Modelling of Positive Energy Districts
-Rapid assessment tools to evaluate PEDs Potentials-

PEDs, Essentielle Komponenten für "Net Zero" City
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Urban Energy Systems Analysis

Urban energy systems are key driver of the clean energy transition

Aim: to support city decision making in developing sustainable clean energy transition strategies for climate neutral cities

Key drivers

- Energy efficiency improvement
- Fuel Switching: clean fuels (BG, H2,..)
- Electrification of end use
- Promoting local/regional renewables
- Decarbonisation of heat and power sectors
- **Others:** Digitalization, flexibilization, sector coupling

Target groups: cities, energy utilities, real states developers , industry

- Urban Energy Demand-Supply Analysis
- Sustainable Urban Energy Strategies Formulation
- EE and RE Assessment, DSM& Smart Solutions
- **Decarbonization and Mitigation Scenarios**
- Positive Energy Districts **(PEDs)**
- Energy Infrastructure optimization
- Urban Energy-Water-Food Nexus
- KPIs-based monitoring & evaluation concept

MOTIVATION

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Why PEDs are important for climate neutral cities?

- Cities are responsible for 75% of global energy consumption and 80% of GHG emission,
- Cities are recognised as a high enabler of sustainable development within SDGs (G7, G11, G12, G13)
  →G11: make cities and human settlements inclusive, sustainable and resilient)
- Building sector –being main energy consumer and CO_2 emitter- is the driver of the sought urban energy system transformation, given its high potential for energy efficiency improvement and local RE integration.

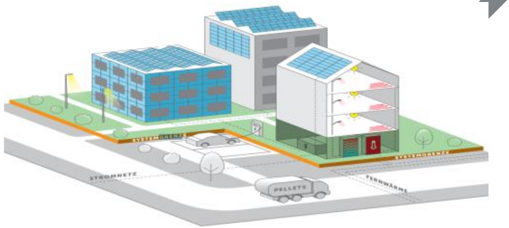
PEDs promise to be the enabler of the conceived future visions of Climate Neutral Cities

- ➢ committed to a sustainable low-carbon transformation path;
- ➢ driven by efficient solutions for buildings and mobility;
- ➢ keen to ensure high liveability and affordability of urban services for all residents.

Numerous international, European and Austrian initiatives are working to develop solutions, plans and roadmap for deploying PEDs.

MOTIVATION

concepts, definition and activities on PEDs



- PEDs represent an innovative urban energy concept to support the desired energy system transformation at district scale.
- PEDs-concept exceeds the state of the art of PEBs and strives to integrate different building types to harness their existing synergies.
- PEDs require the highest level of energy saving, full dependency on local RE energy supply and flexible interaction with regional energy system.
- PEDs still need to overcome a multitude of interdisciplinary challenges covering technological, financial, regulatory and societal aspects.

Key aspects determining the type of PED

- Site, boundaries, and climate conditions
- Available local RE supply and flexibility options,
- Typology and type of buildings mix,
- Socio-economic activities and district population density.

FLEXIBLE APPROACH FOR SCREENING THE POTENTIAL OF PEDS IN URBAN AREAS

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1. Identification of relevant urban typologies

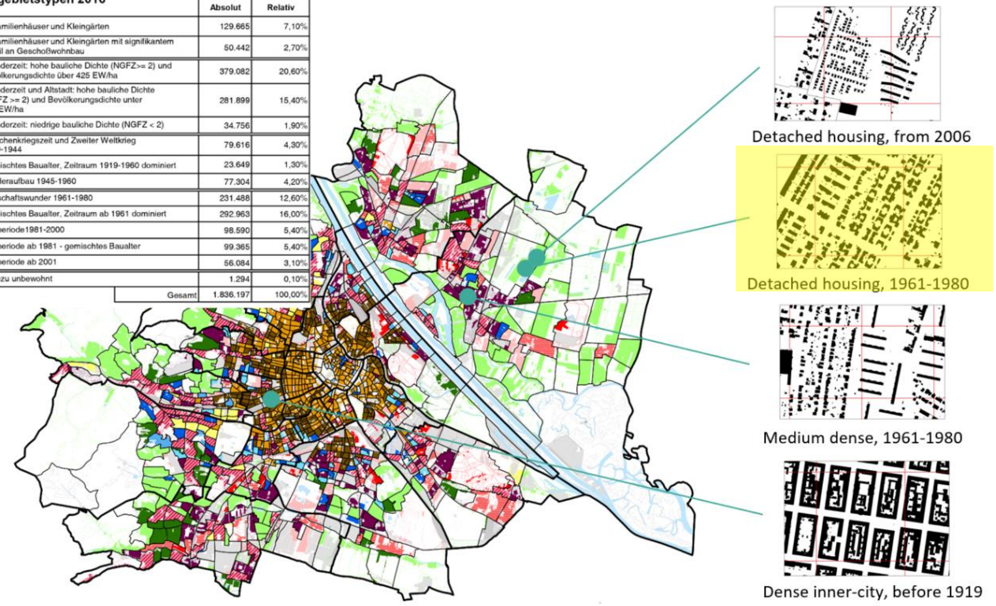
2. Data collection as input for the MAPED tool using GIS-based tools to extract area boundaries, population, built-up area, building footprints etc.

3. Assessment with **MAPED Tool**

4. Analyses of different supply options and related conditions/challenges for implementation

Wohngebietstypen 2016

		Einwohner	
		Absolut	Relativ
1	Einfamilienhäuser und Kleingärten	129.665	7,10%
2	Einfamilienhäuser und Kleingärten mit signifikantem Anteil an Geschoßwohnbau	50.442	2,70%
3	Gründerzeit: hohe bauliche Dichte (NGFZ>= 2) und Bevölkerungsdichte über 425 EW/ha	379.082	20,60%
4	Gründerzeit und Altstadt: hohe bauliche Dichte (NGFZ >= 2) und Bevölkerungsdichte unter 425 EW/ha	281.899	15,40%
5	Gründerzeit: niedrige bauliche Dichte (NGFZ < 2)	34.756	1,90%
6	Zwischenkriegszeit und Zweiter Weltkrieg 1919-1944	79.616	4,30%
7	Gemischtes Baualter, Zeitraum 1919-1960 dominiert	23.649	1,30%
8	Wiederaufbau 1945-1960	77.304	4,20%
9	Wirtschaftswunder 1961-1980	231.488	12,60%
10	Gemischtes Baualter, Zeitraum ab 1961 dominiert	292.963	16,00%
11	Bauperiode1981-2000	98.590	5,40%
12	Bauperiode ab 1981 - gemischtes Baualter	99.365	5,40%
13	Bauperiode ab 2001	56.084	3,10%
14	nahezu unbewohnt	1.294	0,10%
	Gesamt	1.836.197	100,00%



- **Detached housing 1961-1980 (EFH Dicht), (91% SFH, 9% TH/MFH)**
- Detached housing constructed from 2006 (**EFH Neubau**) (100% SFH)
- Medium dense area 1961 and 1980 (**Wirtschaftswunder**) (63% SFH, 5% TH, 32% MFH)
- Dense inner-city area (**Gründerzeit**), built before 1919 (almost 100% MFH)

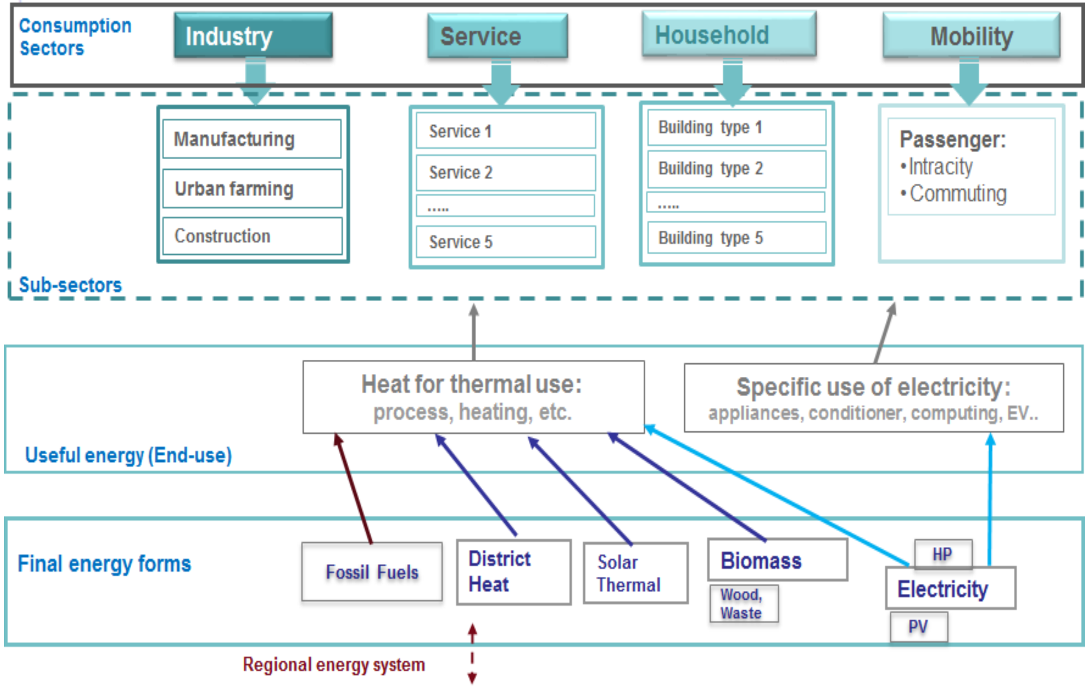
MAPED (Model for Analysis of Positive Energy Districts)

Main Input Data:

- **Demographic, social data**: population, dw size, and type.
- **Climate data**: (HDD) and (CDD)
- **Technological data**: U-values of building envelope, efficiency& penetration rates of FE by end-use
- **Current Specific energy consumption data**: for all end-use (SH, WH, Cooking, lighting, appl.
- **Potential of local renewables**: PV + ST on roof top area; PV on facades, open land area, transport infrastructure area in the district, monthly solar irradiation.

Main Drivers of Transformation to PED

- Energy efficiency improvement for all end-uses
- Effective building refurbishment following building standard OIB RL6
- Electrification and decarbonisation
- Shifting space heating to HP + ST
- Increasing the DW share for space cooling
- Assumed interaction with regional electric grid.
- No change in population, Dw size, HDD and CDD



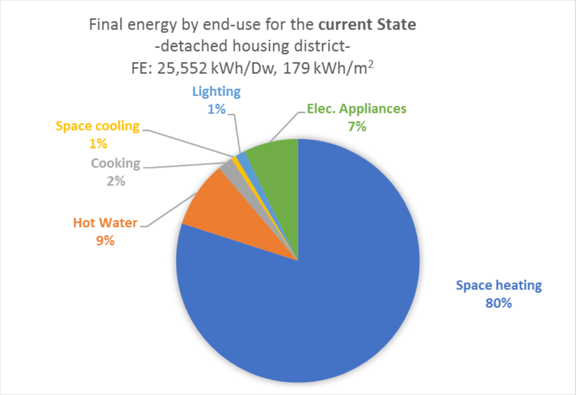
Following the End-use Approach

Link to Publication: 10.3390/en14154449

	EFH_1960er		Gründerzeit		Mischnutzung hoch		EFH Neubau	
Main construction period	1961 - 1980		before 1919		before 1919		2006 - 2010	
								
Total Area (m²)	62.500		62.500		62.500		62.500	
Gross floor area (m²)	23.761		133.667		260.472		19.396	
Residential area (%)	99%		99%		32%		100%	
Service Area (%)	1%		1%		68%		0%	
Built-up Area (%, m²)	27%	17.167	50%	31.516	65%	40.435	17%	10.423
Trafic Area (%, m²)	17%	10.329	30%	18.716	29%	17.838	16%	10.209
Green Area (%, m²)	56%	35.004	0%	0	0%	0	9%	5.446
Water-bodies Area (%, m²)	0%	0	0%	0	0%	0	0%	0
Population (Personen)	312		2.512		441		376	
Residential Units	154		1.429		252		143	
Apartment type-1 (Geb. 1 Whg)	91%		0%		4%		99%	
Apartment type-2 (Geb 2 Whg)	2%		1%		9%		1%	
Apartment type-3 (Geb 3 + mehr Whg)	7%		99%		83%		0%	
Sevice Sector Floor Area (m²)	0		0		148.324		0	
Share of floor area of Offices	0%		0%		43%		0%	
Share of floor area of Commerical/ Shopping	0%		0%		29%		0%	
Share of floor area of Hotels & Resturants	0%		0%		12%		0%	

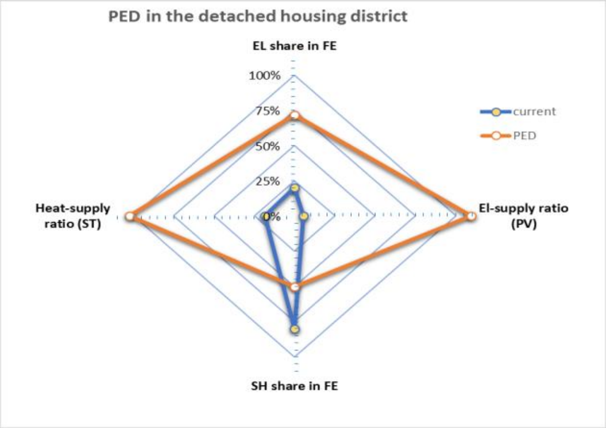
SELECTED RESULTS

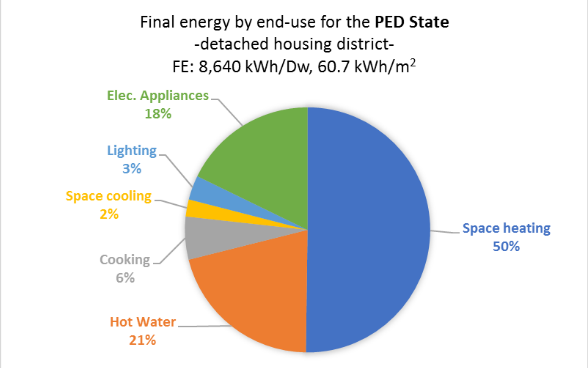
Detached housing 1961-1980 (EFH Dicht), (91% SFH, 9% TH/MFH)

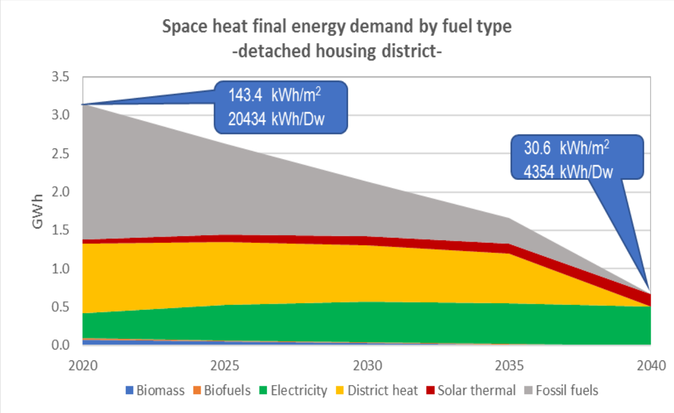


The detached housing district has the potential to become a PED of the 2nd kind with an annual positive energy balance of 109% for PV-electricity supply and 102.5% for ST-heat supply.

Up to 30% of intracity E-mobility can be covered.







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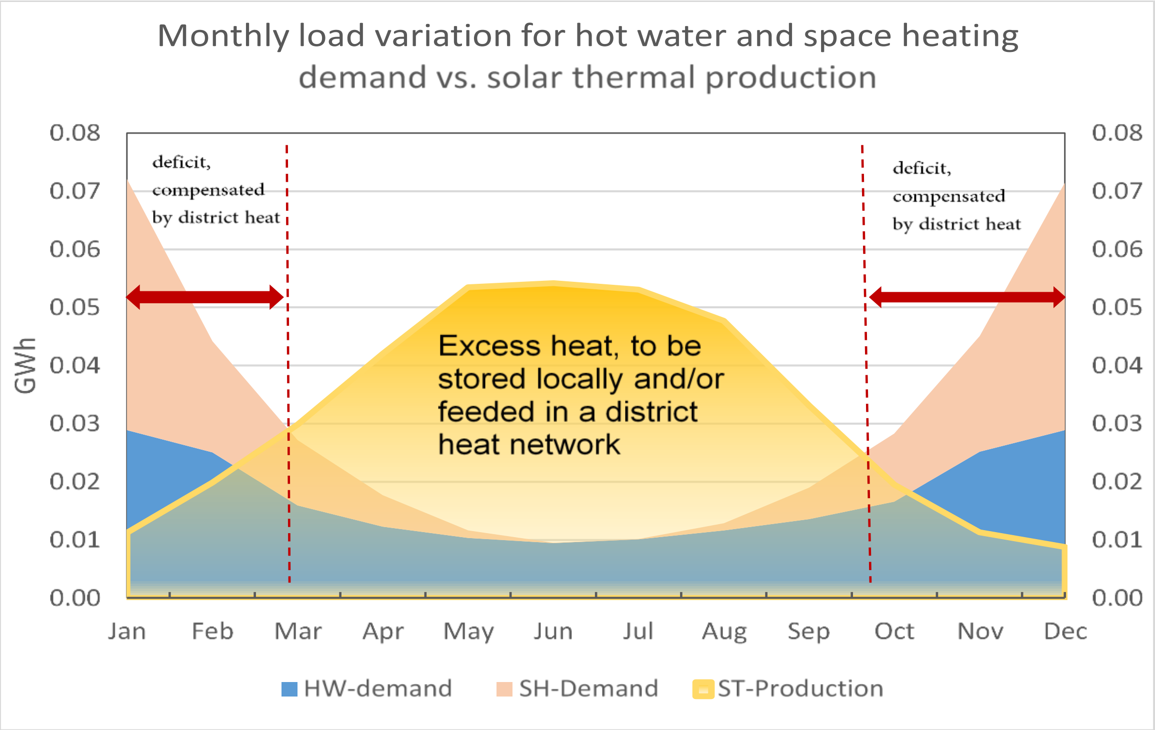

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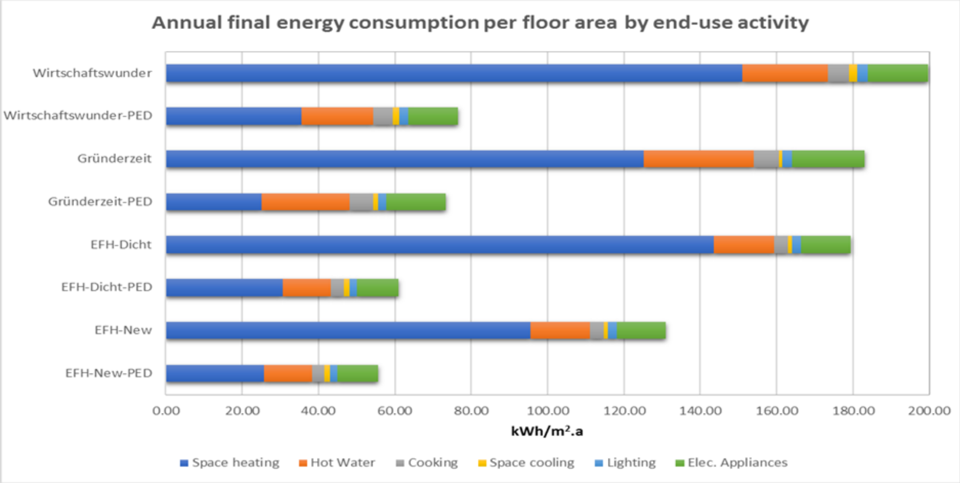

	Detached housing 1960ies (EFH Dicht)		Dense inner-city before 1919 (Gründerzeit)		Medium dense 1960ies (Wirtschaftswunder)		Detached housing after 2006 (EFH Neubau)	
KPIs	current	PED	current	PED	current	PED	current	PED
FE/m²	179.4	60.7	183.0	73.4	199.6	76.6	130.9	55.5
UE/m²	165.0	102.4	168.8	106.8	166.4	104.3	121.4	90.7
FE/Dw	25,552.3	8,640.4	11,912.4	4,778.7	23,704.2	9,095.8	19,504.0	8,271.4
UE/Dw	23,497.8	14,582.6	10,990.3	6,953.1	19,757.8	12,382.7	18,087.7	13,513.7
SH-UE/m²	128.8	70.1	112.4	57.6	125.5	68.0	85.7	58.8
SH-FE/m²	143.4	30.6	125.2	25.1	151.0	35.5	95.5	25.7
EL share in FE	20.4%	72.3%	24.6%	67.6%	22.2%	70.8%	23.9%	71.5%
SH share in FE	80.0%	50.4%	68.4%	34.2%	75.7%	46.3%	72.9%	46.2%
SR_{PV}	5.2%	109.7%	2.0%	45.0%	3.0%	61.6%	4.5%	89.6%
SR_{ST}	18.8%	102.5%	12.2%	60.6%	16.7%	91.3%	20.4%	97.0%

FE: final energy, UE: useful energy, Dw: dwelling, SH: space heating, El: electricity, SR: supply ratio, calculated on annual basis to cover electricity demand by local PV and part of heat demand (SH and WH) by local solar thermal (ST).

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