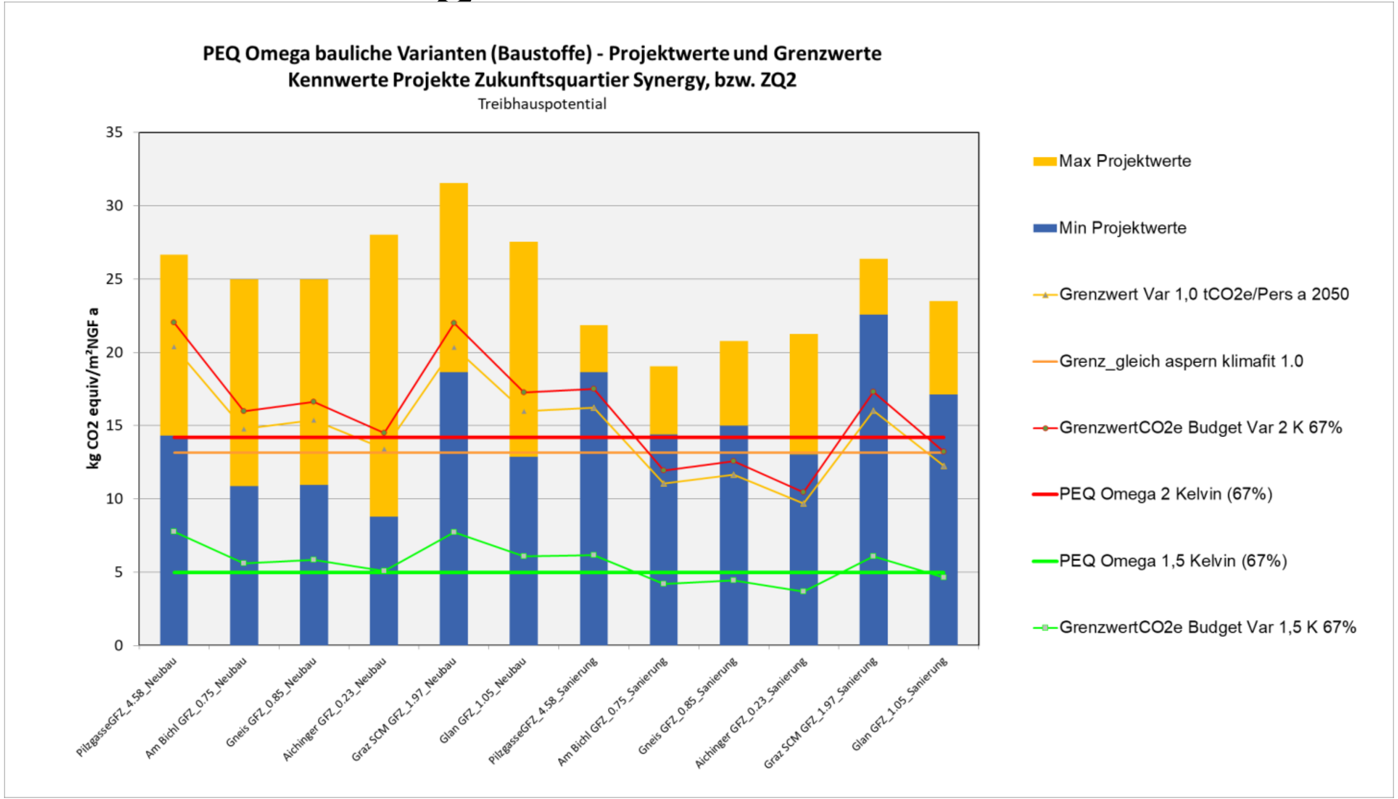
…werte CO2 …ts bis 2050 (Referenz 202

	Bestand heute		75.58	kg /m²NGFa		Gleichverteilung				
	Zielwert heute		13.14	kg /m²NGFa						
rel	0%	Emissionstyp			Anteile am Gebäudesektor		Emissionsanteile kg/m²NGF/			
	Systemische CO2 Reduktio	Bestand	Omega ZW Saniert	Sanierungsrate	Bestand	Omega ZW saniert	Bestand	Omega ZW saniert	Kumulierte emissionen	
	100%	75.6	13.1	0%	100%	0%	75.5801328	0	75.6	
	96.7%	73.1	12.7	3%	97%	3%	70.6497888	0.41930543	146.6	
	93.3%	70.5	12.3	3%	93%	7%	65.8857206	0.80969324	213.3	
	90.0%	68.0	11.8	3%	90%	10%	61.2879293	1.17116344	275.8	
	86.7%	65.5	11.4	3%	87%	13%	56.8564142	1.50371602	334.2	
	83.3%	63.0	11.0	3%	84%	17%	52.5911754	1.80735099	388.6	
	80.0%	60.5	10.5	3%	80%	20%	48.4922129	2.08206834	439.1	
	76.7%	57.9	10.1	3%	77%	23%	44.5595267	2.32786807	486.0	
	73.3%	55.4	9.6	3%	74%	26%	40.7931167	2.54475019	529.4	
	70.0%	52.9	9.2	3%	70%	30%	37.1929831	2.7327147	569.3	
	66.7%	50.4	8.8	3%	67%	33%	33.7591258	2.89176158	605.9	
	63.3%	47.9	8.3	3%	64%	36%	30.4915447	3.02189085	639.5	
	60.0%	45.3	7.9	3%	60%	40%	27.3902399	3.12310251	670.0	
	56.7%	42.8	7.4	3%	57%	43%	24.4552115	3.19539655	697.6	
	53.3%	40.3	7.0	3%	54%	46%	21.6864593	3.23877297	722.5	
	50.0%	37.8	6.6	3%	51%	50%	19.0839834	3.25323178	744.9	
	46.7%	35.3	6.1	3%	47%	53%	16.6477838	3.23877297	764.8	
	43.3%	32.8	5.7	3%	44%	56%	14.3778605	3.19539655	782.3	
	40.0%	30.2	5.3	3%	41%	59%	12.2742135	3.12310251	797.7	
	36.7%	27.7	4.8	3%	37%	63%	10.3368428	3.02189085	811.1	
	33.3%	25.2	4.4	3%	34%	66%	8.56574833	2.89176158	822.6	
	30.0%	22.7	3.9	3%	31%	69%	6.96093018	2.7327147	832.2	
	26.7%	20.2	3.5	3%	27%	73%	5.52238833	2.54475019	840.3	
	23.3%	17.6	3.1	3%	24%	76%	4.25012277	2.32786807	846.9	
	20.0%	15.1	2.6	3%	21%	79%	3.1441335	2.08206834	852.1	
	16.7%	12.6	2.2	3%	17%	83%	2.20442052	1.80735099	856.1	
	13.3%	10.1	1.8	3%	14%	86%	1.43098384	1.50371602	859.1	
	10.0%	7.6	1.3	3%	11%	89%	0.82382344	1.17116344	861.1	
	6.7%	5.0	0.9	3%	8%	92%	0.38293934	0.80969324	862.3	
	3.3%	2.5	0.4	3%	4%	96%	0.10833152	0.41930543	862.8	Temperaturhub
	0.0%	0.0	0.0	3%	1%	99%	0	0	862.8	1.94
		1171.5	203.7	99%					kg/m²NGF/30a	K
								vs ploss Budgets		
								2° 50%	1095.9	kg/m²NGF/30a
								2° 67%	932.2	kg/m²NGF/30a
								1,75° 67%	566.9	kg/m²NGF/30a
								1,5° 67%	327.5	kg/m²NGF/30a

- Bezug Energiedienstleistungen PEQ Omega
- Sanierungsrate konstant, 1% der Gebäude wird nicht energetisch saniert, alle anderen auf Standard PEQ! andere Verteilungen möglich
- Annahme, dass Konversionsfaktor Treibhausgase Energiequellen (vor allem Strom, aber auch Biomasse inkl. Aufbringung und Instandhaltung) im Jahr 2050 0 kg CO2e/kWh betragen.
- Umrechnung Personen und NGF näherungsweise laut aktueller Statistik
- NGF Wachstum bis 2050 noch nicht berücksichtigt

Fazit: Mit der Annahme 800 kg CO2e/Person Jahr 2023 ergibt sich eine Gesamtemission PEQ Omega von 862,8 kg CO2e/m²NGF 30a mit kontinuierlicher Sanierungsrate bis 2050.

PEQ Omega

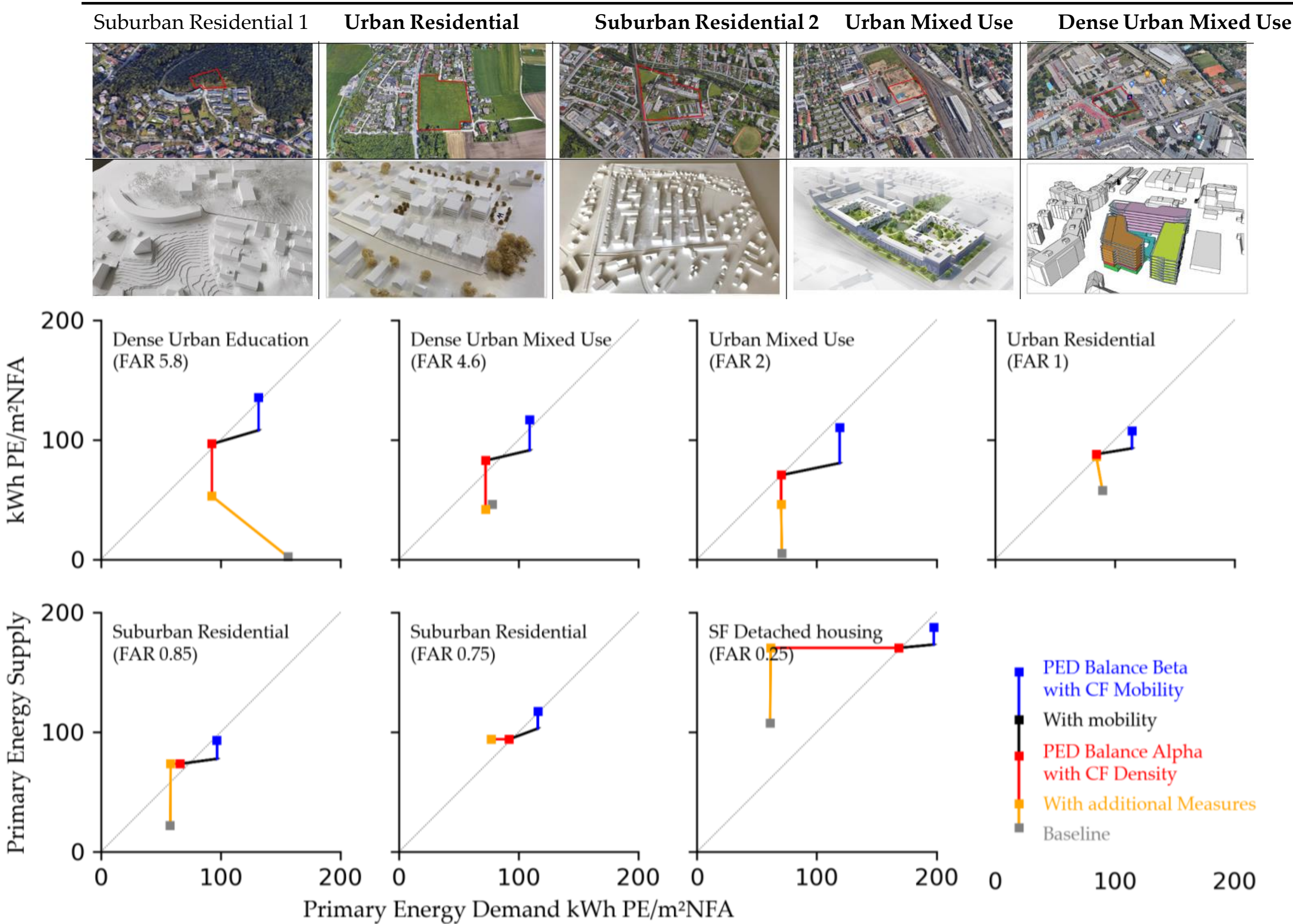


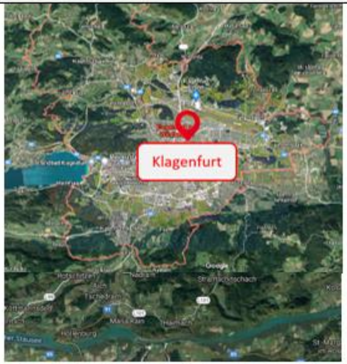
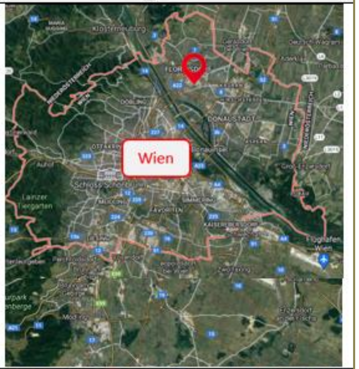
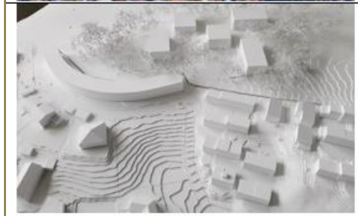
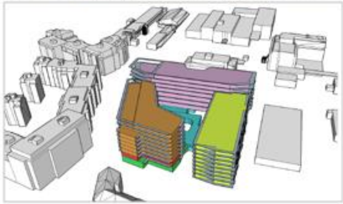
Characteristics Projects 2023 (White Paper 2022)High-efficiency building (PH)Characteristics variable with allocation of use and densityNo optimization Mobility across basic assumptionsComment: delete allocation new construction/renovation.Influence C storage has positive effect on low densities (is logical).

Examples

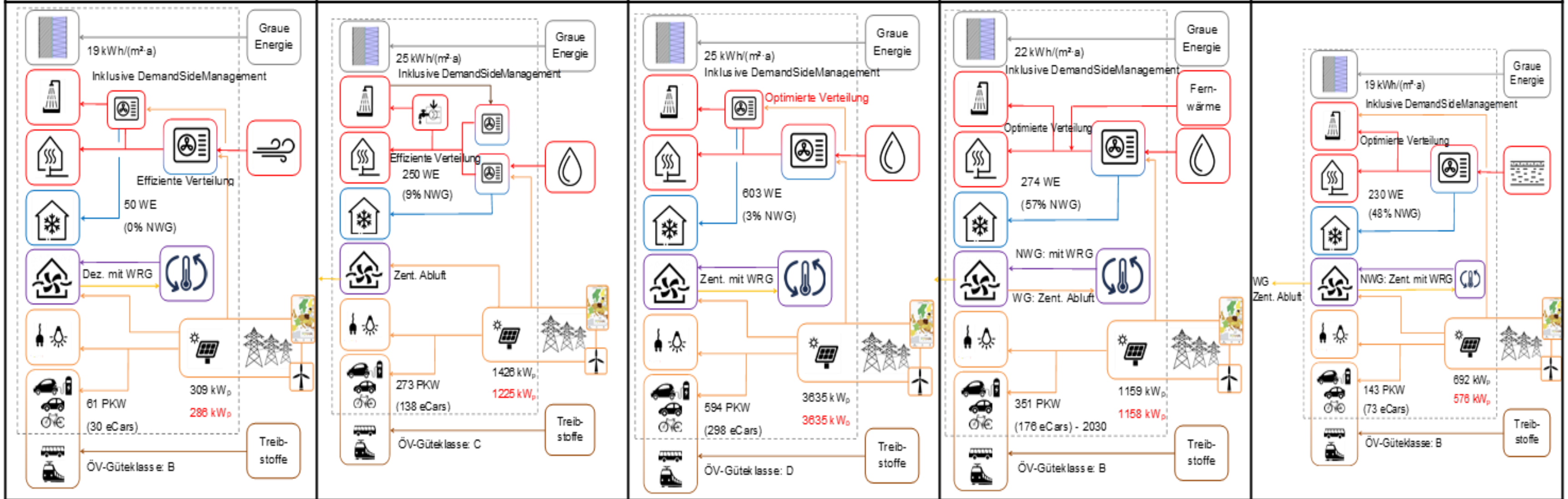
WITHOUT virtual context factors (CF), none of them are PED

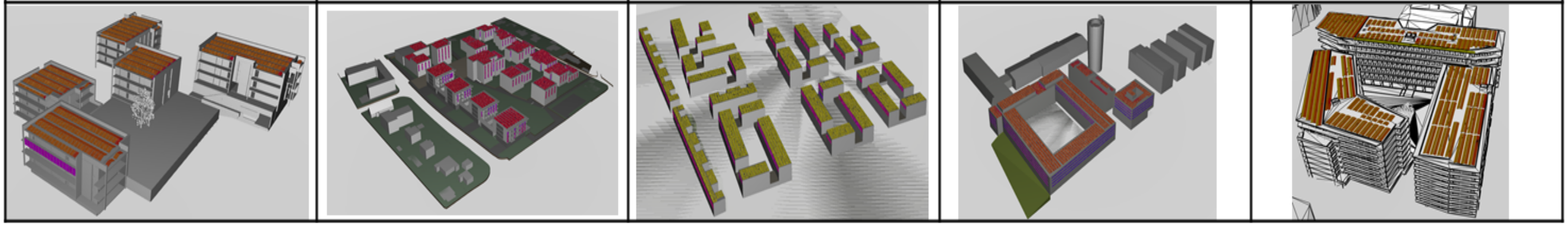
WITH CF, all districts realize their maximum potential and can include Mobility!

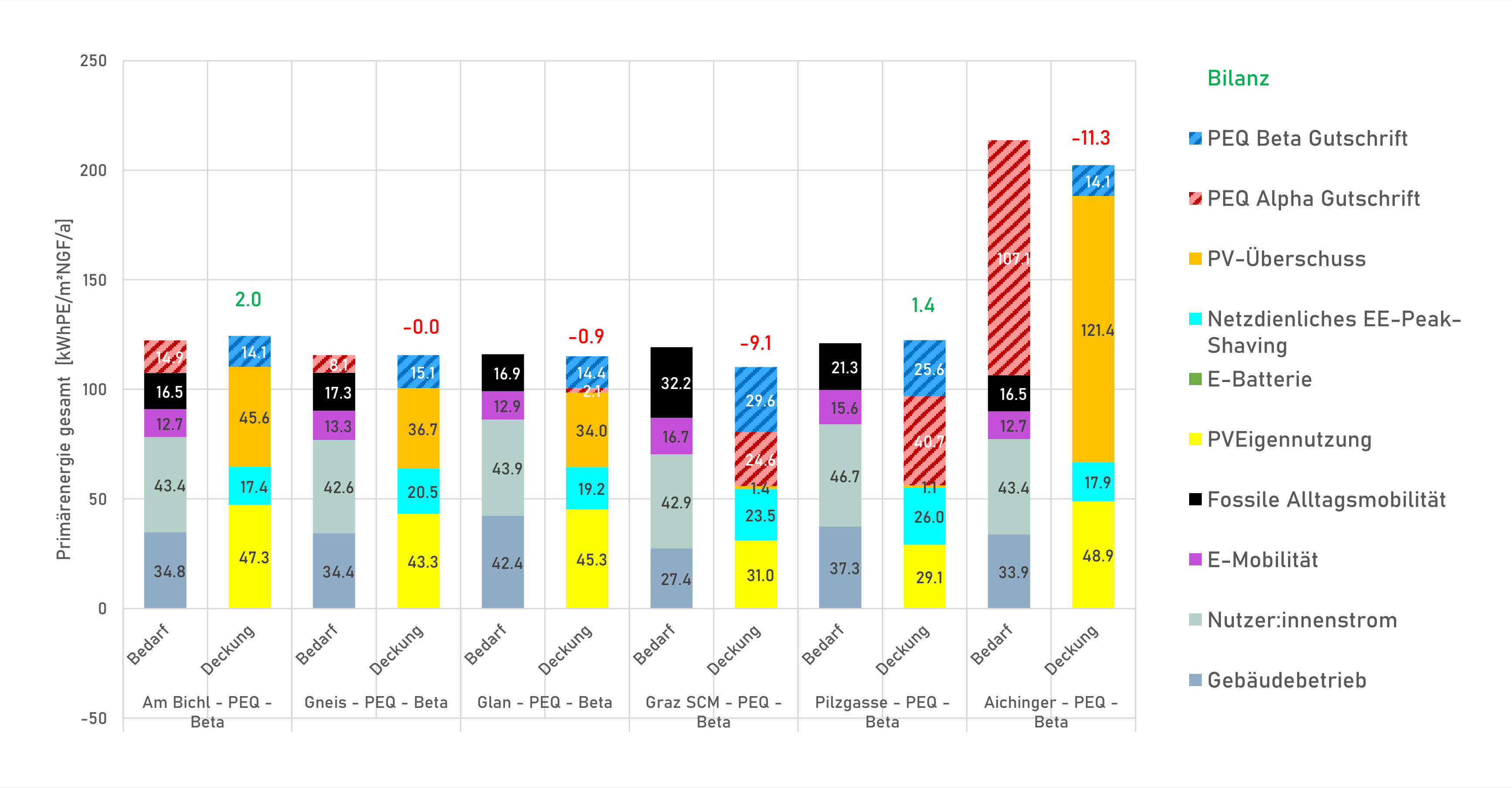


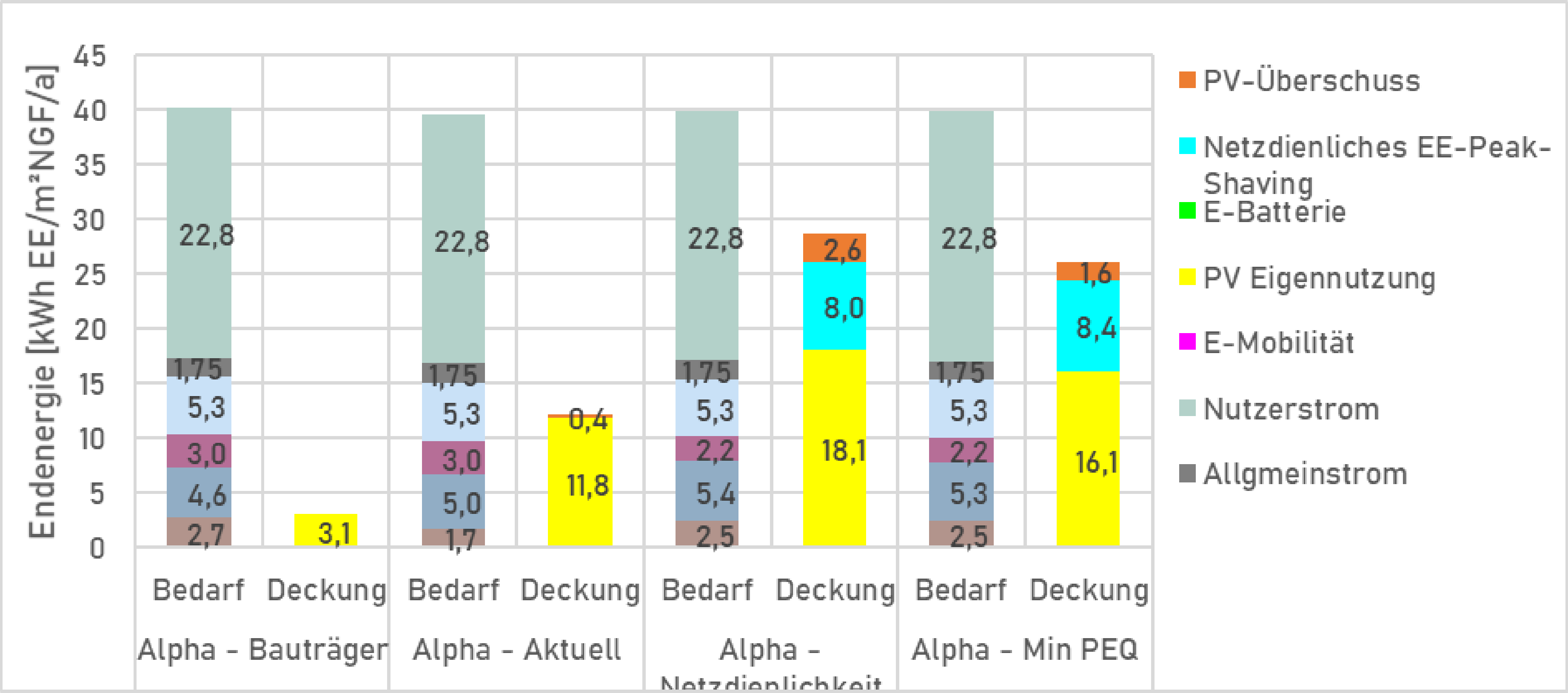
Am Bichl III	GEWIN Gneis	An der Glan	Smart City Mitte	Pilzgasse 33
				
				
				

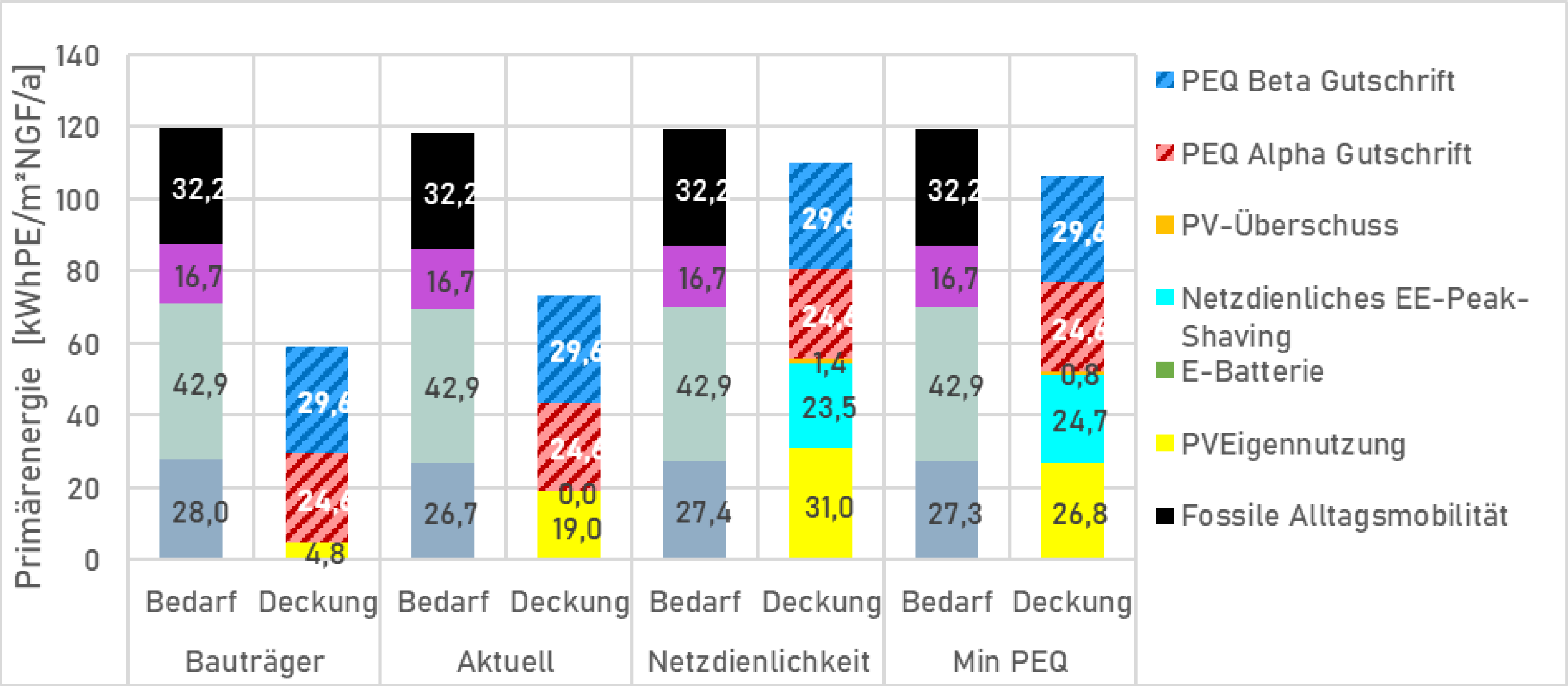
Am Bichl	GEWIN Gneis	An der Glan	Smart City Mitte	Pilzgasse 33



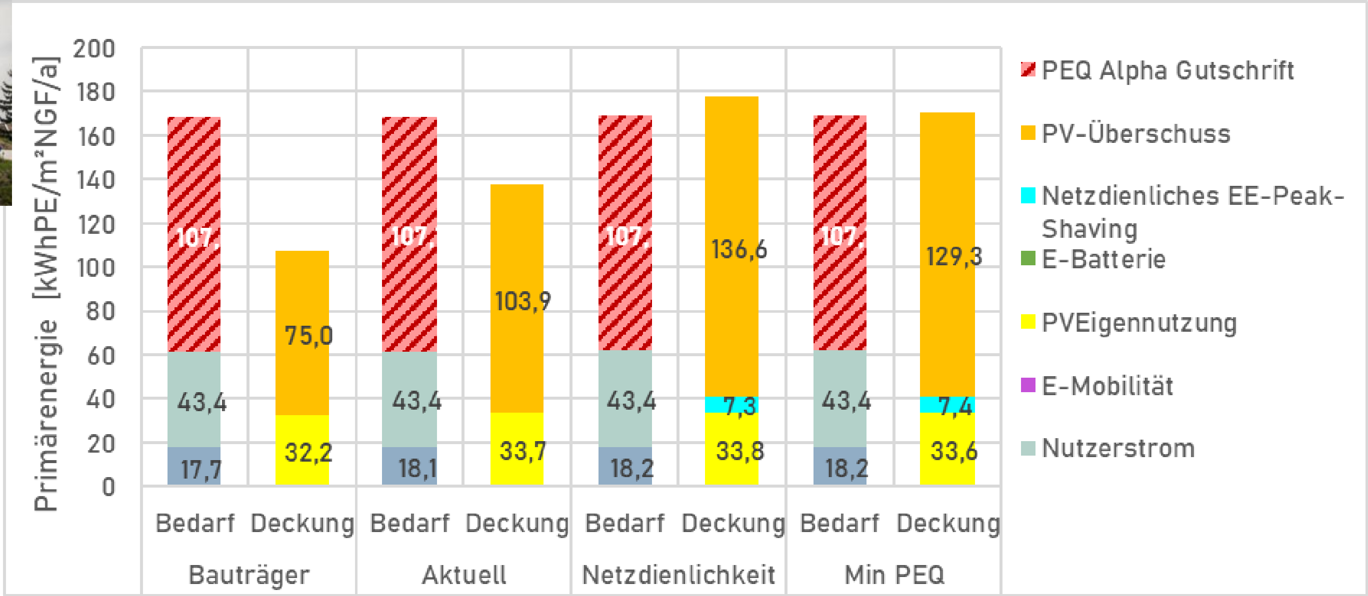


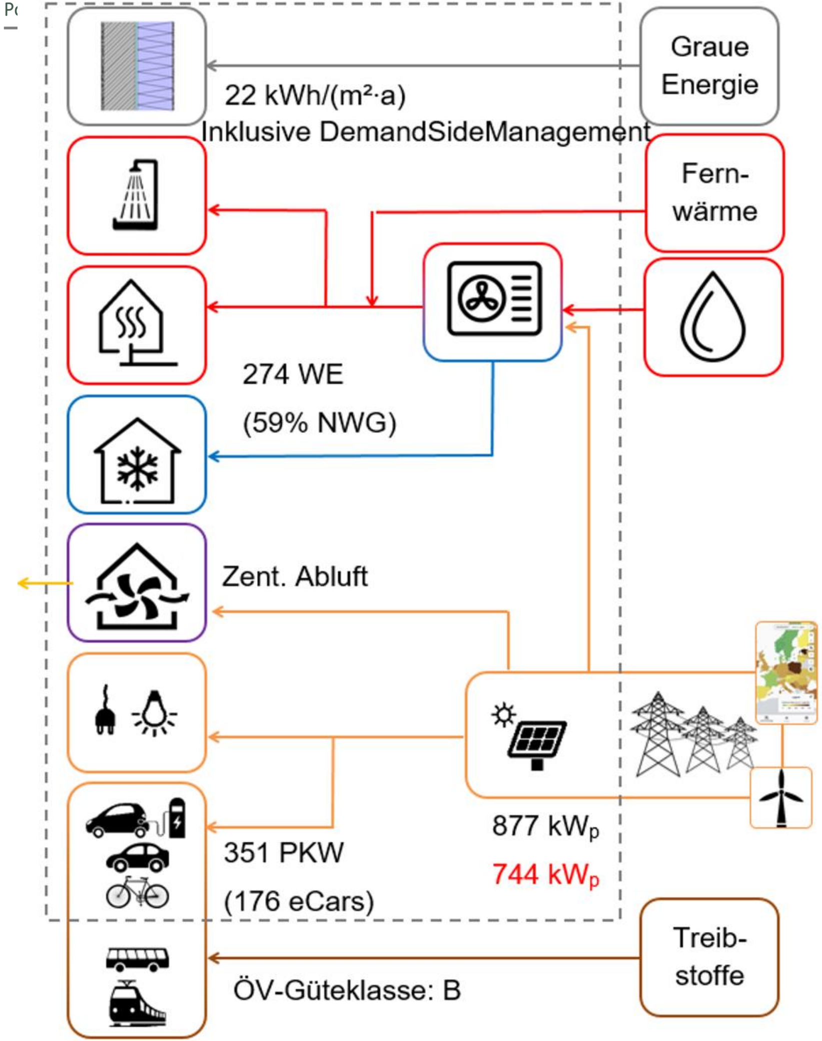

Bilanz
PEQ Beta Gutschrift
PEQ Alpha Gutschrift
PV-Überschuss
Netzdienliches EE-Peak-Shaving
E-Batterie
PVEigennutzung
Fossile Alltagsmobilität
E-Mobilität
Nutzer:innenstrom
Gebäudebetrieb
Primärenergie gesamt [kWhPE/m²NGF/a]
250
200
150
100
50
0
-50
Bedarf
Deckung
Am Bichl - PEQ - Beta
Gneis - PEQ - Beta
Glan - PEQ - Beta
Graz SCM - PEQ - Beta
Pilzgasse - PEQ - Beta
Aichinger - PEQ - Beta
2.0
-0.0
-0.9
-9.1
1.4
-11.3
14.9
16.5
12.7
43.4
34.8
14.1
45.6
17.4
47.3
8.1
17.3
13.3
42.6
34.4
15.1
36.7
20.5
43.3
16.9
12.9
43.9
42.4
14.4
2.1
34.0
19.2
45.3
32.2
16.7
42.9
27.4
29.6
24.6
1.4
23.5
31.0
21.3
15.6
46.7
37.3
25.6
40.7
1.1
26.0
29.1
107.1
16.5
12.7
43.4
33.9
14.1
121.4
17.9
48.9

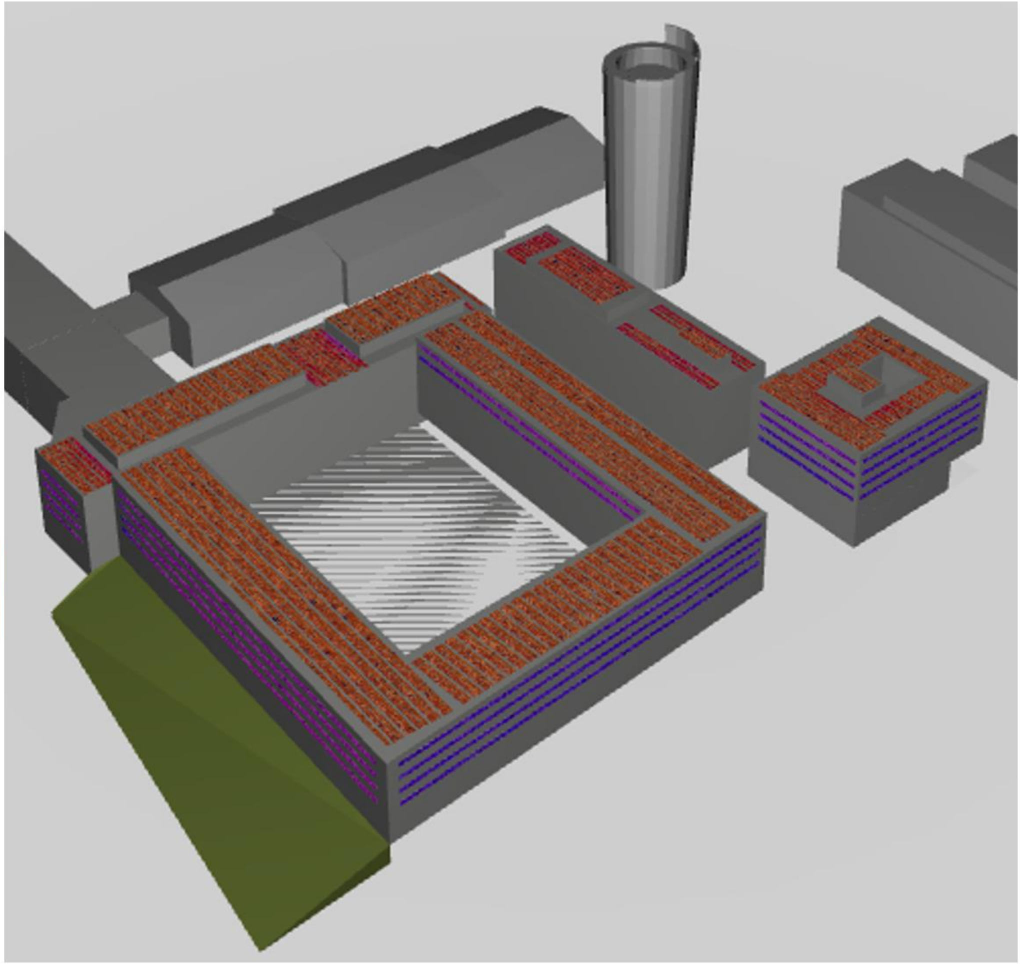

Endenergie [kWh EE/m²NGF/a]
45
40
35
30
25
20
15
10
5
0
22,8
1,75
5,3
3,0
4,6
2,7
3,1
22,8
1,75
5,3
3,0
5,0
1,7
0,4
11,8
22,8
1,75
5,3
2,2
5,4
2,5
2,6
8,0
18,1
22,8
1,75
5,3
2,2
5,3
2,5
1,6
8,4
16,1
Bedarf
Deckung
Bedarf
Deckung
Bedarf
Deckung
Bedarf
Deckung
Alpha - Bauträger
Alpha - Aktuell
Alpha - Netzdienlichkeit
Alpha - Min PEQ
PV-Überschuss
Netzdienliches EE-Peak-Shaving
E-Batterie
PV Eigennutzung
E-Mobilität
Nutzerstrom
Allgmeinstrom


Primärenergie [kWhPE/m²NGF/a]
140
120
100
80
60
40
20
0
32,2
16,7
42,9
28,0
29,6
24,6
4,8
32,2
16,7
42,9
26,7
29,6
24,6
0,0
19,0
32,2
16,7
42,9
27,4
29,6
24,6
1,4
23,5
31,0
32,2
16,7
42,9
27,3
29,6
24,6
0,8
24,7
26,8
Bedarf
Deckung
Bedarf
Deckung
Bedarf
Deckung
Bedarf
Deckung
Bauträger
Aktuell
Netzdienlichkeit
Min PEQ
PEQ Beta Gutschrift
PEQ Alpha Gutschrift
PV-Überschuss
Netzdienliches EE-Peak-Shaving
E-Batterie
PVEigennutzung
Fossile Alltagsmobilität

SFH Detached Housing




Graue Energie
22 kWh/(m²·a)
Inklusive DemandSideManagement
Fern-wärme
274 WE
(59% NWG)
Zent. Abluft
877 kW$_p$
744 kW$_p$
351 PKW
(176 eCars)
Treib-stoffe
ÖV-Güteklasse: B

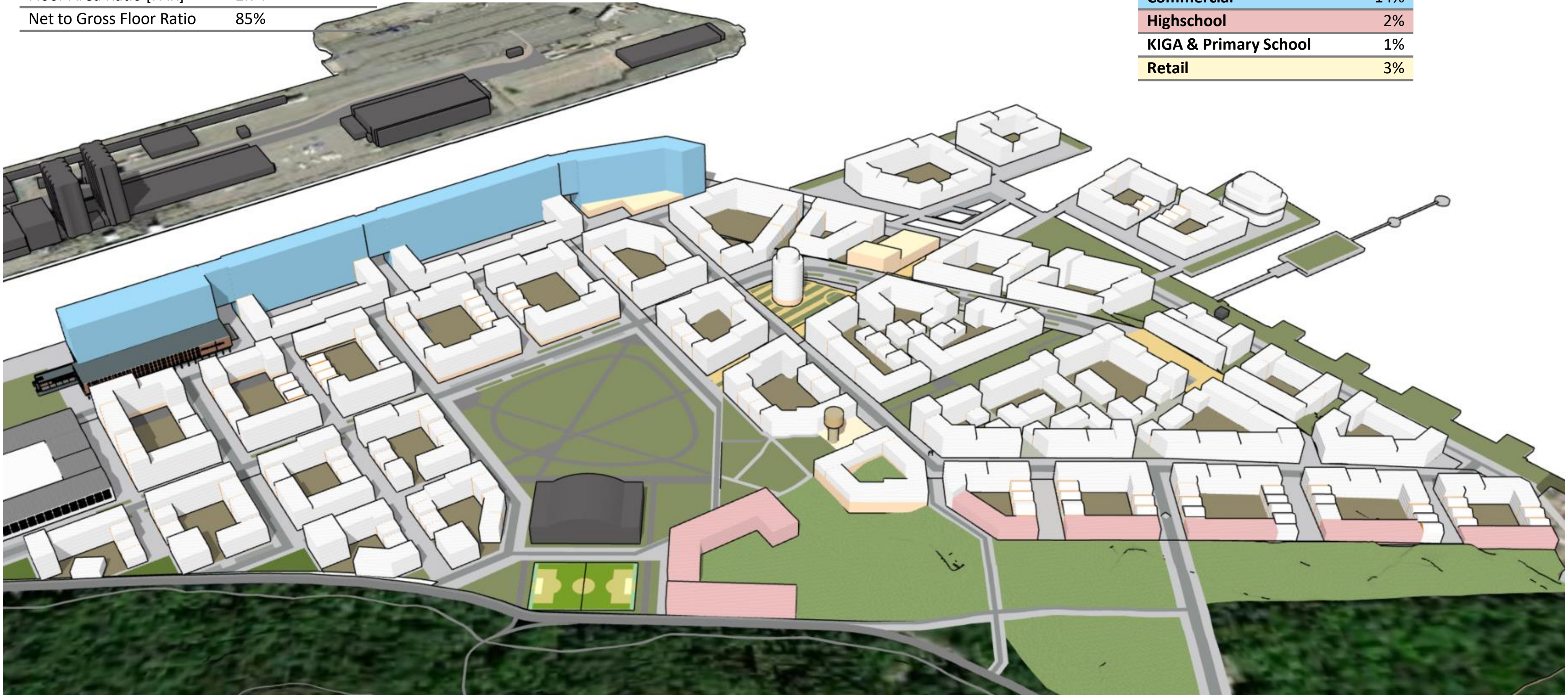


SRS Loudden

District Area	55.56	ha
Gross Floor Area	647 331	m²

District Plot Area	236471	m²
Building Storeys (avg)	5.2	
Floor Area Ratio [FAR]	2.74	
Net to Gross Floor Ratio	85%	

Residential	**80%**
Commercial	14%
Highschool	2%
KIGA & Primary School	1%
Retail	3%



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Floor Area Ratio [FAR]	**2.74**	
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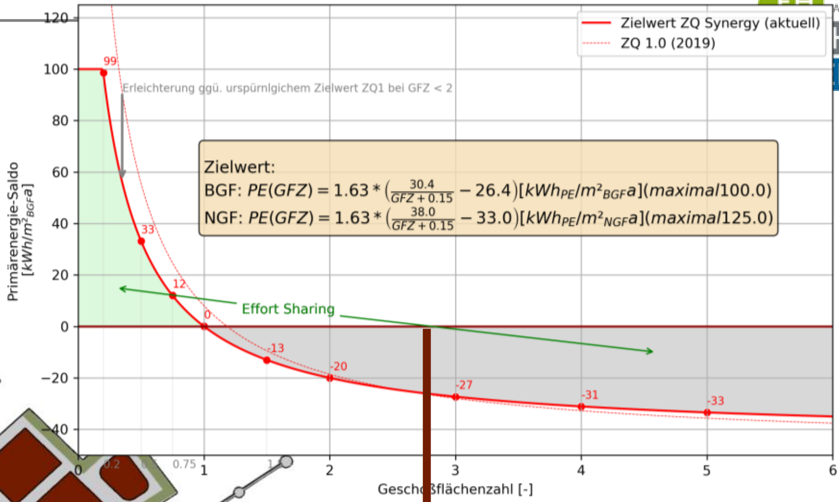


PED Alpha

Context Factor *due to Density*

27.5	kWh/m²GFAa
32.3	kWh/m²NFAa

Example

100% Roof utilization ->

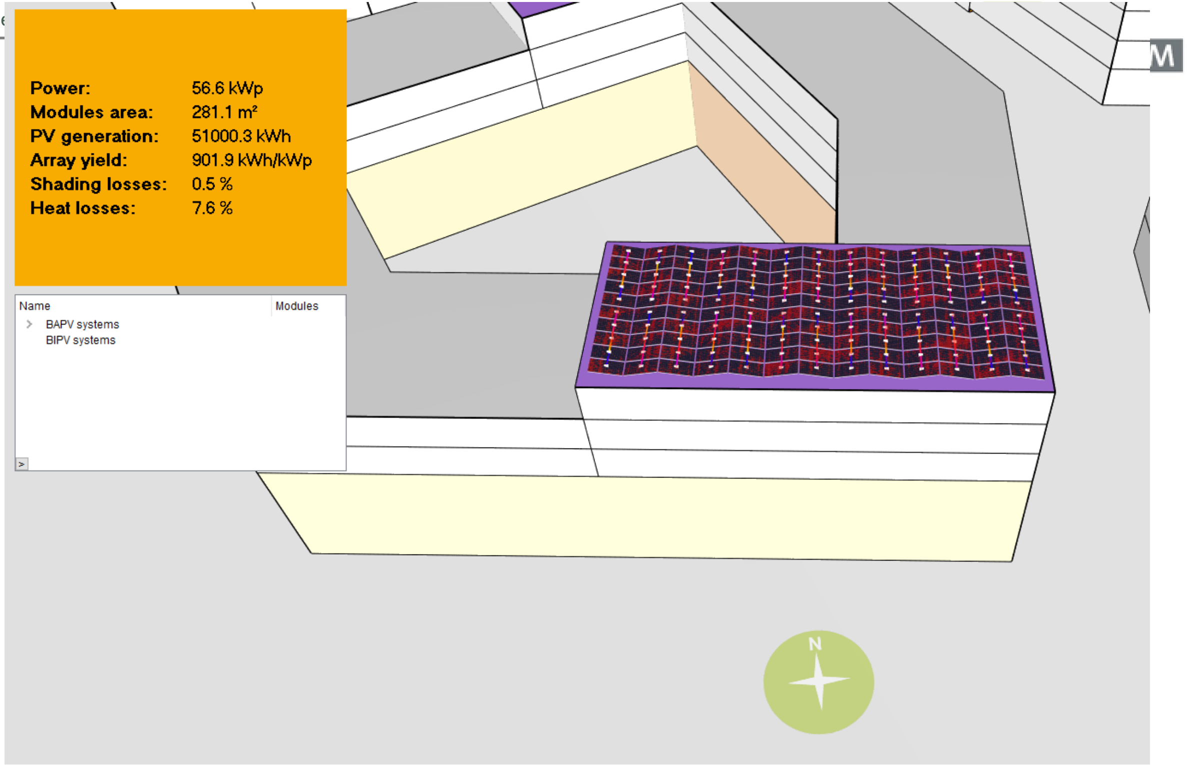
PV Model		
Available Roof Area	124313	m²
Weather	Stockholm Bromma 2020	
Source	meteonorm 8	
Annual Global Horizontal Irradiation	988	kWh/m²
Module	Sunpower SPR-435 1046x2067	mm
Annual Yield	901	kWh/kWp
Max Utilization	19.017	MWp
	138	kWh/m²Roof
	26.5	kWh/m²GFA
Utilization	25%	
Installed Power	4.754	MWp
PV Production	6.6	kWh/m²GFA
	7.78	kWh/m²NFA

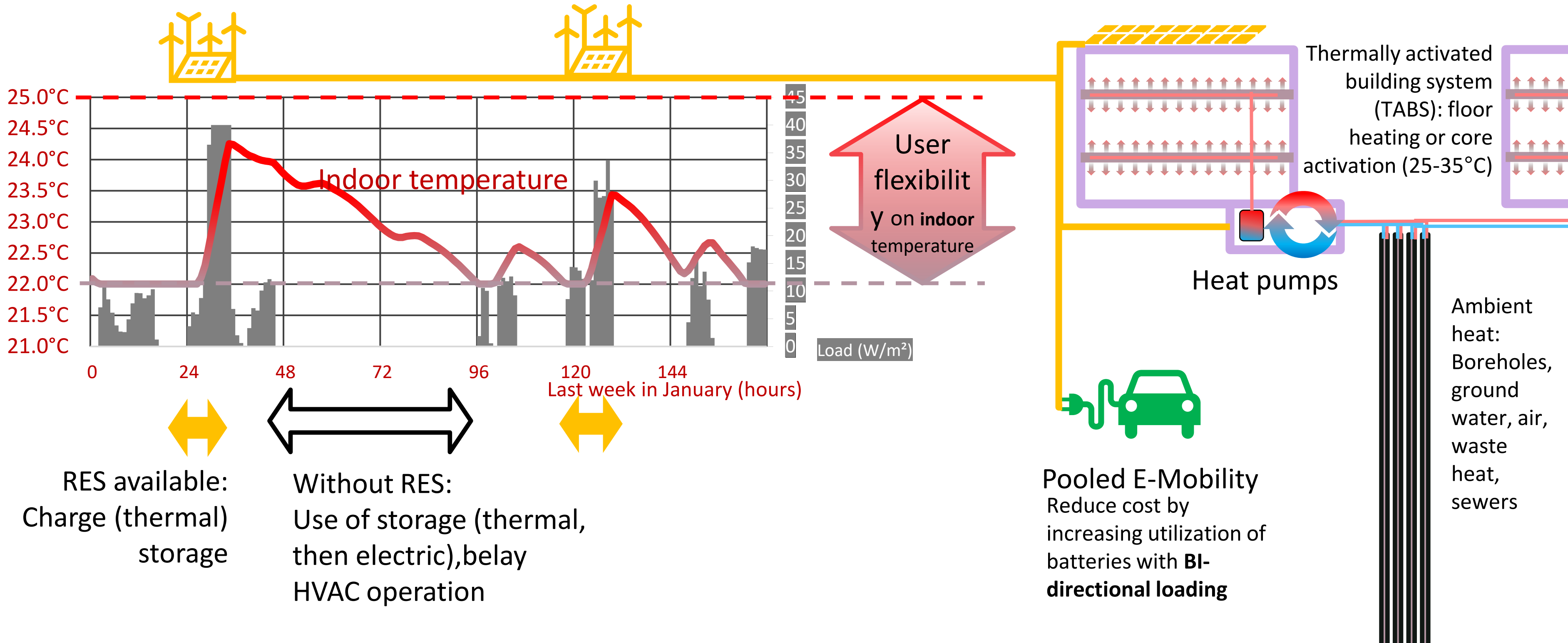
Analyzed Variants:

-25% all roofs

-70% all roofs

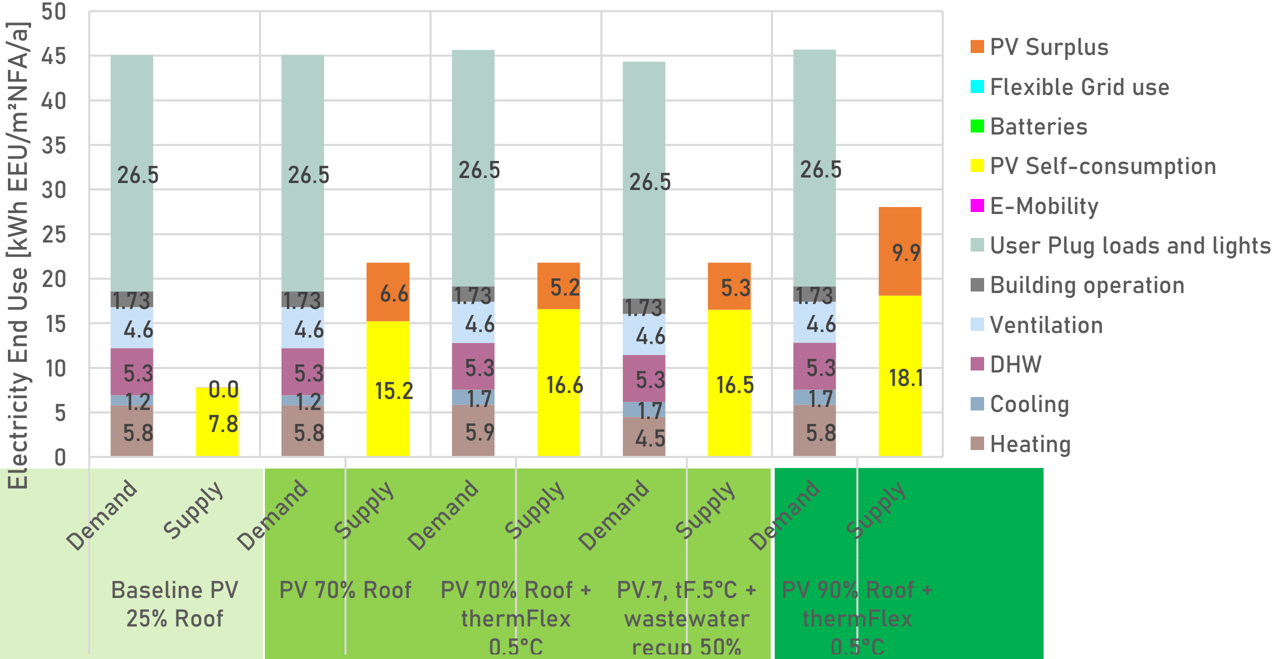
-90% all roofs




25.0°C
24.5°C
24.0°C
23.5°C
23.0°C
22.5°C
22.0°C
21.5°C
21.0°C
0
24
48
72
96
120
144
Last week in January (hours)
Indoor temperature
45
40
35
30
25
20
15
10
5
0
Load (W/m²)
User flexibility on indoor temperature
RES available: Charge (thermal) storage
Without RES: Use of storage (thermal, then electric),belay HVAC operation
Thermally activated building system (TABS): floor heating or core activation (25-35°C)
Heat pumps
Ambient heat: Boreholes, ground water, air, waste heat, sewers
Pooled E-Mobility
Reduce cost by increasing utilization of batteries with **BI-directional loading**

jose: Wwrecup 70-80%

Analyzed Variations
Electricity End Use



Baseline (BL):
- 25% Roof PV Utilization
- SRS Hulls
- GS Heatpumps

70% Roof PV:
- as BL
- with thermal Flexibility of
  - 0.5 K
  - 2 K
- w/ 50% wastewater recuperation

90% Roof PV Utilization
- as before
- 0.5 thermal flexibility

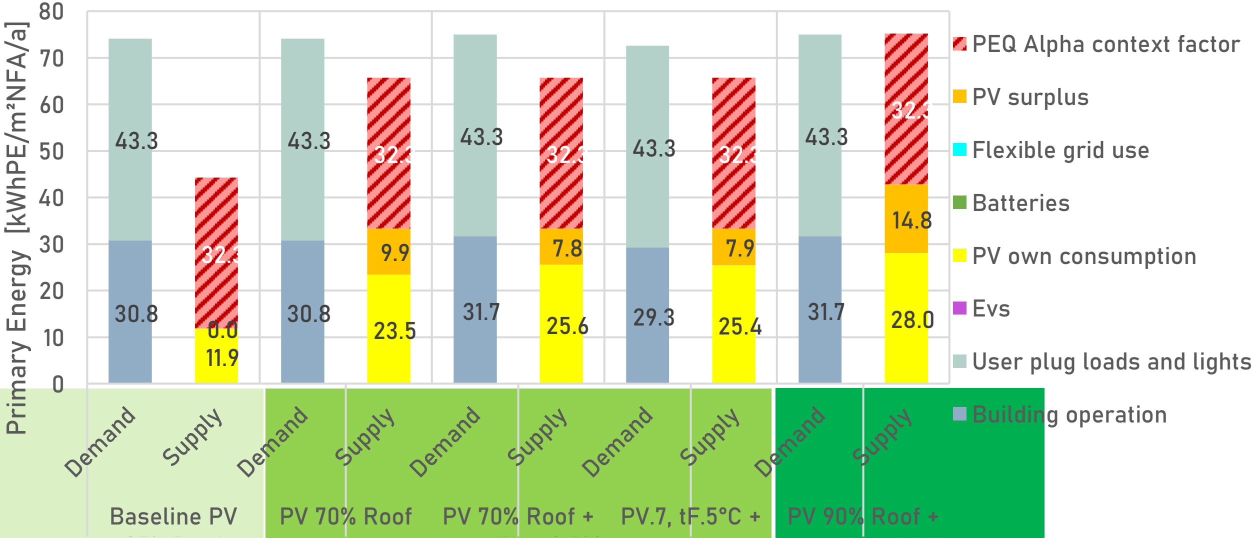
Parameters

Thermal Hull			
Thermal Transmittance	Wall	0.15	W/m²K
	Windows	0.87	W/m²K
	Roof	0.1	W/m²K
	Floor	0.16	W/m²K
Visible Transmittance		0.7	-
Thermal active mass		204	Wh/m²K
Ventilation			
Heat recovery		90%	
Energy Supply	Heat Pump (ground source, water)		
Heating	COP	4.25	
	Transmission losses	5%	
	Temp Set Point	22°C	
Cooling	COP	4.75	
	Transmission losses	5%	
	Temp Set Point	25°C	
DHW	COP	3	
Energy Demands			
Heating		**23.2**	kWh/m²a
Cooling		**5.4**	kWh/m²a
DHW		**11.1**	kWh/m²a
Plug Loads (per usage)	District avg	**26.5**	kWh/m²a
	Residential	**26.7**	kWh/m²a
	Office	**19.4**	kWh/m²a
	HighSchool	**14.1**	kWh/m²a
	Primary & Kindergarden	**6.1**	kWh/m²a
	Retail Supermarket	**30.8**	kWh/m²a
	Retail	**4.4**	kWh/m²a

Analyzed Variations
Primary Energy Balance

a PED can supply its own demand with local RES, both sides have equal sides

Parameters		
Conversion factors		
Electricity Primary Energy	kWhPE/kWhUE	1.6
Electricity GHG	kgCO2eq/kWhUE	0.146



Baseline (BL):
- 25% Roof PV Utilization
- GS Heatpumps

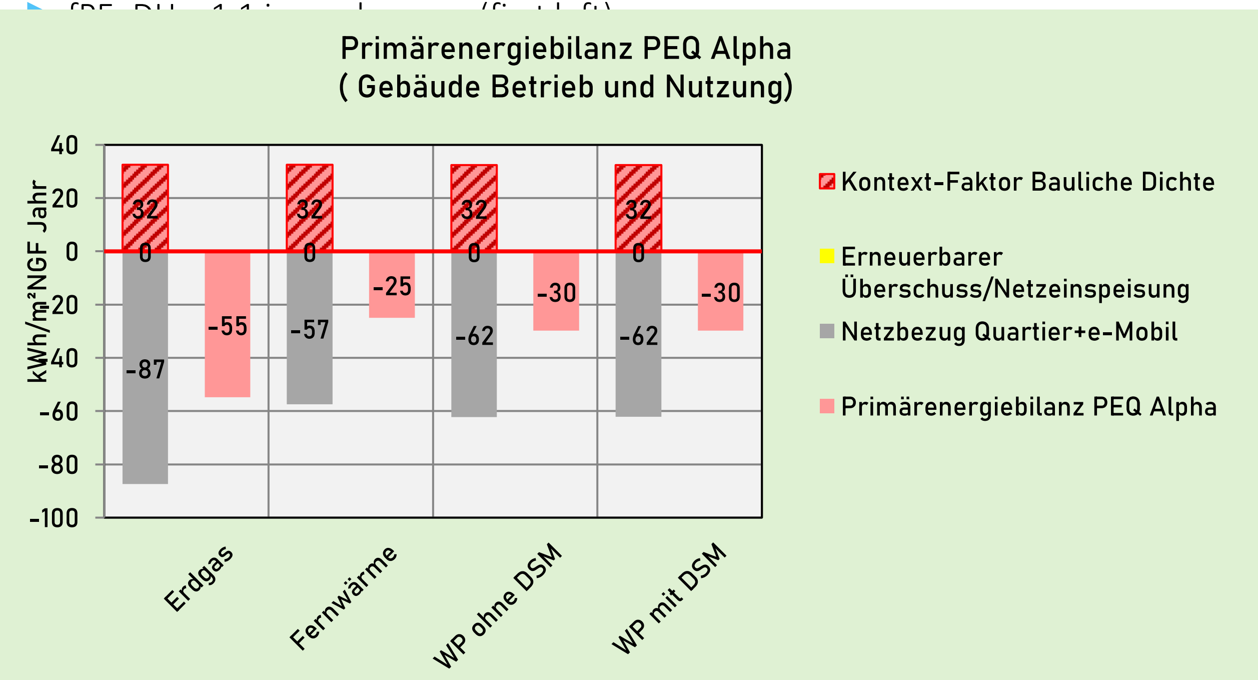
70% Roof PV:
- as BL
- with thermal Flexibility of
  - 0.5 K
  - 2 K
- w/ 50% wastewater recuperation

90% Roof PV Utilization
- as before
- 0.5 thermal flexibility

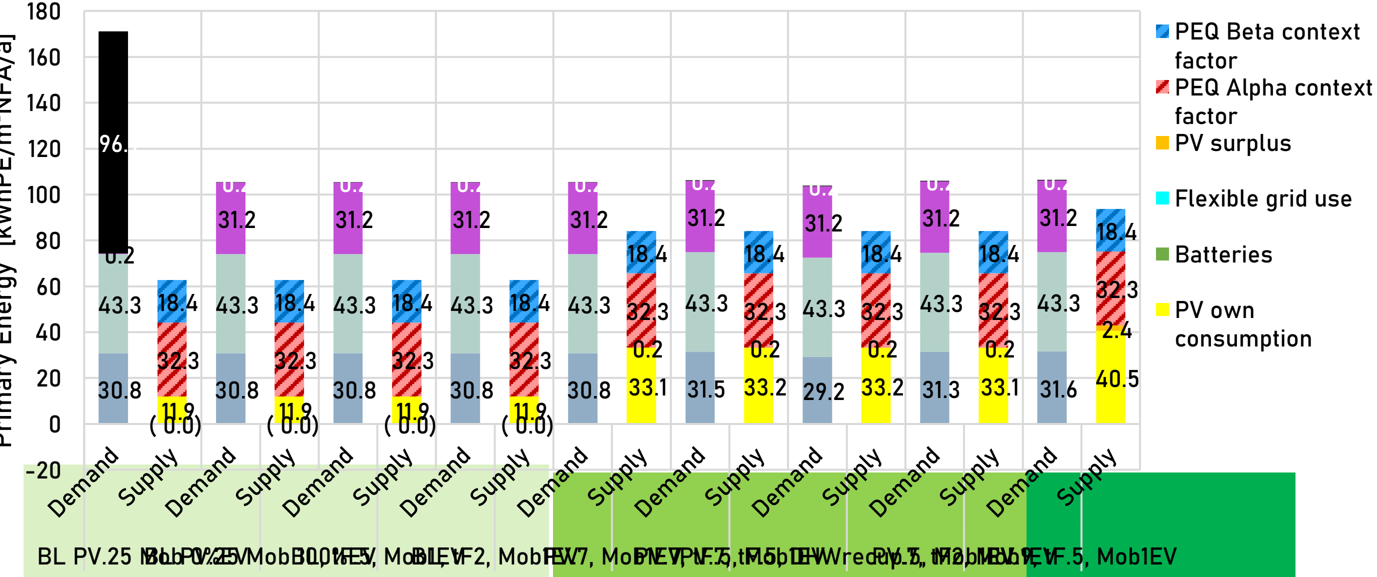
Parameters		
Conversion factors		
Electricity Primary Energy	kWhPE/kWhUE	1.6
Electricity GHG	kgCO2eq/kWhUE	0.146
District Heating var1	kWhPE/kWhUE	1.1
District Heating var2	kWhPE/kWhUE	0.33

DH Variant

- District heating performance depends on conversion factor



Analyzed Variations
Mobility



Baseline (BL):
- 25% Roof PV Utilization
- 0% EVs
- 100% EVs
- 100% EVs + thermalFlexibility .5K
- 100% EVs + thermalFlexibility 2K

70% Roof PV: all100%EV
- thermal Flexibility 0.5 K
- thermal Flexibility 2 K
- w/ 50% wastewater recuperation

90% Roof PV Utilization thermal Flexibility 0.5 K

Parameters

Conversion factors		
Electricity Primary Energy	kWhPE/kWhUE	1.6
Electricity GHG	kgCO2eq/kWhUE	0.146

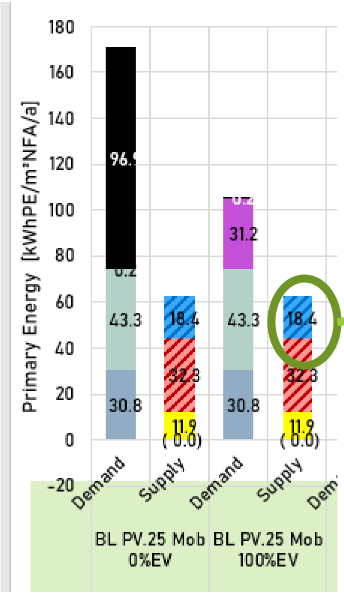
Mobility	
Residents	10334PAX
EVs (on site, domestic and incoming)	3000
Annual individual motorized mobility	11000Pkm/a

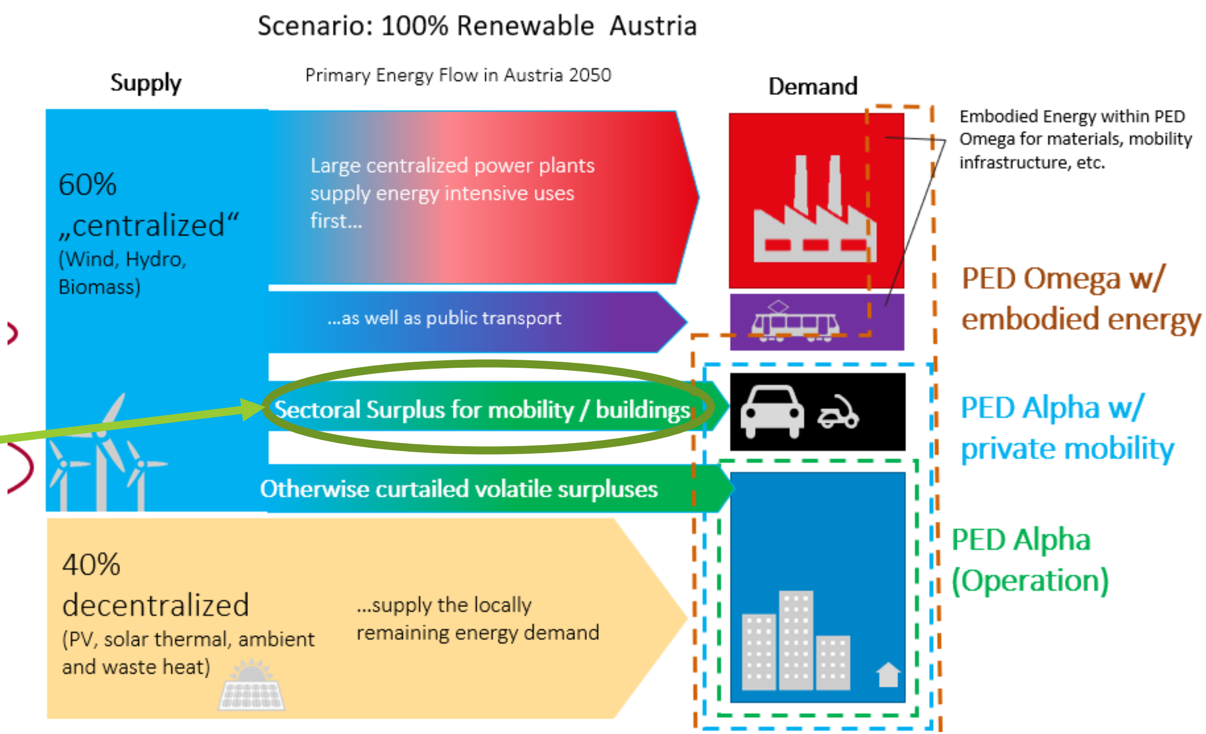
Specific energy demand and context factor BETA uses Austrian, but should depend on Swedish Floor usage density

Context Factor should also reflect Renewability of future Swedish Energy System, not Austrian

Specific energy demand and context factor BETA
uses **Austrian**, but should depend on **Swedish Floor usage density**

Context Factor should also reflect **Renewability of future Swedish Energy System**, not Austrian





Main points of the Austrian Proposal

- Quantitative Definition!
- PED Target Score depends on local potential in the form of district density
- PED Score improves with Energy Flexibility measures
- PED Score can be connected to national / EU climate and energy goals for the building sector

- Cities4PED Proposal: Devise 1 EU unified definition **method**, different national parameter values and final PED target score requirements

Sources

- Development and application in a number of research projects within City of the Future, JPI Europe, Aspern 3420:
- Future Quarter 1.0, ZQ TakeOff, ZQ Synergy (completed), Future Quarter 2.0 incl. White Paper PEQ - Guide (completed) and ZQ3Demo (ongoing), Cities4PEDs (completed), TRANS-PED (completed), INTERACT (completed), Citizens4PEDs (ongoing); SimplyPositive (ongoing), aspern klimafit (completed).
- Core team FH Technikum Wien, Renewable Energy; Urban Innovation Vienna (UIV); Institute of Building Research and Innovation (IBRI); In some projects SIR, Drexel reduced, TB Becker, Hacon etc.
- Detailbeschreibung der Methodik in **White Paper PEQ – Leitfaden: Plus-Energie-Quartier. Definition und Operationalisierung (in Erscheinung in www.nachhaltigwirtschaften.at)**

- S. Schneider, T. Zelger, D. Sengl, und J. Baptista, „A Quantitative Positive Energy District Definition with Contextual Targets“, *Buildings*, Bd. 13, Nr. 5, Art. Nr. 5, Mai 2023, doi: 10.3390/buildings13051210.