simply positive

D1.1. Report on operation scenarios, technical characterization and identified stakeholders of Focus Districts

July 2023

SONNENPLATZ Großschönau

Città di Settimo Torinese

AMS AMSTERDAM INSTITUTE FOR ADVANCED METROPOLITAN SOLUTIONS

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Executive Summary

The aim of the deliverable is to gather the development scenarios, technical characterizations, and stakeholders of the four Focus Districts of the project SimplyPositive:

- District Lunca Pomostului in Resita, Romania
- Fiat District in Seetimo Toriniese, Italy
- City of Amsterdam, Netherlands, and
- Großschönau, Austria

The documents assess which data is available for PED definition, concept, and process development. As such, the deliverable serves as starting point for the investigations to come and describes for each district available data in the following areas: general information, climatic conditions, building constructions, energy system, and operation scenarios. Furthermore, an analysis regarding multi-stakeholder governance of the focus districts was performed.

The data was structured as follows:

Characteristic	Focus District			
	RO – Resita	IT – Settimo Torinese	NL – Amsterdam	AT - Großschönau
Climate	✓	✓	✓	✓
Building constructions	☒	✓	✓	✓
Energy Systems	☒	✓	✓	✓
Operation Scenarios	✓	✓	✓	✓
Stakeholder identification	✓			

✓ – data is available; ☒ – data is not available at the moment.

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List of Abbreviations and Acronyms

BFD	Brownfield Development
EU	European Union
FAR	Floor Area Ratio
GFA	Gross Floor Area
GFD	Greenfield Development
GHI	Global horizontal irradiation
HDD	Heating degree days
PED	Positive Energy District
PV	Photovoltaic
SD	Stock Development
SECAP	Sustainable Energy and Climate Action Plan
WP	Work Package

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1. Introduction

1.1. Purpose of the document

The aim of the document is to provide a first characterization and analysis of the project focus districts from multiple perspectives of the envisaged operation scenarios: district goals, constructive features, energy use, technologies and equipment present in the area. Furthermore, the document provides a detailed stakeholder map, identifying and classifying typical stakeholders and stakeholder engagements within a PED process. The document gathers this available data and creates a foundation for the further activities of the SimplyPositive project.

1.2. Relation to other project activities

The document is providing data for the remaining Work packages:

- WP3 will build upon the data provided here as a starting point for the D3.2 Gap Analysis, which will compare the initially available data with the data required for modelling the PEDs for assessment of PED definition compliance and any intermediary steps. As such it will also be the basis for the Assessment report D3.3
- WP6 will also use the data to start the design of the SECAP process.

1.3. Structure of the document

The document consists of four plus one sections corresponding to the four demo sites in Romania, Italy, the Netherlands, and Austria respectively. Each member state corresponds to one to two districts which were analysed along these topics:

- District description: Location, Size, Usage, Heritage, etc.
- Climate: Temperatures, Irradiation, Sunlight, Precipitation
- Building constructions
- Energy Systems: Heating, cooling, domestic hot water and electricity supply, possible existing renewable energy sources in the district
- Operation Scenarios: description of possible district development and usage scenarios, possible system boundaries, energy and other targets and goals.

Stakeholder identification for all focus districts is highlighted in a separate section with providing methodology background.

2. Romania - Resita

The municipality of Reşita is located in the southwestern part of Romania, in the historical province of Banatș it is the seat of Caraş-Severin county, located in the depression with the same name, at 208 - 245 m altitude, at the north-western foothills of the Semenic Mountains and the eastern foothills of the Dognecea, on the upper course of the Bârzava river, at the intersection of the parallel of 45º18'00" north latitude with the meridian of 21º53'25" east longitude; 85 404 citizens (1 Jan. 2019), of which 40.983 men and 44.421 women. Area: 197.7 km², of which 21.5 km² in urban areas; density: 3,972 inhabitants/km².

Figure 1 – Location of Reşita

Originally, two districts were focused for PED development, but after internal considerations "Lunca Pomostului" district was selected for the purpose of this project. Lunca Pomostului is a mix between residential, commercial, institutional, industrial and office areas; the neighbourhood is made up mainly of old blocks with small rooms that make them less interesting from an economic point of view for potential residents, compared to other types of housing and areas, which causes their isolation on the local real estate market. General description of the focus district is presented in Table 1 and Table 2.

Table 1 – Lunca Pomostului – Summative description

	Value	Unit
District Area	12.78	ha
Gross Floor Area (GFA)	130,700	m²
District Plot Area	33,800	m²
Share of plot area built	27,45	%
Building Storeys (avg)	low-rise buildings less than 4 storeys – 316 3379 apartments	

Table 2 – Lunca Pomostului – Buildings characteristic

Usage	Percentage of the area	Type of owner
Residential	App 22%	mostly private
Commercial	Not available at this point	private
Primary School (incl. Kindergarten)	- Secondary schools and primary schools - 3 - Kindergartens 4	public
Secondary School (incl. Uni)	- Vocational and foreman schools 2	public
Retail Food	Not available at this point	private
Retail Other	Not available at this point	private

Mobility infrastructure: crossed by national road (DN 58) which connects the cities of Anina, Reșita and Caransebeș and Petru Maior street.

2.1. Climate

The city belongs to the continental temperate zone with Mediterranean influences with cool summers and mild winters. The municipality of Reşita is located in the northwestern part of the Semenic massif in a topographic corridor area oriented in the north-northwest - south-southeast direction. The climate is typical of the intracarpathian depressions of the Banat mountains. The specific microclimate of the area is particularized, due to the sinuous shape of the Bârzava river valley, protected by hilly peaks of 400 - 500 m, with good protection against winds oriented in the north-west - south-east direction.

Climate [1]

Temperature annual average	11,9	°C
Global horizontal irradiation (GHI)	1295,0	kWh/m²
Heating degree days (HDD)	2688	

The climate conditions in the demo site location accessed from [2]. On the next graph the average temperature and precipitation are shown (Figure 2). Reşita could be characterized as a dry zone with daily summer temperature 24-27 °C and daily winter temperature 4-6 °C.

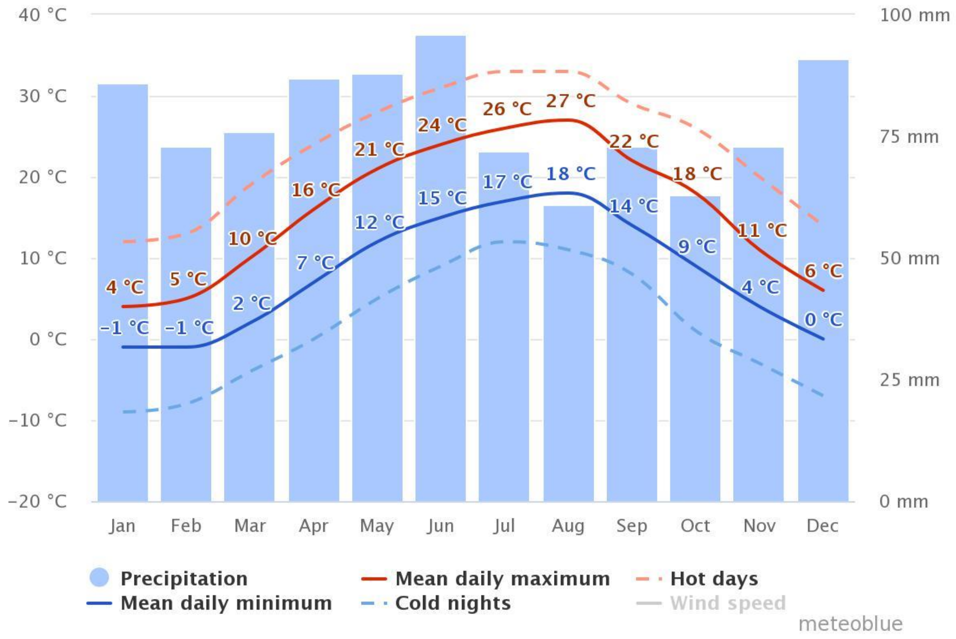


Figure 2 – Reşita - Average temperatures and precipitation

The graph (Figure 3) shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Reşita is partly cloudy place as overcast and partly cloudy days happens the most part of month.

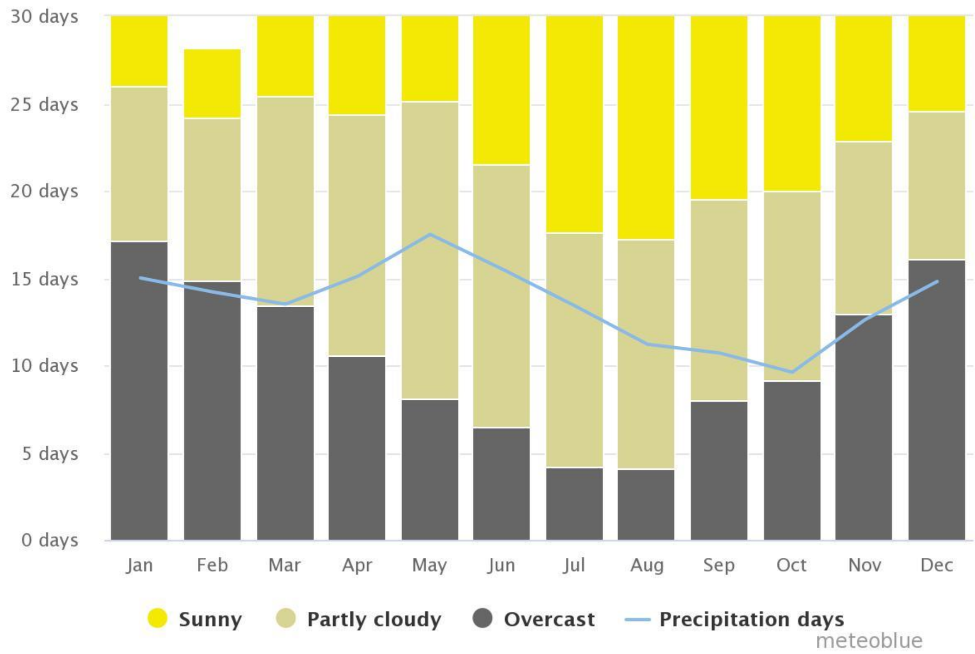


Figure 3 – Reşita - Cloudy, sunny and precipitation days

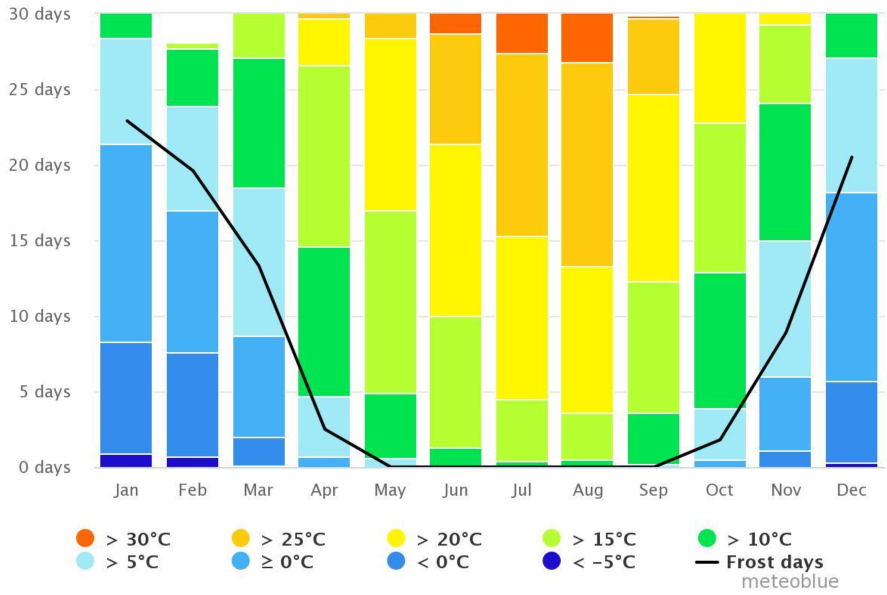


Figure 4 – Reşita - Maximum temperatures

How many days per month certain precipitation amounts are reach is shown on Figure 5. Focus districts located in a dry place where at least 12-15 days per month are without precipitations.

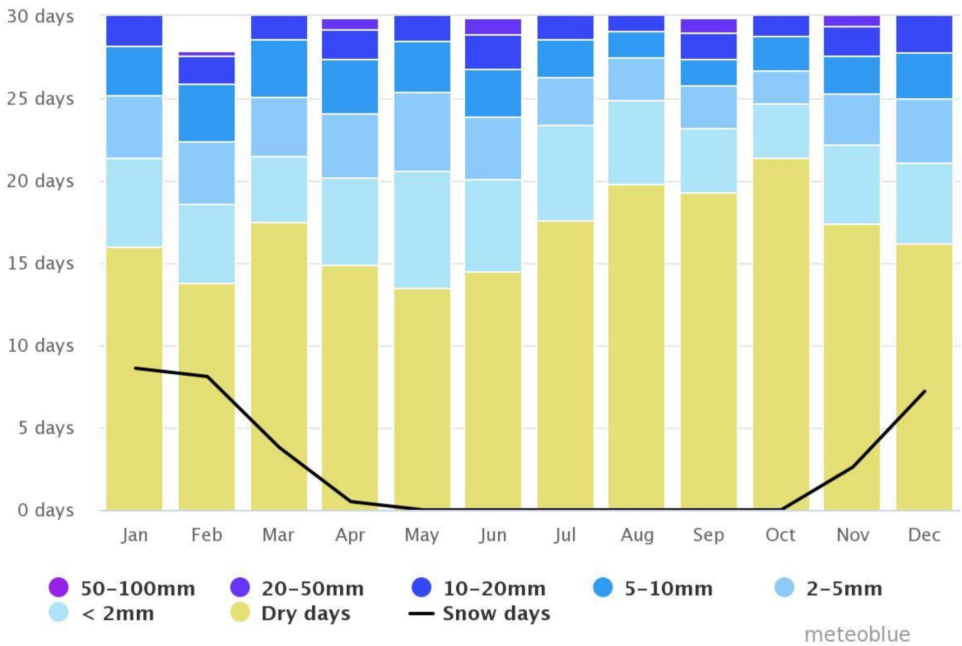
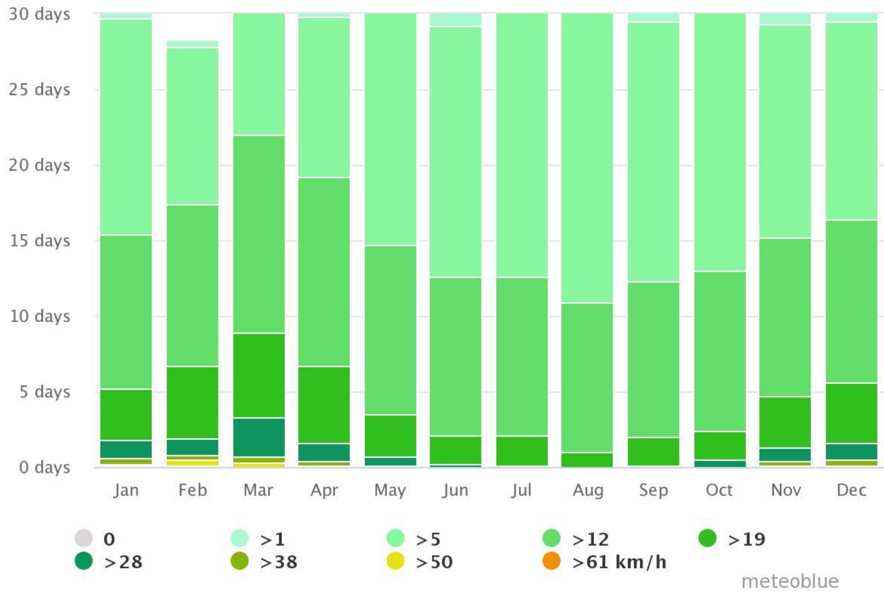
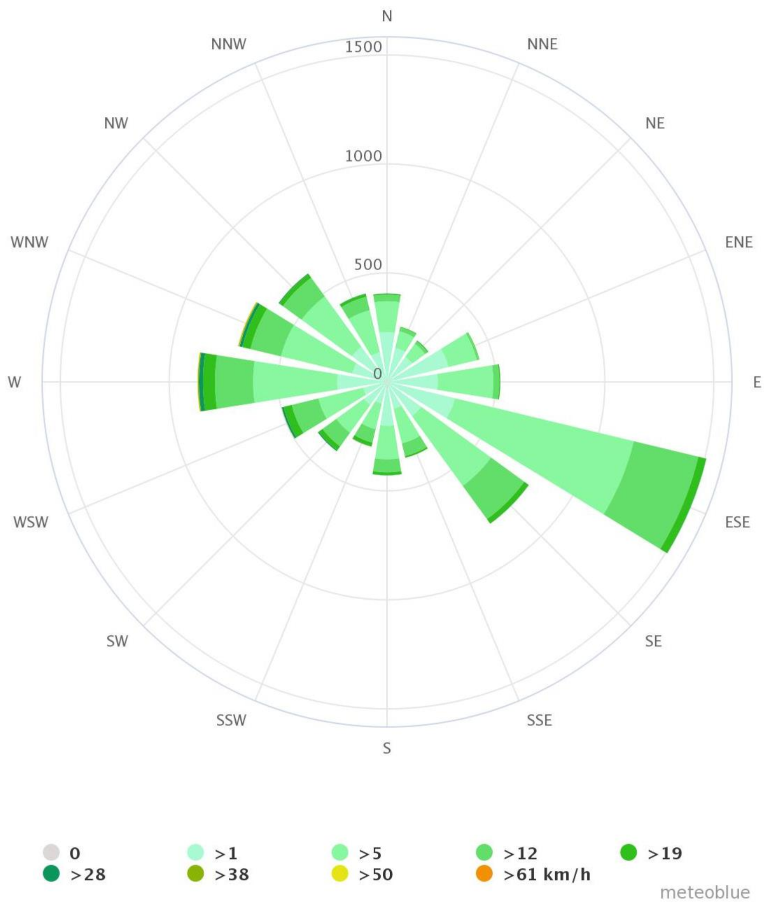


Figure 5 – Reşita - Precipitations amount

The following diagram shows the days per month, during which the wind reaches a certain speed in Reşita (Figure 6). Prevailing ESE wind.



a)



b)

Figure 6 – a.) Reşita Wind speed and b.) Reşita Wind rose

2.2. Building constructions

Buildings need extensive refurbishment. The quality of the housing stock is lower than the rest of the city, mainly due to their age and poor configuration. No further data available.

2.3. Energy System

No further data available.

2.4. Operation Scenarios

Goals:

- 20% Emission Reduction compared to 1990
- There are NO renewable targets currently

Renovation has already started in other parts of the city. The town hall managed to transform a market with old stalls into a modern public space. Several old trees were cleared, and several dozen young trees were planted in their place. Parking lots were set up parallel to the road. It is very important that a tree was planted for every two to three parking spaces. The sidewalk was moved closer to the buildings, at the expense of the unutilized and unkempt green area. Tracks have been laid out for cyclists. Traffic speed was limited by signs to 30 km/h. Street furniture was installed. The street lighting was modernized. The garbage platform has been replaced with an underground one. The rehabilitation project of the six streets in Lunca Pomostului had a value of over two million euros and was financed from European funds through the Regional Operational Program 2014-2020.

Legislative limitations: only local restructuring of non-consolidated platforms (around thermal points, garbage collection platforms), or enhancement of special objectives (ex. the archaeological site at Ogăşele).

3. Turin, Settimo Torinese (IT)

City Settimo Torinese located in the Po valley - NE of Turin - in a short distance from the bank of the Po river. As the most identifying neighbourhoods of the city the „Villaggio FIAT“ was chosen. District size is approx. 250.000 m²; site's Population is approx. 3.200 citizens - 1500 families; site's density is approx. 128 citizens/ha – approx. 7% city's population. Mainly residential, with a few commercial areas, along one of the main streets (supermarkets, neighbourhood shops, café'/bars). All the sites are privately owned except for schools, internal green areas and park.

Figure 7 – Location of Settimo Torinese

General description of the focus district is presented in Table 3.

Table 3 – Settimo Torinese – Summative description

Name of parameter	Value	Unit
District Area	19	ha
Gross Floor Area (GFA)		m^2 GFA
District Plot Area		m^2
Floor Area Ratio (FAR)		
Share of plot area built		
Net to Gross Floor Area Ratio		
Building Storeys (avg)		

Types of building by purpose is presented in Table 4.

Table 4 – Settimo Torinese – Buildings characteristic

Usage	Percentage of the area	Type of owner
Residential	No data available	No data available
Commercial	No data available	No data available
Primary School (incl. Kindergarten)	No data available	No data available
Secondary School (incl. Uni)	No data available	No data available
Retail Food	No data available	No data available
Retail Other	No data available	No data available

3.1. Climate

The Focus District lies in the continental temperate zone with Mediterranean influences with cool summers and mild winters. In Settimo Torinese the climate is warm and temperate, with average temperatures >12°C and significant rainfall throughout the year.

Climate [1]		
Temperature annual average	13,0	°C
Global horizontal irradiation (GHI)	1425,7	kWh/m²
Heating degree days (HDD)	2306	

The climate conditions in the demo site location accessed from [2]. On the next graph the average temperature and precipitation are shown (Figure 8). Settimo Torinese could be characterized as a dry zone with daily summer temperature 25-30 °C and daily winter temperature 7-12 °C.

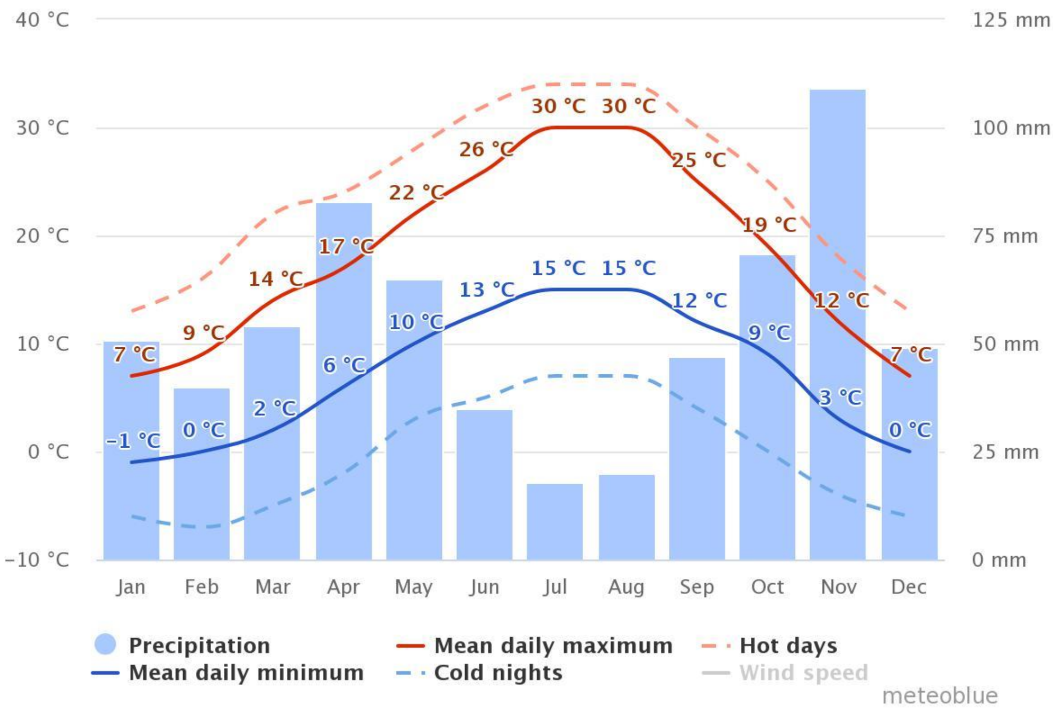


Figure 8 – Settimo Torinese – Average temperatures and precipitation

The graph (Figure 9) shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Settimo Torinese is mostly sunny place as overcast days happens not more than 1/3 of month in autumn and winter.

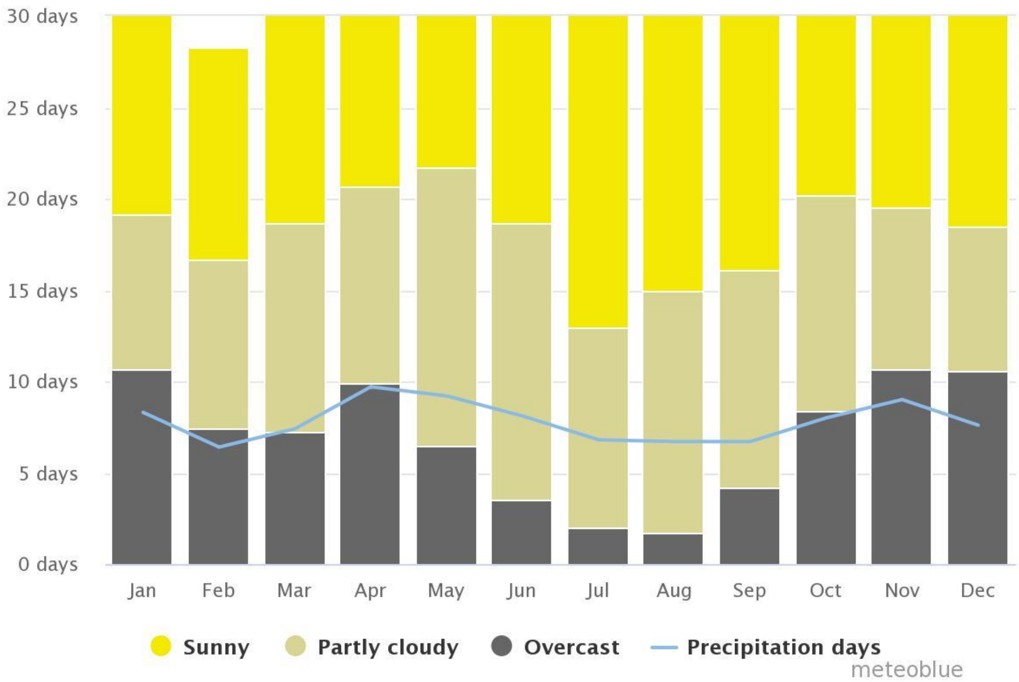


Figure 9 – Settimo Torinese - Cloudy, sunny and precipitation days

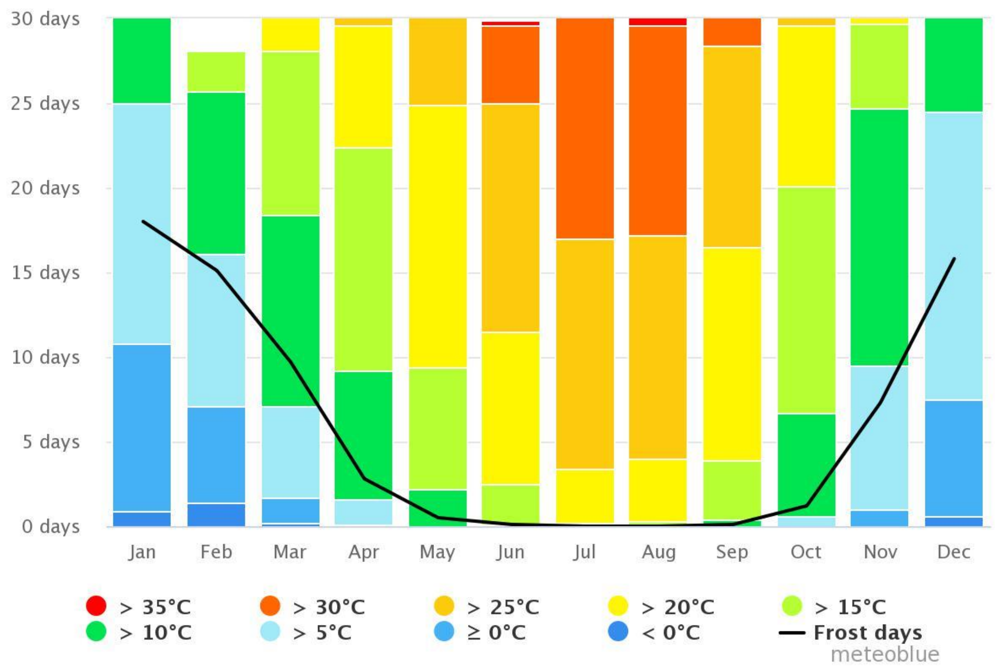


Figure 10 – Settimo Torinese - Maximum temperatures

How many days per month certain precipitation amounts are reach is shown on Figure 11. Settimo Torinese is a dry place as at least 20 days per month are without precipitations.

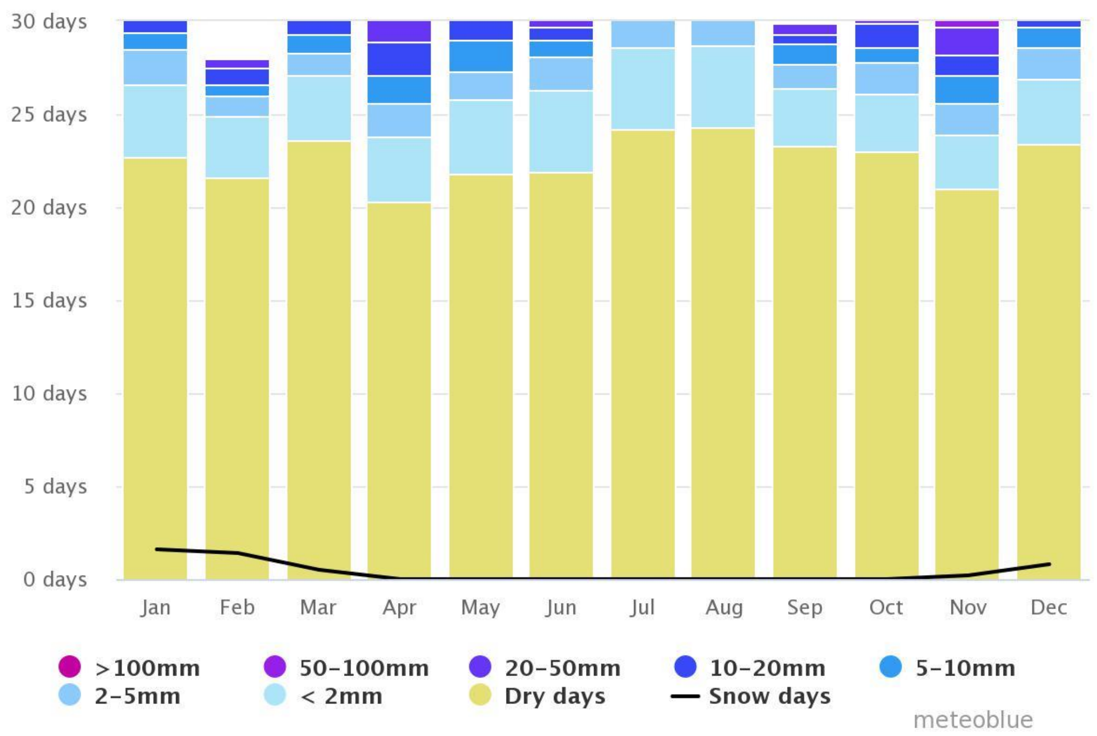
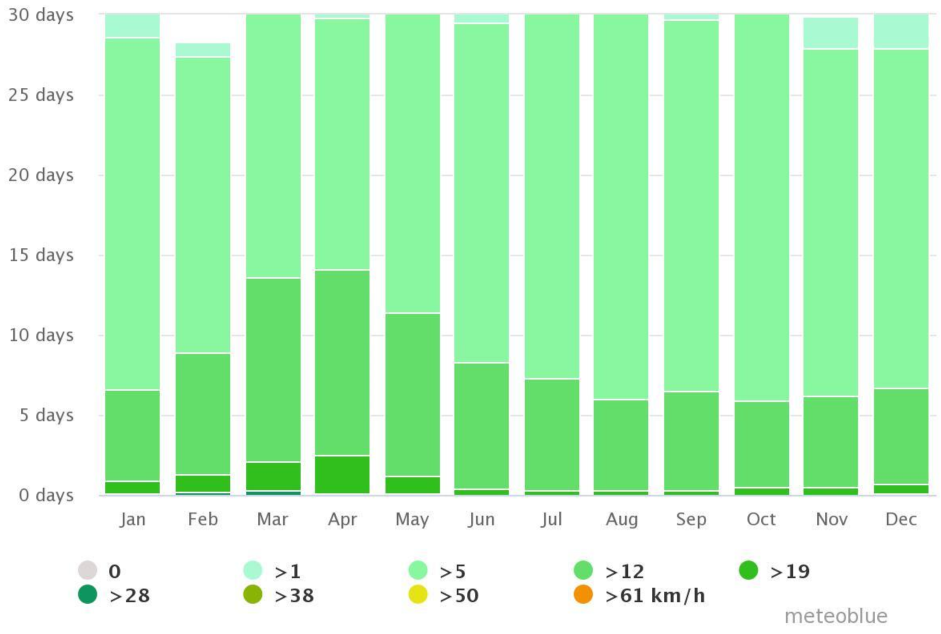


Figure 11 – Settimo Torinese - Precipitations amount

The following diagram shows the days per month, during which the wind reaches a certain speed in Settimo Torinese (Figure 12). Prevailing WNW wind.



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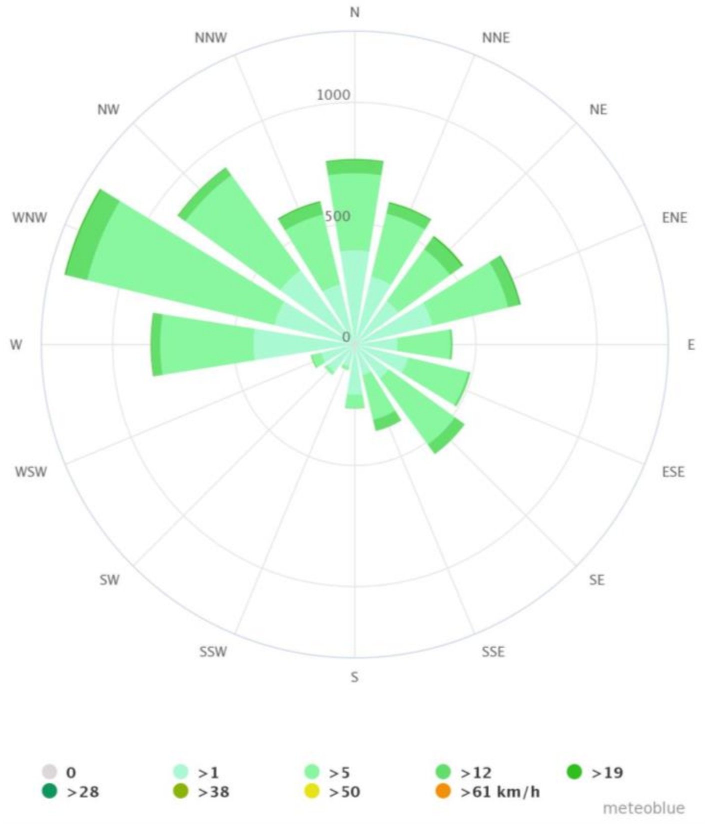


b)

Figure 12 – a.) Settimo Torinese Wind speed and b.) Settimo Torinese Wind rose

3.2. Building constructions

All buildings need expensive renovation and maintenance works due to their old structures (more than 50 years); the quality of the housing is low, mainly because of the time and poor configuration.

In the Focus District of the Settimo Torinese there are 5 types of the buildings are available (Figure 13). Below are brief descriptions of the buildings.

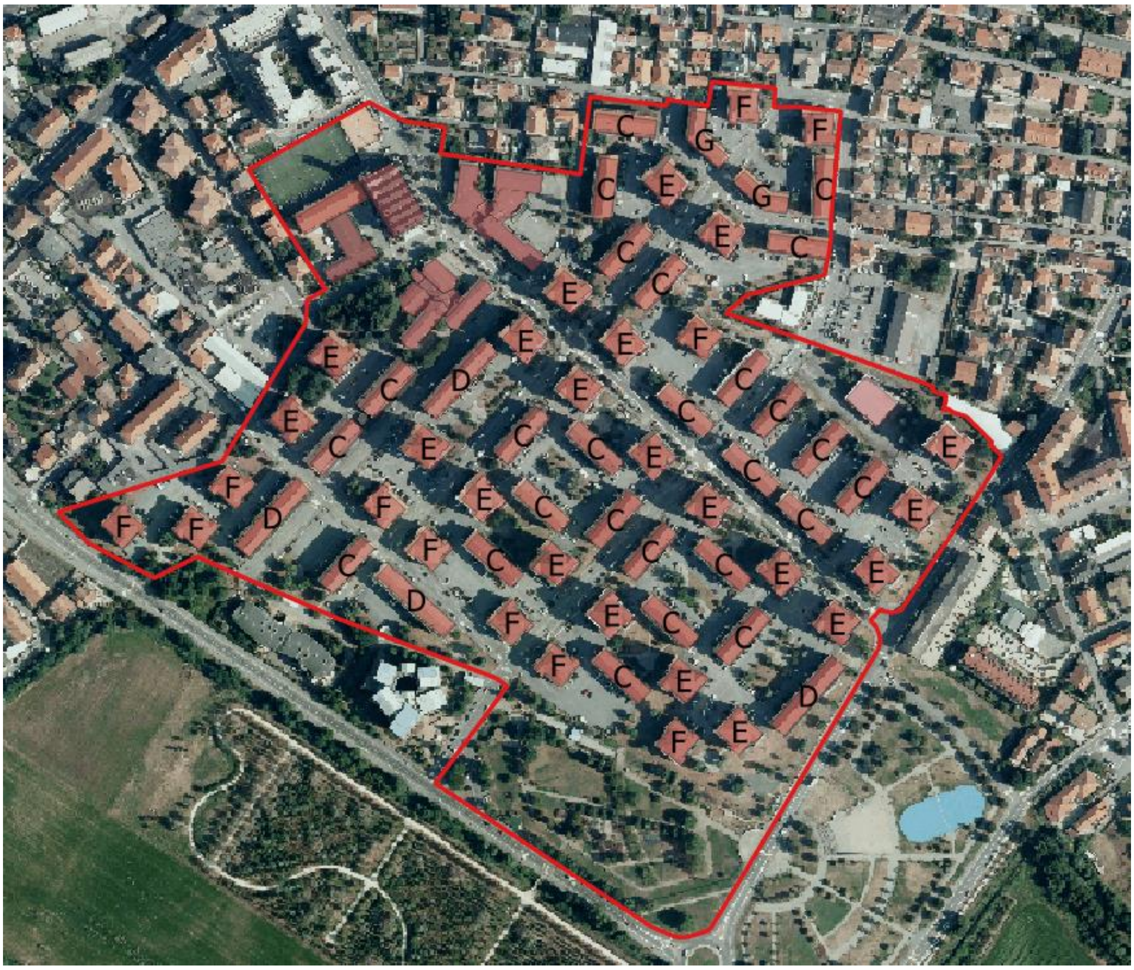


Figure 13 – Buildings location in the Focus District (Settimo Torinese)

Building “type C” description.

Address: Post Code/City: Country:	Villaggio FIAT Settimo Torinese Italy
Construction/retrofit year:	1966
Location (coordinates):	see Figure 13
Altitude (m):	207 m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	510
Number of floors	4

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks con camera d’aria	0,40
Internal walls	Bricks	0,10 – 0,15
Roof Construction	Gypsum Board	0,00
	Wood Beam	0,00
	Rock Wool	0,00
	Roof Tiles	0,025
Floor Construction	Concrete	0,10
	tavelle	0,15
	Tiles	0,05
Windows / Doors Frame	wood	
Glazing type	1 glass	0,006
Shading	roller shutter	

Building “type D” description.

Address: Post Code/City: Country:	Villaggio FIAT Settimo Torinese Italy
Construction/retrofit year:	1966
Location (coordinates):	see Figure 13
Altitude (m):	207m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m^2)	750
Number of floors	4

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks con camera d’aria	0,40
Internal walls	Bricks	0,10 – 0,15
Roof Construction	Gypsum Board	0,00
	Wood Beam	0,00
	Rock Wool	0,00
	Roof Tiles	0,025
Floor Construction	Concrete	0,10
	tavelle	0,15
	Tiles	0,05
Windows / Doors Frame	wood	
Glazing type	1 glass	0,006
Shading	roller shutter	

Building “type E” description.

Address: Post Code/City: Country:	Villaggio FIAT Settimo Torinese Italy
Construction/retrofit year:	1966
Location (coordinates):	see Figure 13
Altitude (m):	207m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m^2)	490
Number of floors	8

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks con camera d’aria	0,40
Internal walls	Bricks	0,10 – 0,15
Roof Construction	Gypsum Board	0,00
	Wood Beam	0,00
	Rock Wool	0,00
	Roof Tiles	0,025
Floor Construction	Concrete	0,10
	tavelle	0,15
	Tiles	0,05
Windows / Doors Frame	wood	
Glazing type	1 glass	0,006
Shading	roller shutter	

Building “type F” description.

Address: Post Code/City: Country:	Villaggio FIAT Settimo Torinese Italy
Construction/retrofit year:	1966
Location (coordinates):	see Figure 13
Altitude (m):	207m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	450
Number of floors	4

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks con camera d’aria	0,40
Internal walls	Bricks	0,10 – 0,15
Roof Construction	Gypsum Board	0,00
	Wood Beam	0,00
	Rock Wool	0,00
	Roof Tiles	0,025
Floor Construction	Concrete	0,10
	tavelle	0,15
	Tiles	0,05
Windows / Doors Frame	wood	
Glazing type	1 glass	0,006
Shading	roller shutter	

Building “type G” description.

Address: Post Code/City: Country:	Villaggio FIAT Settimo Torinese Italy
Construction/retrofit year:	1966
Location (coordinates):	see Figure 13
Altitude (m):	207m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	470
Number of floors	4

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks con camera d’aria	0,40
Internal walls	Bricks	0,10 – 0,15
Roof Construction	Gypsum Board	0,00
	Wood Beam	0,00
	Rock Wool	0,00
	Roof Tiles	0,025
Floor Construction	Concrete	0,10
	tavelle	0,15
	Tiles	0,05
Windows / Doors Frame	wood	
Glazing type	1 glass	0,006
Shading	roller shutter	

3.3. Energy System

District heating network extends for approximately 47 kilometres, serves 70% of homes and industrial plants, guarantees the supply of approximately 80 GWh of thermal energy per year and uses wastewater from the nearby De L 'Oréal factory. A virtuous system that makes it possible to supply heat to over 6,000 public and private users in the municipal area, serving 33,000 customers and avoiding 37% of CO_2 emissions into the atmosphere (equal to 17,000 fewer cars on the road in the city).

The largest share of the energy consumption of the municipality refers to the industrial sector. In recent years there has been a decrease in overall consumption, mainly determined by the industrial sector and the private transport sector, while the residential, tertiary, agricultural and public sectors, vice versa, have increased their consumption.

The residential sector represents about 30% of total energy consumption at the municipal level. In this sector, the most used fuel is natural gas. The heat consumption is distributed through a district heating network.

3.4. Operation Scenarios

Goals:

- raising the energy and bio-architectural efficiency of the building entities;
- creation of a Renewable Energy Community (CER): an association between citizens, businesses, local administrations, and small/medium enterprises that decide to join forces with the aim of producing, exchanging and consume energy from renewable sources on a local scale;
- implementation of the Energy management service (in favour of the union of Municipalities to which Settimo belongs) with the task of analysing, monitoring and optimizing the use of energy in a rational and efficient manner, with energy diagnoses, redefinition of public lighting consumption, redevelopment energy of public buildings.

4. Amsterdam (NL)

The entire city of Amsterdam (Figure 14) was selected as a focus district. Amsterdam is located in the Dutch province of North Holland. It has a population of 882 633 citizens (by the end of 2021), population density is about 5 277/km^2 [4].

Figure 14 – Location of Amsterdam

The description of the Amsterdam district is presented in Table 5.

Table 5 – Amsterdam – Summative description

Name of parameter	Value	Unit
District Area	24 327.1493	ha
GFA	44721686	m^2
District Plot Area	15 607 440	m^2

Types of building by purpose is presented in Table 6 [5]. Living area is dominated and covers about 4.8 % of whole district area.

Table 6 – Amsterdam – Buildings characteristic

Usage	Number of objects	Area
Living	13754	11,723,750 m^2
Services	1931	790,035 m^2
To work	1451	1,059,235 m^2

4.1. Climate

The climate conditions in the demo site location accessed from [2]. On the next graph the average temperature and precipitation are shown (Figure 15). Amsterdam could be characterized as a dry zone with daily summer temperature 20-22 °C and daily winter temperature 6-7 °C.

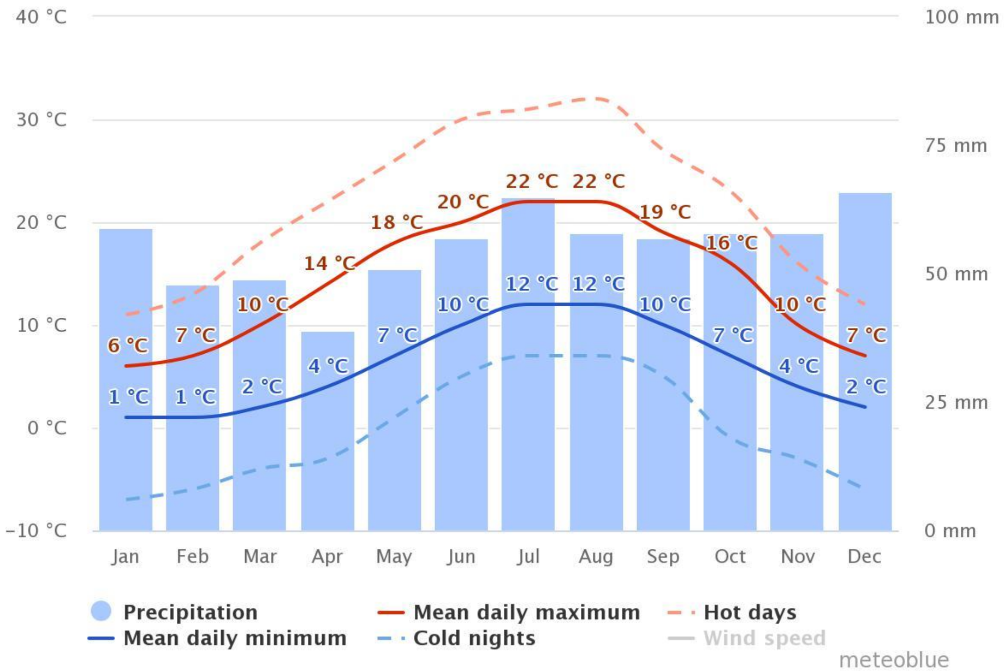


Figure 15 – Amsterdam - Average temperatures and precipitation

The graph (Figure 16) shows the monthly number of sunny, partly cloudy, overcast and precipitation days.

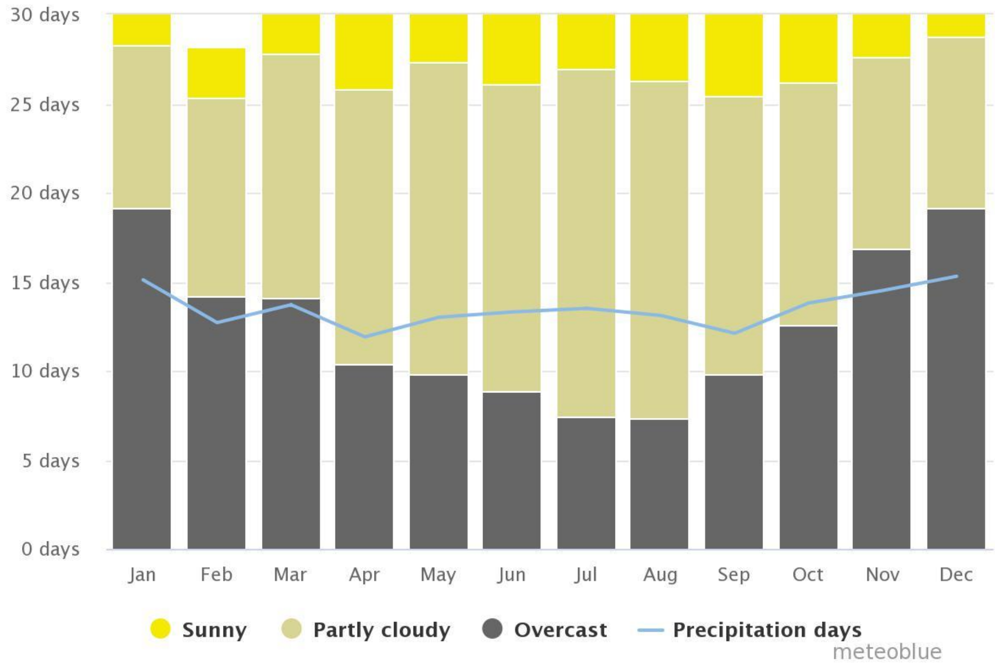


Figure 16 – Amsterdam - Cloudy, sunny and precipitation days

The following graph shows how many days reach certain temperature for each month (Figure 17).

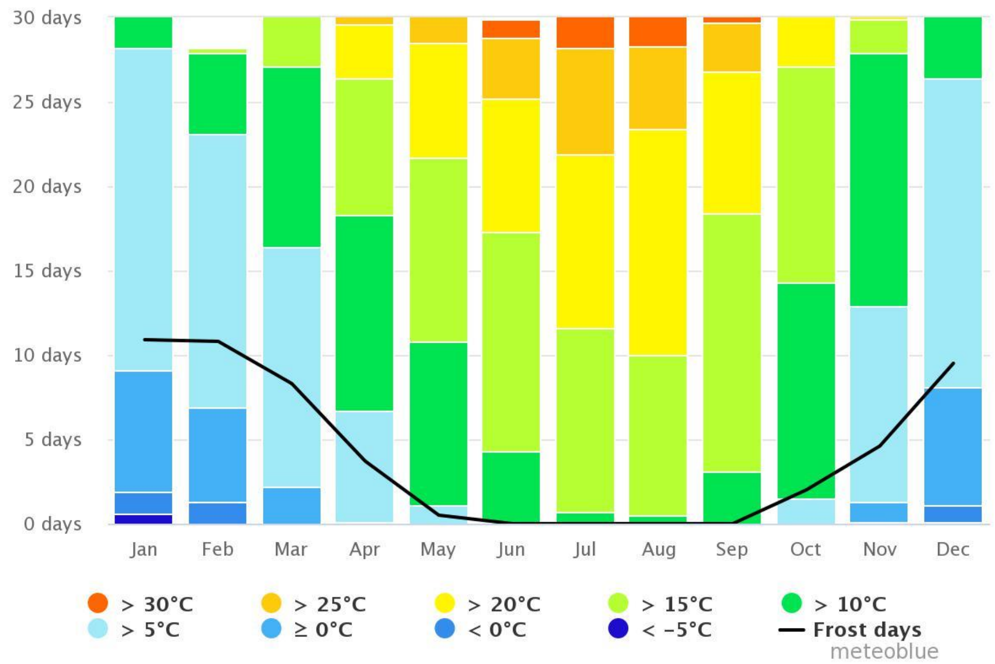


Figure 17 – Amsterdam - Maximum temperatures

How many days per month certain precipitation amounts are reach is shown on Figure 18. More than half of month is dry in Amsterdam.

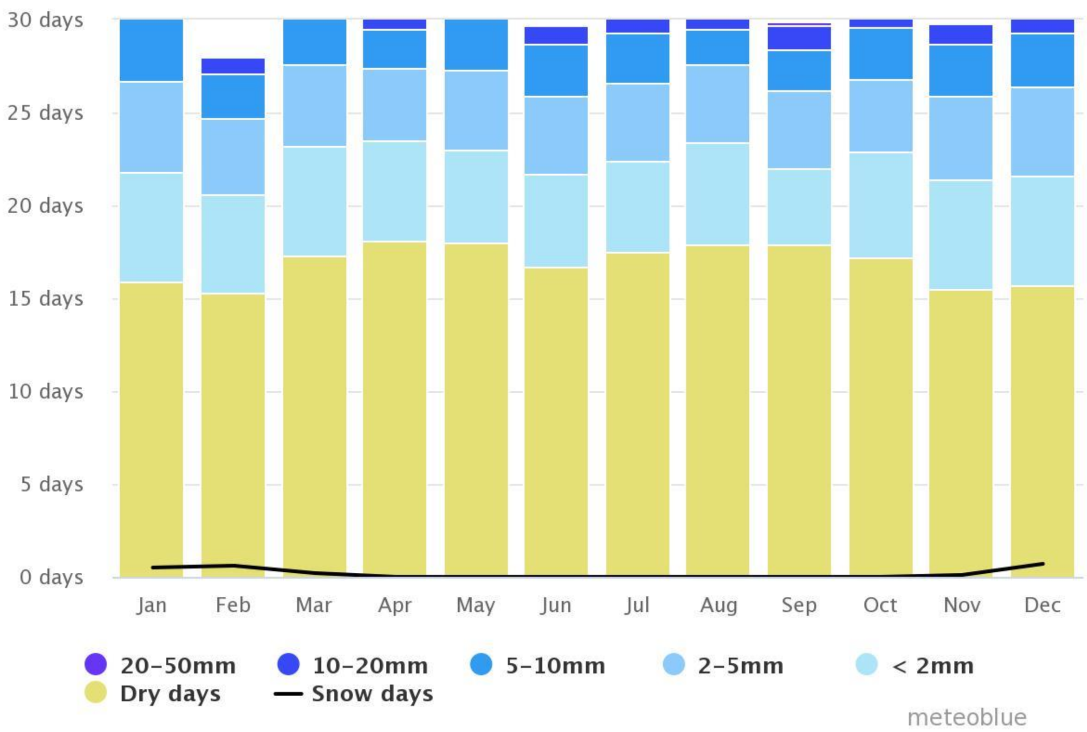
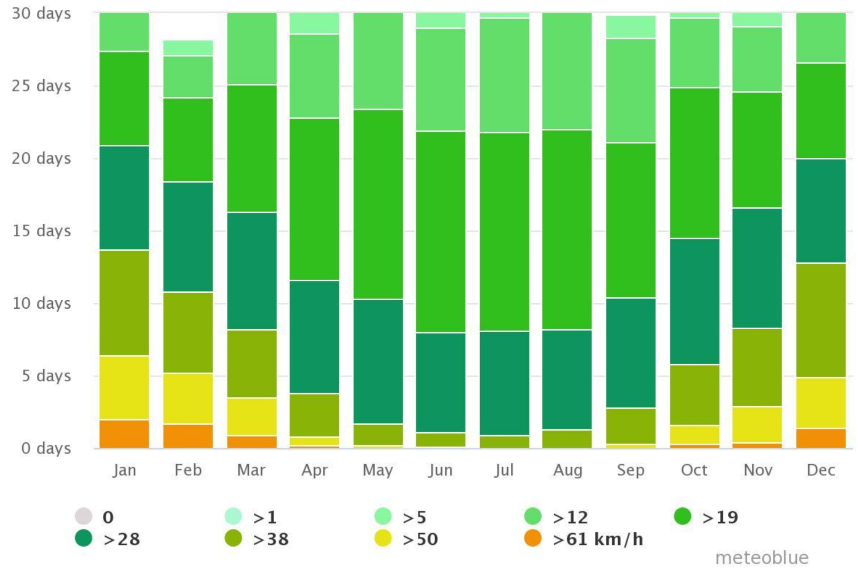
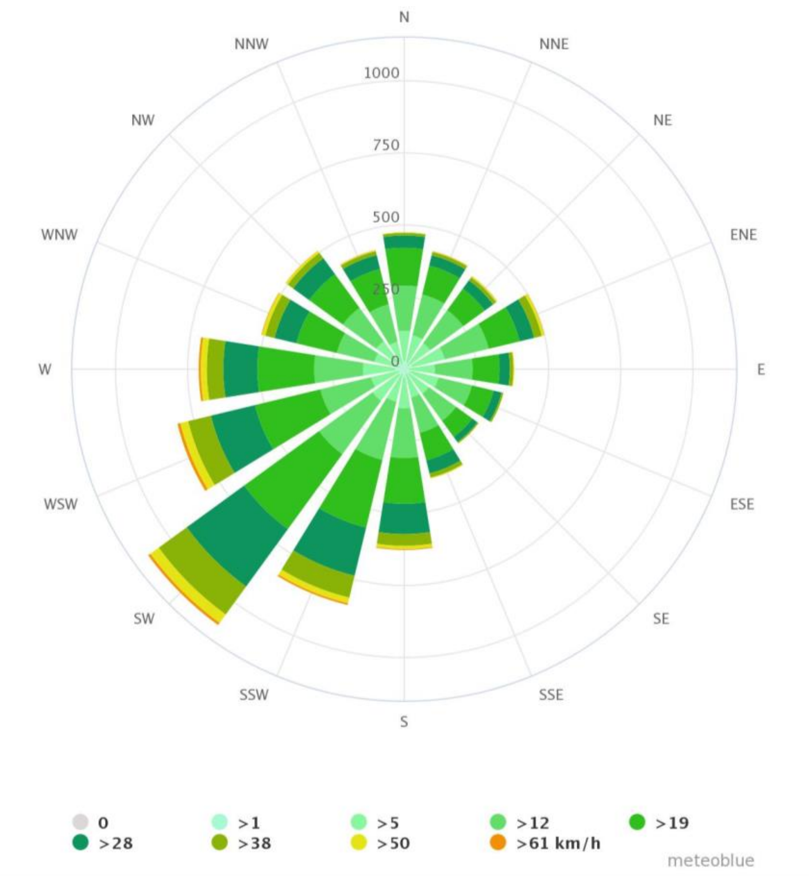


Figure 18 – Amsterdam - Precipitations amount

The following diagram shows the days per month, during which the wind reaches a certain speed in Amsterdam (Figure 19). Prevailing SW wind.



a)



b)

Figure 19 – a.) Amsterdam Wind speed and b.) Amsterdam Wind rose

4.2. Building constructions

Whole Amsterdam building could be divided by few subgroups depends on construction years (Figure 20). The most building were constructed between 1986-2001, the old historical buildings are only 4 % of city buildings [5].

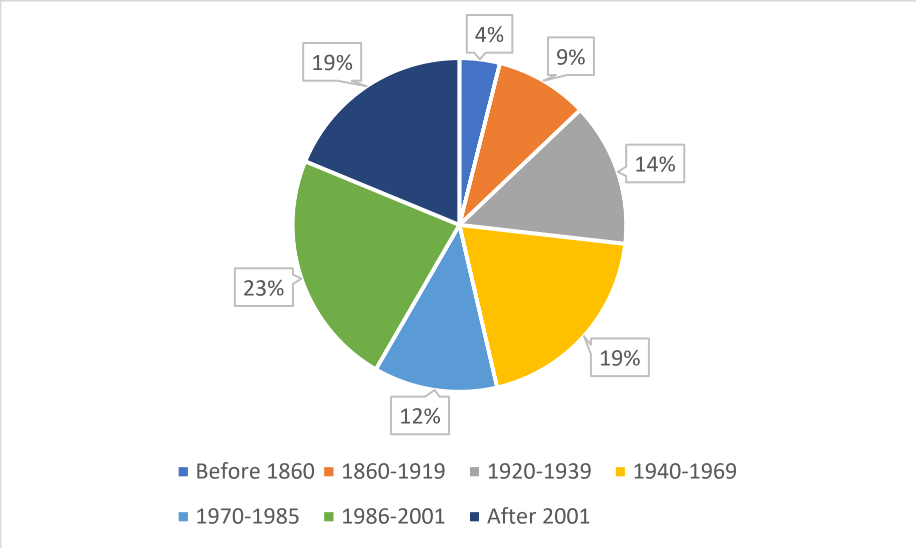


Figure 20 – Periods of buildings construction in Amsterdam

4.3. Energy System

Amsterdam has developed energy system. Heat supply comes from surface water (66.278.679 GJ/year), wastewater (1.257.700 GJ/year), drink water (125.800 GJ/year), sun (61.081.513 GJ/year), residual heat (819.936 -3.161.642 GJ/year), industrial waste heat (260 GJ/year) [6].

The regions out of the centre are covered by a central heating and cooling system (Figure 21) [5], which is covers 2916 (heating) and 304 (cooling) objects. The length of heating system is 233 523 m, cooling system length is 20 056 m.

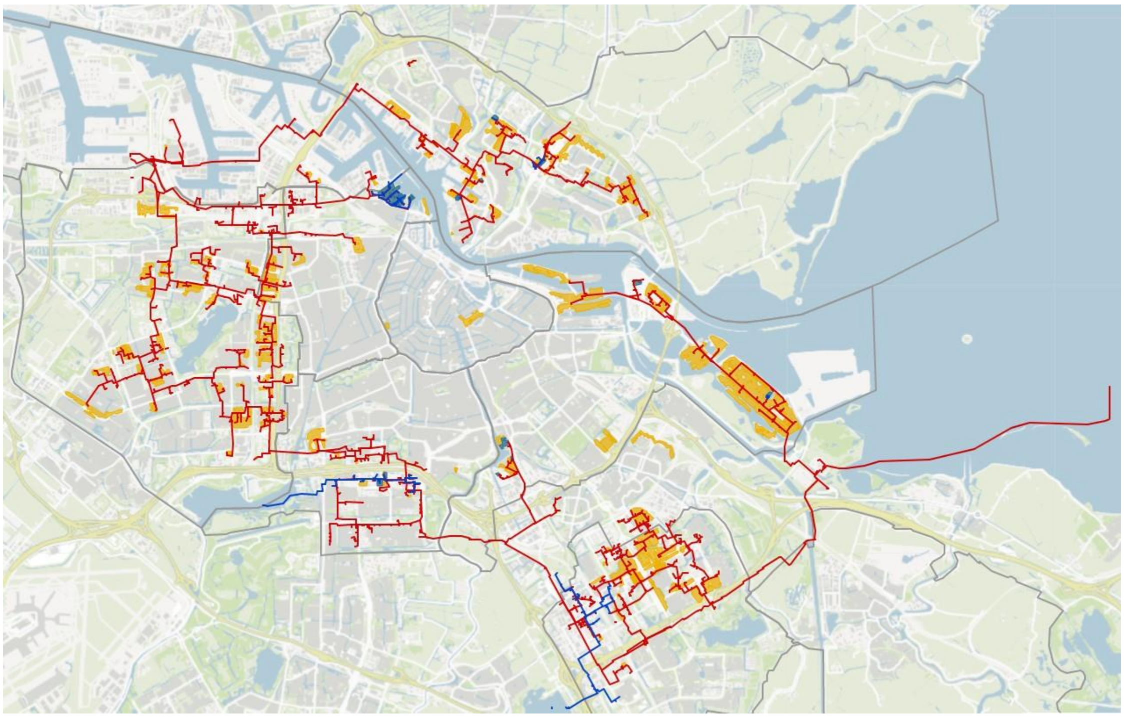


Figure 21 – Amsterdam heating and cooling system

As Amsterdam has climate target goals, the solar energy is implemented as important energy source under positive energy district strategy realization. Currently 14406 living houses and 1568 non-residential properties covered by solar panels (by the end of 2021).

4.4. Operation Scenarios

Currently, Amsterdam releases about 101 kton CO2 per year (in 2019) and has tendency to reduce this number (Figure 22). So, the renewable energy sources play should major role in reducing CO2 emission. The main focus was made on the roof usage and installing solar panels.

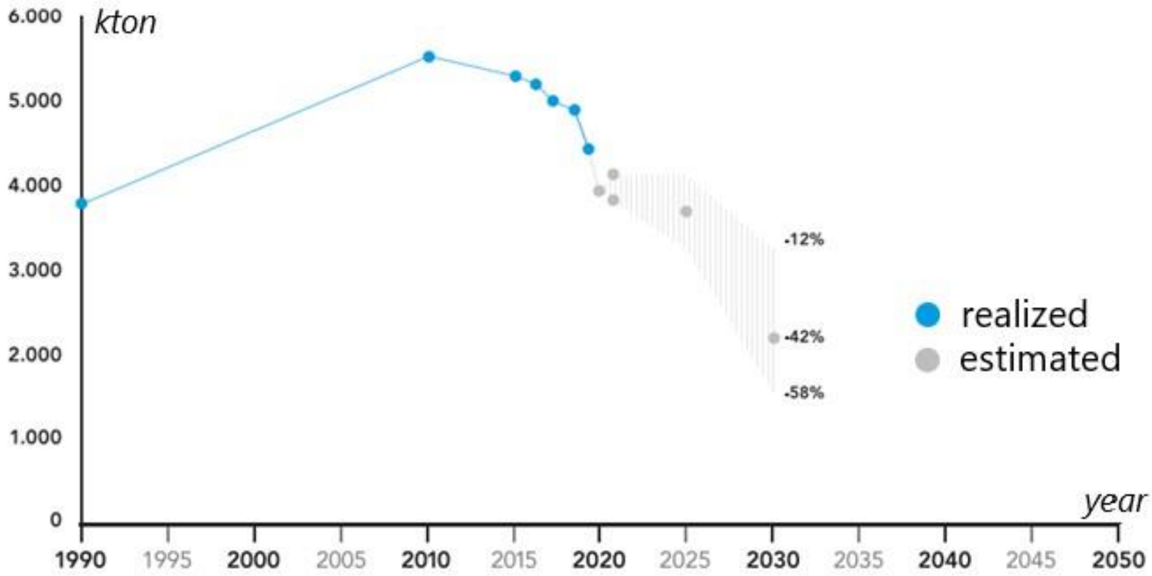


Figure 22 – CO_2 release in Amsterdam

The global Goals for Amsterdam could be formulated as next:

- to obtain 550MW on roofs till 2030;
- all buildings natural gas free till 2040.

However, implementation renewable energy sources usage and goals achievement meet some difficulties:

- The Corona crisis is causing companies to postpone investments in solar panels.
- The lower rates of SDE++ are increasingly insufficient. This calls for continued lobbying towards the national government for a more suitable scheme, with which the roofs can continue to be used.
- Difficult business case and/or complex decision-making (e.g., at homeowners' associations), especially with medium-sized roofs and stacked construction.
- The business case becomes difficult due to insufficiently strong construction on many large roofs.
- Insuring solar panels is becoming increasingly difficult and requires more work and extra inspection costs. A guarantee fund could be set up for this.
- Reinforcement of electrical connections by the network manager takes a lot of time.
- Spatial integration of ground-based systems.

5. Großschönau (AT)

Großschönau, a rather small but very well-known rural municipality in Waldviertel, Lower Austria, Figure XY, has been pushing for decades toward sustainable and environmentally friendly ways of living. Großschönau is rated an e5-municipality, was winning the European Energy Award in Gold for its achievements in energy efficiency and has with the fair BIOEM and the permanent exhibition SONNENWELT two nationwide known showcase projects of sustainable thinking and acting.

Figure 23 – Location of Großschönau

The description of the Großschönau district is presented in Table 7.

Table 7 – Großschönau – Summative description

Name of parameter	Value	Unit
District Area	7,047,800 705	m² ha
Gross Floor Area (GFA)	46,155	m²
District Plot Area	391,000	m²
Built area in building land	12,687	m²
Share of plot area built	3.245	%
Net to Gross Floor Area Ratio	~70	%
Building Storeys (avg)	1.5	floors
Useable floor area of all buildings	60,757	m²

The usage of the district area by the type of buildings is presented in Table 8.

Table 8 – Großschönau – Buildings characteristic

Usage	Area in m²	Percentage of the area	Type of owner
Residential*	21,620	35.58%	15 rented flats, rest private
Commercial**	7,283	11.99%	private
Agriculture***	7,919	13.03%	private
Primary School (incl. Kindergarten)	2,658	4.37%	municipality
Secondary School (incl. Uni)	—	—	—
Retail Food	289	0.48%	private
Retail Other	200	0.33%	private

Source: Calculation based on useable area of all buildings (60.757 m²)
* complete area, which is approved for residential usage (data from building register)
** complete built area of buildings which have registered companies paying municipal tax (as of 2022)
*** complete built area of buildings which have an active announced farmstead (INVEKOS data, as of 2022)

5.1. Climate

The climate conditions in the demo site location accessed from [2]. The climate diagrams showed in Meteoblue are based on 30 years of hourly Climate model simulations and give some indicators of typical climate patterns and are the first simulate climate dataset made public on the net with a resolution of 30 km approximately.

The “mean daily maximum” and “mean daily minimum” show the averages maximum and minimum temperature of an average day for every month (Figure 24). "Hot days” and “cold nights” show the average of the hottest day and the coldest night of every month.

Meteoblue considers monthly precipitations above 150mm are mostly wet, below 30mm mostly dry.

Taking this into consideration, it can be set that Großschönau is a dry zone with temperatures in winters within 5 - 12ºC and in summers within 9-21 ºC.

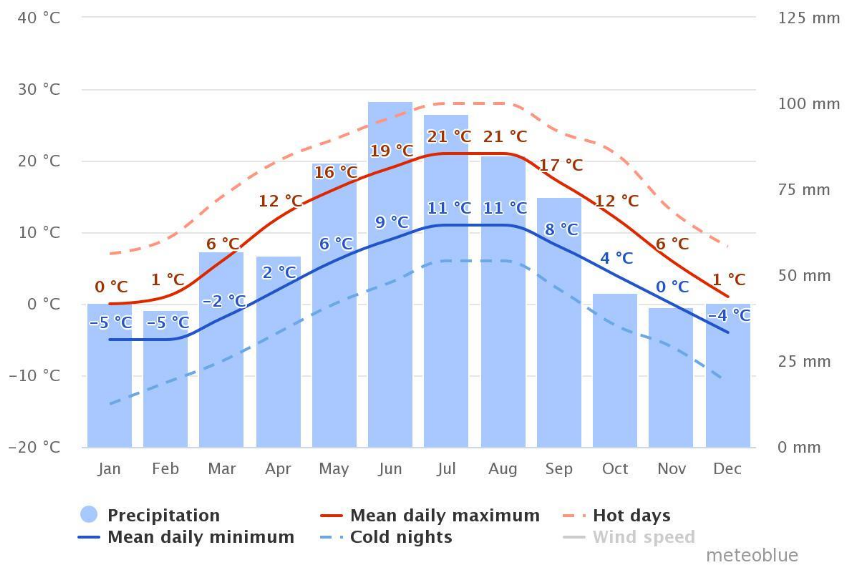


Figure 24 – Großschönau - Average temperatures and precipitation

The graph (Figure 25) shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast.

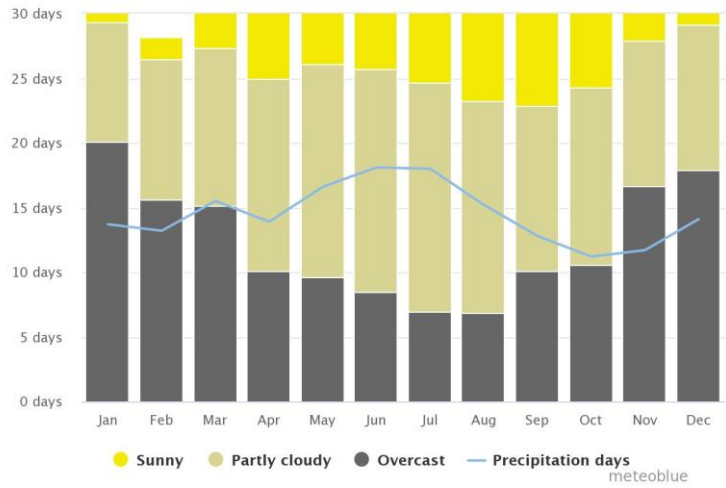


Figure 25 – Großschönau - Cloudy, sunny and precipitation days

Großschönau can be considered a partly cloudy region with and average between 12-18 days of monthly rainy days.

The following graph shows how many days reach certain temperature for each month (Figure 26).

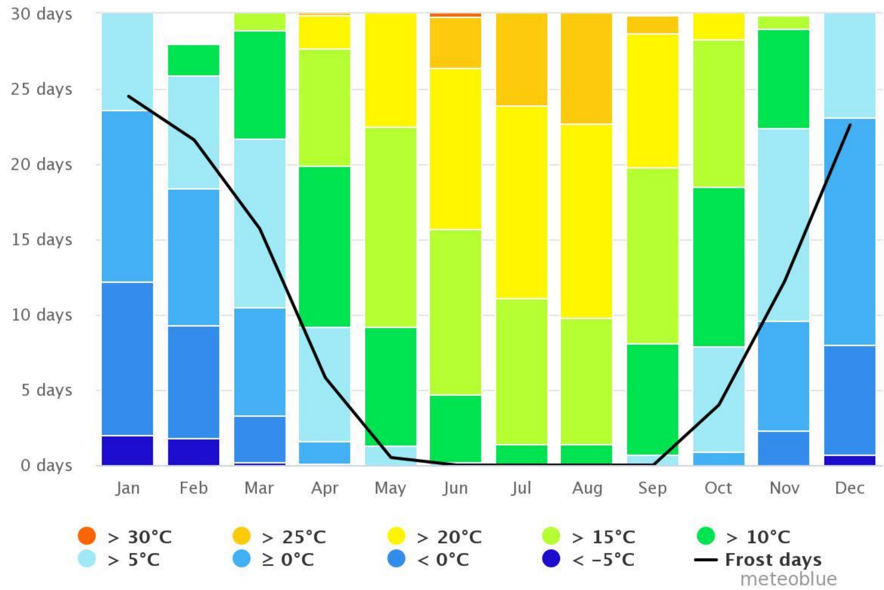


Figure 26 – Großschönau – Maximum temperatures

How many days per month certain precipitation amounts are reach. It corroborates that Großschönau is a dry zone (Figure 27).

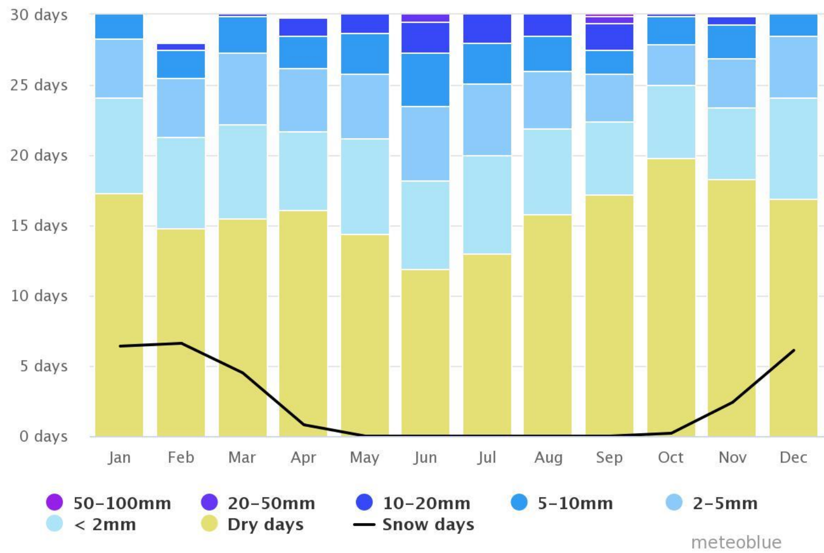
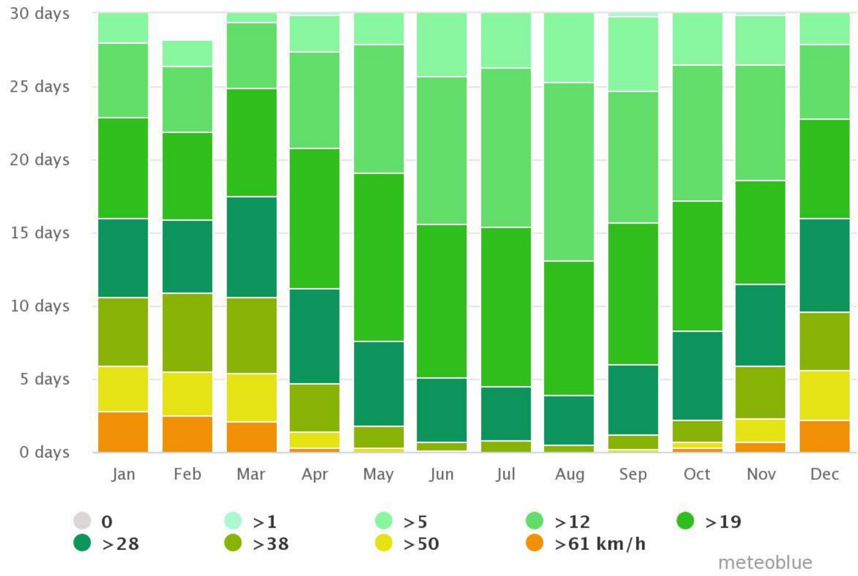
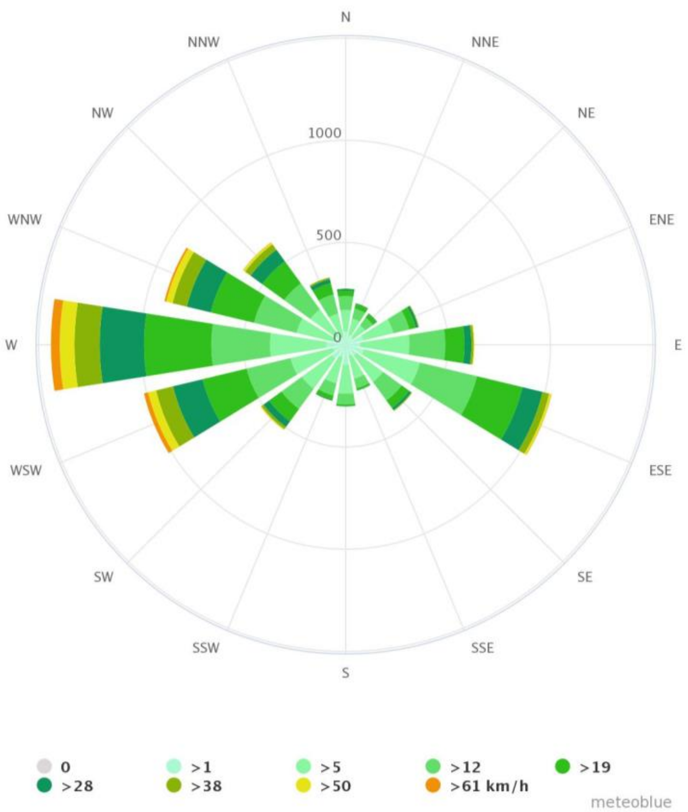


Figure 27 – Großschönau - Precipitations amount

The following diagram shows the days per month, during which the wind reaches a certain speed in Großschönau (Figure 28).



a)



b)

Figure 28 – a.) Großschönau Wind speed and b.) Großschönau Wind rose

In Großschönau the wind blows mainly from W and ESE.

5.2. Building constructions

Below Figure 29 shows Großschönau area from bird's perspective. The information here is provided by registers, maps, and the municipality.

Figure 29 – Großschönau area from bird's perspective

The PED Großschönau consists of 131 listed buildings. Thereof, 22 are either not permanently used (secondary residencies) or not used at all. The remaining 109 buildings contain all types of buildings: residential, commercial, and public buildings.

The most relevant buildings:

- **Town Hall**

The town hall is a stand-alone building used for administration and public services with small occupancy and office related opening hours. The following sections will provide more details about the building, use and energy related information.

Address: **Post Code:** **Country:**	Großschönau 49 3922 Großschönau, Austria
Construction/retrofit year:	2000
Location (coordinates):	48.651979, 14.943063
Altitude (m):	700m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	678
Number of floors	2

Some construction details are given in the following tables:

	Materials	Thickness (m)
External walls	Bricks	0,4-0,65
	EPS	0,06
Internal walls	Bricks	0,1-0,7
Roof Construction	Gypsum Plaster Board	0,02
	Wood Beams	0,24
	Rock Wool	0,24
	Roof Tiles	0,04
Floor Construction	Concrete	0,2
	EPS	0,05
	Tiles / PVC / Laminate	0,03
Windows / Doors Frame	Wood	
Glazing type	2 glasses	
Shading	no	

- **Sonnenplatz Großschönau**

This stand-alone building is mainly used as an office, and has rooms for hosting events, seminars and congresses. Furthermore, it is the reception of a close-by tourist attraction and is equipped with a small cafeteria. Occupancy and use hours are throughout the whole year from 7 to 17, from Monday to Saturday. Connected to this building, the permanent exhibition SONNENWELT is situated. The following sections will provide more details about the building, use and energy related information.

Address: Post Code: Country:	Sonnenplatz 1 3922 Großschönau Austria
Construction/retrofit year:	2011
Location (coordinates):	48.648706, 14.936597
Altitude (m):	700m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	825
Number of floors	2

Some construction details are reported in the following tables:

	Materials	Thickness (m)
External walls*	Aerated Concrete	0,25
	EPS Plus	0,24
Internal walls	Aerated Concrete	0,12-0,25
Roof Construction	Orientated Strand Board	0,03
	Wood Beams	0,40
	Cellulose	0,40
	Wood Fibre Insulation Board	0,02
Floor Construction	Concrete	0,07
	EPS	0,07
	Concrete	0,30
	Foam Glass	0,40
Windows / Doors Frame	Wood/Aluminium	
Glazing type	3 glasses	
Shading	yes	

- **School including Gymnastic Hall**

This stand-alone building is composed of an elementary school and a gym. Occupancy depends on each zone, that is, school opening hours and on demand (according to needs) for the gym. The following sections will provide more details about the building, use and energy related information.

Address: Post Code: Country:	Großschönau 120 3922 Großschönau Austria
Construction/retrofit year:	1994
Location (coordinates):	48.651501, 14.939695
Altitude (m):	700m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	1302
Number of floors	3

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks	0,38
Internal walls	Bricks	0,25
Windows / Doors Frame	Wood	
Glazing type	2 glasses	
Shading	no	

- **Kindergarten**

This stand-alone building is used as a kindergarten. Occupancy is related to opening hours that are concentrated during the morning for weekdays. The following sections will provide more details about the building, use and energy related information.

Address: Post Code: Country:	Großschönau 96 3922 Großschönau Austria
Construction/retrofit year:	1996
Location (coordinates):	48.651054, 14.941178
Altitude (m):	700m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	441
Number of floors	1

Some construction details:

	Materials	Thickness (m)
External walls 1*	Bricks	0,3
	EPS	0,24
External walls 2*	Bricks	0,3
	EPS	0,06
Internal walls	Bricks	0,15-0,3
Roof Construction 1*	Gypsum Plaster Board	0,02
	Wood Beams	0,20
	Rock Wool	0,20
	Roofing	0,02
Roof Construction 2*	Gypsum Plaster Board	0,02
	Wood Beams	0,40
	Rock Wool	0,40
	Roofing	0,02
Floor Construction 1*	Concrete	0,2
	EPS	0,05
	Tiles / PVC / Laminate	0,03
Floor Construction 2*	Concrete	0,2
	EPS	0,34
	Tiles / PVC / Laminate	0,03
Windows / Doors	Frame	Wood
	Glazing type	2 glasses
	Shading	partially

*An add-on was constructed in 2016/17 with more insulation.

- **Guesthouse**

This building has both private (residential) and commercial use as a guesthouse. The following sections will provide more details about the building, use and energy related information.

Address: Post Code/City: Country:	Großschönau 97 3922 Großschönau Austria
Construction/retrofit year:	1977
Location (coordinates):	48.649920, 14.936131
Altitude (m):	700m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	1010
Number of floors	4

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks	0,3
	EPS	0,06
Internal walls	Bricks	0,12
Roof Construction	Gypsum Plaster Board	0,02
	Wood Beams	0,18
	Rock Wool	0,18
	Roof Tiles	0,04
Floor Construction	Concrete	0,2
	Tiles / PVC / Laminate	0,03
Windows / Doors Frame	Wood	
Glazing type	2 glasses	
Shading	no	

- **Examples of residential houses**

Some examples of residential houses, showing the available mixture within the district.

Address: Post Code/City: Country:	Großschönau 11 3922 Großschönau Austria
Construction/retrofit year:	2010
Location (coordinates):	48.649618, 14.938566
Altitude (m):	700m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	190.91
Number of floors	2

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks	0,25
	EPS	0,22
Internal walls	Wood	0,12
Roof Construction	Gypsum Plaster Board	0,02
	Wood Beams	0,30
	Rock Wool	0,30
	Roofing	0,02
Floor Construction	Concrete	0,2
	EPS	0,1
	Concrete	0,06
	Tiles / PVC / Laminate	0,03
Windows / Doors Frame	Wood / Aluminium	
Glazing type	3 glasses	
Shading	partially	

Address: Post Code/City: Country:	Großschönau 55 3922 Großschönau Austria
Construction/retrofit year:	ca. 1900
Location (coordinates):	48.653887, 14.942281
Altitude (m):	700m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	115
Number of floors	1

Some construction details:

	Materials	Thickness (m)
External walls*	Stones and Bricks	0,60 - 0,75
Internal walls	Bricks	0,10 – 0,30
Roof Construction	Wood Beams	0,16
	Roofing	0,02
Floor Construction	Concrete	0,15
	Tiles / PVC / Laminate	0,03
Windows / Doors Frame	Plastic	
Glazing type	2 glasses	
Shading	no	

Address: Post Code/City: Country:	Großschönau 113 3922 Großschönau Austria
Construction/retrofit year:	1990
Location (coordinates):	48.649797, 14.938033
Altitude (m):	700m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m^2)	370.34
Number of floors	3

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks	0,38
Internal walls	Bricks	0,10 – 0,25
Roof Construction	Gypsum Board	0,02
	Wood Beam	0,18
	Rock Wool	0,18
	Roof Tiles	0,04
Floor Construction	Concrete	0,2
	EPS	0,06
	Tiles / PVC / Laminate	0,03
Windows / Doors Frame	Plastic	
Glazing type	2 glasses	
Shading	no	

Address: Post Code/City: Country:	Großschönau 119 3922 Großschönau Austria
Construction/retrofit year:	1996
Location (coordinates):	48.650446, 14.9937721
Altitude (m):	700m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	372
Number of floors	

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks	0,38
Internal walls	Bricks	0,10 – 0,20
Roof Construction	Gypsum Boards	0,02
	Wood Beam	0,10
	Rock Wool	0,10
	Roof Tiles	0,04
Floor Construction	Concrete	0,2
	EPS	0,06
	Tiles / PVC / Laminate	0,03
Windows / Doors Frame	Wood	
Glazing type	2 glasses	
Shading	no	

Address: Post Code/City: Country:	Großschönau 118 3922 Großschönau Austria
Construction/retrofit year:	1996
Location (coordinates):	48.650537, 14.9937434
Altitude (m):	700m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	180.5
Number of floors	3

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks	0,38
Internal walls	Bricks	0,10-0,20
Roof Construction	Gypsum Boards	0,02
	Wood Beam	0,10
	Rock Wool	0,10
	Roof Tiles	0,04
Floor Construction	Concrete	0,2
	EPS	0,06
	Tiles / PVC / Laminate	0,03
Windows / Doors Frame	Wood	
Glazing type	2 glasses	
Shading	no	

Address: Post Code/City: Country:	Großschönau 59 3922 Großschönau Austria
Construction/retrofit year:	1950
Location (coordinates):	48.650717, 14.939199
Altitude (m):	700m
Position:	Stand-Alone
Surroundings:	Village
Gross total area (m²)	145
Number of floors	1

Some construction details:

	Materials	Thickness (m)
External walls*	Bricks and Stones	0,60 – 0,75
Internal walls	Bricks	0,15 – 0,45
Roof Construction	Wood Beams	0,16
	Roofing	0,02
Floor Construction	Concrete	0,2
	Tiles / PVC / Laminate	0,03
Windows / Doors Frame	Wood	
Glazing type	3 glasses	
Shading	no	

5.3. Energy System

More than one kWp of photovoltaic is installed per capita in the municipality, bringing the municipality to the Top10 in this measure in the Lower Austria region. 21 of 109 buildings have PV installed, with more than 350 kWp power installed. Several buildings have more than one PV installation, installed at different stages, and solved as standalone installations within the same building due to technical reasons. The smallest installed PV has a size of 1,08 kWp, and the largest 72 kWp.

Within Großschönau, an energy data measuring network is in place for all public buildings, and step-by-step also private houses are being connected. There are several public charging stations for electrical cars, privately and commercially used battery storages in addition to the before mentioned PV-installations, and a small wind turbine is being installed this year. Two energy communities are set up in line with the Austrian law. The pilot site is situated within the distribution area of electricity DSO NÖ Netz GmbH. Furthermore, within the pilot site is a distant heating system set up, which is based on wood chips as energy source. For the data collection and the following operational analysis, we received some information both from NÖ Netz GmbH, the distant heating association, as well as the Municipality of Großschönau, supporter of the project *SIMPLY Positive*.

Electricity

Großschönau has no connection to the high voltage grid in the near surroundings. The area is accessed from two different medium voltage grids, coming from the south and the north respectively. The low voltage grid is provided by five different substations, see Figure 30.

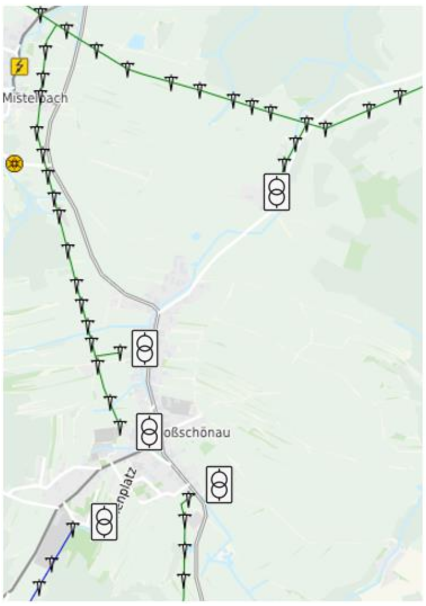


Figure 30 – Voltage grid

Großschönau is supporting the installation of DER, especially solar panels, by providing tailored information to all interested residents and helping throughout the whole project with its contacts and know-how. At this moment, the installation of a small wind turbine is happening within the village, and currently land is being formally dedicated for the usage of a green-field PV power plant within the new zoning plan of Großschönau.

From the 131 listed buildings in Großschönau, more than 20 have PV installed, with more than 350 kWp power installed. Several buildings have more than one PV installation, installed at different stages, and solved as standalone installations within the same building due to technical reasons. The smallest installed PV has a size of 1,08 kWp, and the largest 72 kWp.

All public buildings and installations in the whole municipality are measured and evaluated on a regular basis, with recommendations defined for further improvements and actions to reach self-sufficiency. Based on the latest available data from 2020, public buildings and installations use 201.497 kWh of electricity, where own produced electricity covered 60.763 kWh, and the rest was purchased as 100% renewable electricity from the regional energy supplier EVN AG.

Based on the overall energy concept, private households of the whole municipality used a total of 1.414.627 kWh of electricity within 2021 and had 1.377 kWp installed PV in 2020.

Heat

Within the municipality Großschönau heat is produced mainly (97 %) by firing biomass. The area of Großschönau is covered by 37 % with forests, which would allow even bigger energy gains from this resource. The remaining 3 % of heat are coming from oil-based heaters used in buildings which are not permanently occupied, and therefore the owners are not willing to invest into a change without a need, e.g., due to technical misfunctioning of the system. Within 2020 in the whole municipality 15.903.350 kWh of heat energy have been produced from biomass, and a total of 16.475.433 kWh of energy was used for heating.

Already in 1994, a distant heating network started its operation in Großschönau, covering >50 % of the heat energy used within the village Großschönau. The current power of the stove is 500 kW and supplies a total of maximally 700 kW of users. As the maximal usage never occurs at the same time, the discrepancy in maximal capacities is not problematic, and the heating network could be even increased a bit during the last years. During summer the network is providing warm water for its users, so that they can effectively avoid any other heating possibility in their houses. The whole distant heating unit is run by locally sourced wood chips. It was one of the first distant heating units burning only biomass in the bigger surroundings.

Thanks to constant developments and improvements of the distant heating system, it is very efficient, having different operational scenarios for summer and winter usage, allows for bidirectional heat injection, and can be used as puffer for solar heat energy. The scheme of the network is shown in Figure 31.

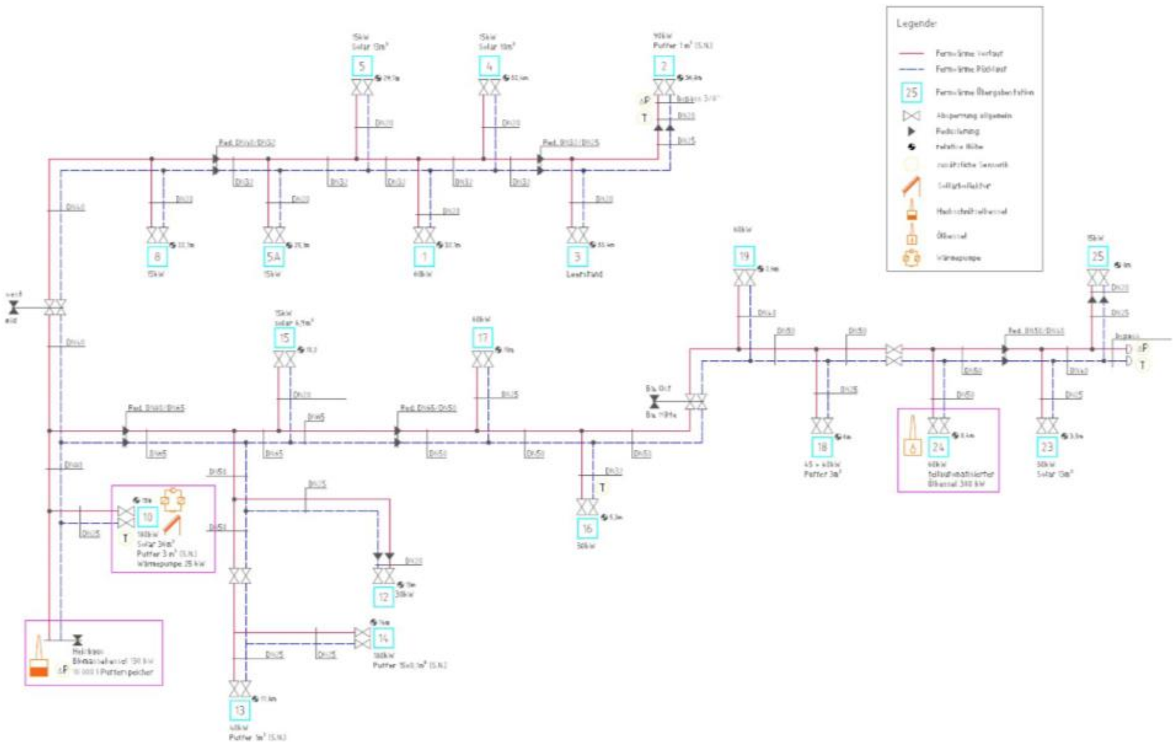


Figure 31 – The scheme of the heating network

Mobility

Großschönau is situated remotely, with large distances to bigger cities (district centres Gmünd and Zwettl 20 km each, Linz 70 km, Vienna 130 km). Therefore, individual mobility has the highest share. Public transport is realized via bus lines, which are targeted mainly to school pupils and not really suited for everyday travelling or commuting.

Großschönau was assessing the potential of carsharing by performing a feasibility study. Due to the rather low amount of interested persons no service could be offered yet.

Walking and biking are supported by the municipality and a high-quality infrastructure has been established, with separate walking and biking tracks connecting all villages within the municipality. This was realized with the active participation of local citizens, bringing in their point of view and supporting to create a best usable outcome.

Also, electric cars are supported by the municipality. 8 e-car loading stations are available, 6 of them offering solar energy for free to recharge your e-car. Financial support is provided for the creation of loading infrastructure and / or the switch to electric vehicles.

Nevertheless, close to 100% of energy used in this sector is still provided by fossil-based resources. This sector therefore has the highest potential but is also the most complicated to tackle.

5.4. Operation Scenarios

The municipality Großschönau was developing an overall energy concept [3] in December 2021 and approved it formally within the city council during its first session in 2022. Within this concept the municipality confirms the higher-ranking goals starting at an international level with the Paris-treaty, the 17 sustainable development goals of UN, fit for 55 from European Union, then coming to a national level with the Austrian governmental program 2020-2024, and to a regional level with targets of Lower Austria, climate goals of Lower Austrian municipalities, the energy pact of Waldviertel, and the regional goals of the area Lainsitztal. Großschönau aims to reach always the most ambitious target of the stated higher-ranking goals.

Großschönau aims to be a Positive Energy Municipality by 2030 (a municipality is being self-sufficient on a yearly energy balance level regarding electricity by 2025, incl. consumption of local industry) including mobility and is proactively working towards this aim, in line with its slogan “Spür die Energie” in English “Feel the Energy”.

6. Multi-stakeholder governance in PEDs

In an output-oriented perspective, PEDs can be described as *"energy-efficient and energy-flexible urban areas or groups of connected buildings which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy"* [7]. In this perspective PEDs are the *"integration of different systems and infrastructures and interactions between buildings, the users and the regional energy, mobility and ICT-System"* promoting local energy efficiency, production, and flexibility [7]. To achieve such integrations and interactions, different procedural frameworks for designing energy-related aspects of PEDs have been proposed in recent years [e.g. 8–11].

Complementing this output-oriented perspective, a governance perspective reads PEDs as mid- to long term development processes that *"will always involve multiple buildings blocks and a large number of stakeholders and contributors, which will each have their own ambitions, agendas, interests and constraints"* [12]. Here, the role of municipalities and local authorities in promoting a PED development processes as vehicle for their own urban renewal and/or Smart City strategies. Doing so raises questions of how to identify stakeholders, activate their co-creation potential and coordinate their interactions in fair and transparent ways. As shown by Krangsås et al. [13], finding answers to such governance related questions is the most relevant key challenge for realizing PEDs:

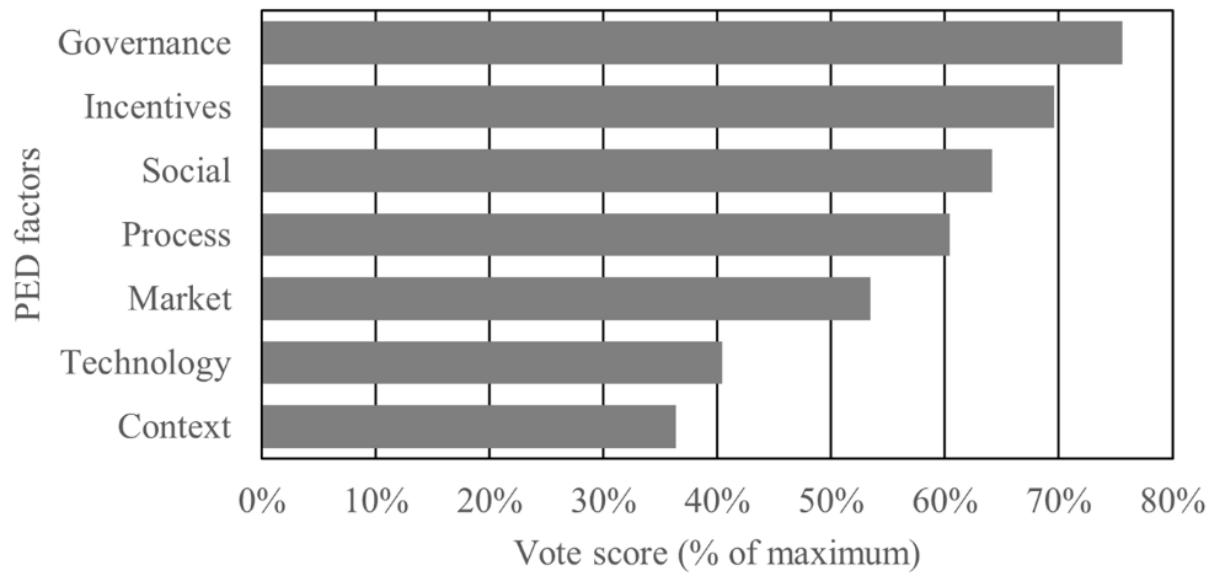


Figure 32 – Key challenges for implementing PEDs [13]

Trying to meet the need for innovative forms of collaboratively designing, implementing, and sustaining positive energy development paths for districts two strands can be identified in the ongoing discussion:

On the one hand, contributions focusing on theoretical insights by providing procedural frameworks for the inclusion of stakeholder in den design and implementation of PEDs [e.g. 14]:

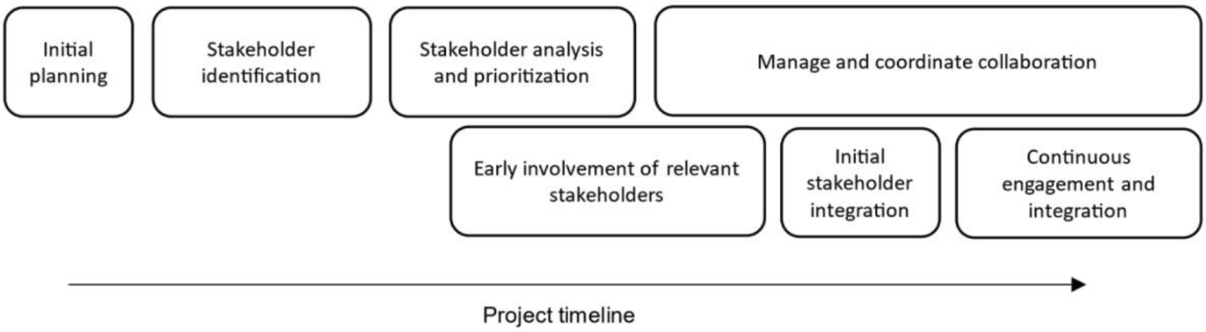


Figure 33 – A generic stakeholder management model [14]

Due to their theoretical perspective, contextual factors like climatic circumstances, district characteristics or legal frameworks are often represented as varying interferences out of the model´s scope.

On the other end of the spectrum, in depth presentations of highly contextualized stakeholder participation (sub-)processes in existing PEDs can be found [e.g. 15–17]. Besides the plurality of stakeholders involved in PED processes, a clear focus in citizen participation [8, e.g. 18–21] can be identified in recent contributions. So far, only a very limited number of studies [e.g. 22] on the multi-stakeholder governance of designing and implementing of PEDs have been conducted.

6.1. A multi-stakeholder perspective on ongoing PED projects

From the perspective of communities and administrations the distinction between an output- and a process-oriented perspective on PEDs seems to be an academic finesse. Being aware of these perspectives offers the opportunity to combine insights on substantial characteristics of ongoing PED projects [e.g. 23, 24] with insights on the governance arrangements behind the design and implementation of these PEDs [e.g. 22]. Such a combined analysis can offer communities and administrations valuable inspirations on how to conceptualize their multi-stakeholder PED design and implementation processes.

To provide such a combined analysis, we focus on the following pages on three questions:

A) What development strategies for PEDs can be identified in ongoing projects?

B) What governance arrangements have been used for designing and implementing these development strategies?

C) What typical stakeholder constellations were involved in these arrangements?

6.2. Methodological approach

An initial systematic review of existing literature on stakeholder collaboration in the design and implementation phase of ongoing PED projects within the EU built the basis of our analysis. From this review a corpus of materials on

- **characteristics of ongoing PED projects with the EU**
- **governance arrangements for designing and implementing PED projects**

was formed for further qualitative analysis. In this analysis, special focus was given on finding overlaps between in the materials on characteristics of ongoing projects [e.g. 23, 24] and governance arrangements [e.g. 22]. These overlaps were critically reviewed, if they allow a coherent connection between the characteristics of PED projects and the associated governance arrangements. We were able to identify two such overlaps – reproducing insights also found in the Cities4P EDS project [22]:

- **The variety in legal frameworks:**
  Ranging from subject legislation to constitutional law, different national to local legal frameworks proved to be an influential factor for PED governance arrangements. Since these legal frameworks form an unalterable context – but not a characteristic of PED projects – they were excluded from further analysis.
- **The overall PED development strategy:**
  Three archetypical strategic approaches on how and where to implement PEDs have been identified:

Table 9 – Archetypical PED development strategies

Archetype	PED development strategy	Ownership of land
Greenfield development (GFD)	district development by using agricultural or other undeveloped land for new buildings and infrastructure	centralized
Brownfield development (BFD)	district development by reusing developed and/or industrial land for new buildings and infrastructure	semi-centralized to distributed
Stock development (SD)	district development by adapting existing buildings and infrastructure	disperse

Using these archetypical PEDs development strategies as unifying framework, we addressed research questions A to C:

For the distribution of the development strategies in ongoing PED projects (question A) we started with identifying ongoing PED projects in Europe. Doing so, we started with the PED database elaborated by Zhang et al. [24], which was thankfully provided by Xingxing Zhang. This database included 60 PED projects, which were supplemented by PED projects found during our literature review on ongoing PED projects which included these sources:

Table 10 – Sources for the review on ongoing PED projects

Source	PED projects*
PED-database from Zhang et al. (2021)	60
JPI Urban Europe Booklet on PED projects [25]	19
PED database at PED EU NET [26]	14
PED projects listed at PED EU NET [27]	8
PED projects listed at JPI Urban Europe "Positive Energy Districts and Neighborhoods Pilot Call" [28]	17
Overall:	118

This total of 118 PED projects were checked in a qualitative analysis, if each project qualifies as PED according to the definition given by JPI Urban Europe [7][1]. Since a lot of the reviewed PED projects proved to be initiatives towards reduced energy consumption in general, this narrower understanding of PEDs led to significant reduction of projects under investigation (n: 55). For each of these remaining PED projects a qualitative assessment of the dominant development strategy was conducted, based on available project materials.

To answer what typical governance arrangements (question B) and stakeholder constellations (question C) are in place for designing and implementing ongoing PED projects, qualitative content analysis was used.

[1] According to this definition, PEDs are "energy-efficient and energy-flexible urban areas or groups of connected buildings which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy".

6.3. Development strategies in ongoing PED projects

In our sample of 55 ongoing PED projects we can find a rather balanced distribution of archetypical development strategies:

Table 11 – Frequencies of development strategies in ongoing PED projects

Archetypical PED development strategy	Project count
SD: Stock development	16
BFD: Brownfield development	15
GFD: Greenfield development	14
BFD & SD	4
GFD & BFD	4
GFD & SD	1
GFD, BFD & SD	1
Total:	**55**

For themselves, stock development as well as green and brownfield development account for about 26% to 29% of the total PED projects under investigation (cf. Figure 34). In nearly every fifth (18%) PED project two (or more) development strategies were combined: In each case of 4 projects brownfield development was combined with stock development as well as with greenfield development. Only one project expanded an existing brownfield with existing buildings, combining all three development strategies.

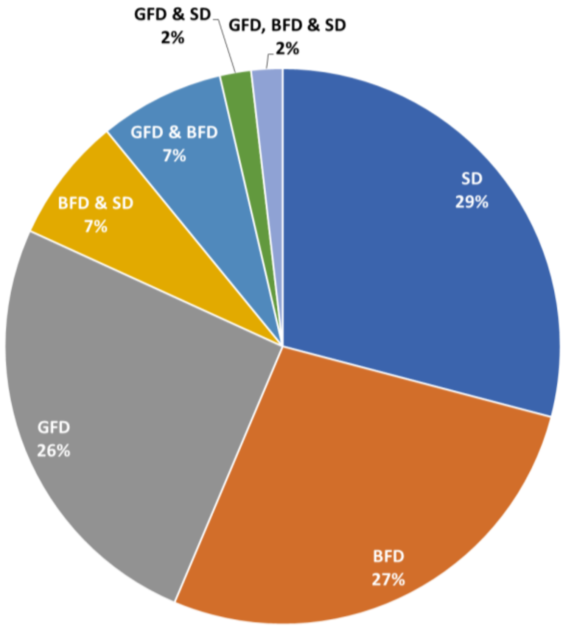


Figure 34 – Distribution of PED development strategies

Analyzing the narratives backing the selected PED development strategy is in most cases strongly influenced by existing urban development strategies as well as the demographic development behind it. Greenfield development approaches have the most ambitious urban and energetic targets, aiming for fully integrated smart districts to accommodate a growing population outside the existing city pace. Brownfield development approaches often focus on reinventing former industrial or commercial districts inside the city space. Energy optimized new buildings and their integration in existing large-scale infrastructures (like district heating systems) form the core of the energetic redevelopment. Like greenfield developments, accommodating a growing population is the main motivation behind this development strategy – only this time on already developed plots of land inside the city space. In contrast, PEDs based on a stock development strategy are not driven by demographic pressure. Most stock development projects focus on the energetic upgrade of selected buildings stocks (e.g. historic centers or municipal buildings).

6.4. Governance arrangements and stakeholder constellations for designing and implementing ongoing PED projects

Reviewing literature on the multi-stakeholder governance of PED projects, we found a clear **focus on citizens as stakeholders** and their participation [17, 19 – 21, e.g. 29, 30]. These citizen-centric studies cover the design and implementation of participation methods for promoting energy citizenship, ranging from narrative tours over participatory mappings to capacity building interventions.

These citizen-centric approaches take place in wider governance arrangements (including multiple non-citizen stakeholders) for the implementation of PEDs. These wider, multi-stakeholder perspective on governance arrangements to design and implement PEDs received significantly less attention so far. Only a very limited number auf studies tried to provide insights in these multi-stakeholder arrangements [14, e.g. 15, 16, 22]. From this very limited number of studies, the insights provided by Cities4PEDS Atlas [22] on recurring PED implementation strategies proved to be the most empirically grounded one. Using qualitative content analysis, we were able to clearly link these seven recurring strategies with our initially identified three PED development strategies. This enabled us to link our sample of ongoing PED projects to the recurring implementation strategies identified in the Cities4PEDS project. Since this link only provides an educated guess on the actual multi-stakeholder governance strategies in the sampled PED projects, an adjustment between the assumed and actually implemented strategies became necessary. Based on materials available for each sampled PED project, a qualitative alignment was made. Beside some minor deviations, this alignment revealed a remarkably good fit between the assumed and actually implemented governance strategies. Due to this goodness of fit, no inductive additions had to be made to the initial seven recurring development strategies form the Cities4PEDS Atlas [22]. Hence, our analysis clearly confirms the validity of the findings of the Cities4PEDS Atlas.

Table 12 provides an overview on the validated multi-stakeholder governance strategies identified in our sample of ongoing PED projects.

Table 12 – Typical PED development strategies and their multi-stakeholder approaches [Source: Own creation 2023; based on: 22]

PED development strategy en détail		District characterization	Energy approach	Multi-stakeholder approach	PED examples
Greenfield development (GFD) and/or Brownfield development (BFD)	High-target, **city coordinated** energy district	newly built-up areas inside the city, high density, high integration targets, centralized planning culture, governmental development initiative, central ownership	• **expansion of existing centralized energy system: district heating** • additional decentral systems: heat exchanger, solar panels etc.	High-target, city coordinated energy district	newly built-up areas inside the city, high density, high integration targets, centralized planning culture, governmental development initiative, central ownership
	Satellite, company coordinated smart energy district	Independent districts on the outskirts, central ownership, strong focus on integration (smart grid etc.)	• **full integration (e-mobility, smart grid & smart buildings)** • **centralized energy systems (existing district heating system, deep geothermal etc.)** • complementary technologies (battery storage, smart meters, water management etc.)	Satellite, company coordinated smart energy district	Independent districts on the outskirts, central ownership, strong focus on integration (smart grid etc.)
Brownfield (BFD) &	Mixed-use, company	newly built-up multifunctional areas, close to inner city, boost reputation of district	• **new building stock: centralized system (e.g. heat network)**	Mixed-use, company coordinated energy district	newly built-up multifunctional areas, close

simply positive

PED development strategy en détail		District characterization	Energy approach	Multi-stakeholder approach	PED examples
	coordinated energy district		• building stock: decentral systems (e.g. solar panels, heat pumps, biofuel boilers) & renovation		to inner city, boost reputation of district
	Uniform, locally supported district with energy as a lever	Outskirt districts, pre- & postwar uniform building typology, car-oriented, housing cooperation ownership, socio-economic vulnerable residents	• **often no clear focus on energy transition: energy as leverage for tackling other societal challenges.** • **use of industrial residual heat** • **block building stock: connect to centralized systems (e.g. district heating)** • other building stock: incremental roll out of low-cost decentral solutions	Uniform, locally supported district with energy as a lever	Outskirt districts, pre- & postwar uniform building typology, car-oriented, housing cooperation ownership, socio-economic vulnerable residents
	Historical, block-by-block, city-coordinated energy district	historical districts in the city center, cultural and touristic significance, higher density, expensive renovation, few inhabitants	• **Smaller, decentralized solutions (e.g. solar panels, heat pumps)**	Historical, block-by-block, city-coordinated energy district	historical districts in the city center, cultural and touristic significance, higher density, expensive renovation, few inhabitants

simply positive

PED development strategy en détail		District characterization	Energy approach	Multi-stakeholder approach	PED examples
			• Renovation of historic building stock (preserve heritage)		
	Diverse energy district without central coordination	Districts near the city center, diverse building structures, fragmented ownership	• **step-by-step rollout of decentral systems (e.g. heat pumps, solar panels, local geothermal energy)** • renovation of building stocks	Diverse energy district without central coordination	Districts near the city center, diverse building structures, fragmented ownership
	Citizen-owned infrastructure in a village energy district	rural context, dispersed & low-density residential building stock, privately owned	• **solutions outside the settlement (e.g. wind turbines, open space photovoltaic, deep geothermal energy)** • **renovation of building stock** • densification of building stock for centralized grid solutions	Citizen-owned infrastructure in a village energy district	rural context, dispersed & low-density residential building stock, privately owned

Since our inductive approach did not indicate the need for extending the seven development strategies from the Cities4PEDS Atlas, the following description of typical multi-stakeholder governance approaches builds upon and paraphrases the insights provided by the Cities4PEDS Atlas [22]. To provide a richer understanding of these multi-stakeholder governance approaches, we adopted Cities4PEDS´s approach of providing information on a) the general PED development intention, b) typical components of the PED`s energy strategy and c) on the multi-stakeholder governance approach.

6.4.1. Typical multi-stakeholder governance approaches for green- as well as brownfield developments

6.4.1.1. Developing high target, city-coordinated energy districts

PEDs following this development strategy are typically new-built neighborhoods, often constructed on former commercial or industrial sites. The land is usually owned by a few entities like the city, a port or railway company. These neighborhoods are carefully planned to have a smart layout, with high population density, enough public spaces, and amenities like supermarkets and schools. They are commonly found in cities where the government takes the lead in planning and development, setting clear guidelines for the neighborhood's design and construction.

Since most of the cities following this PED strategy have a centralized energy system, the expansion of existing district heating systems to the newly built PED is common. Adapting these existing central systems is feasible by changing energy sources, such as using biofuel or residual heat instead of fossil fuels. The existing infrastructure can be extended or modified without major changes. To achieve a positive energy balance, innovative technologies like heat exchangers, solar collectors, and wastewater heat exchangers are employed in the PED.

Regarding stakeholder governance the city takes on the responsibility of managing and budgeting the process, aiming for greater effectiveness and flexibility. City administrations and experts collaborate to establish principles, requirements, and ambitious sustainability targets. The city enforces the construction of energy infrastructure and high-performance buildings through various means such as land sale contracts, civil law agreements, and specific building regulations. Still, a major challenge lies in determining the future users of these PEDs during the planning stage. To address this, the needs and concerns of future residents, developers, and companies are actively considered, for example through seminars and other engagement formats.

Typical stakeholders involved in this PED development strategy are:

- **In case of brownfield developments: Owners of the land to be redeveloped,**
- **various local and/or regional administrative departments,**

- **interdepartmental working groups,**
- **private as well as public developers,**
- **future residents.**

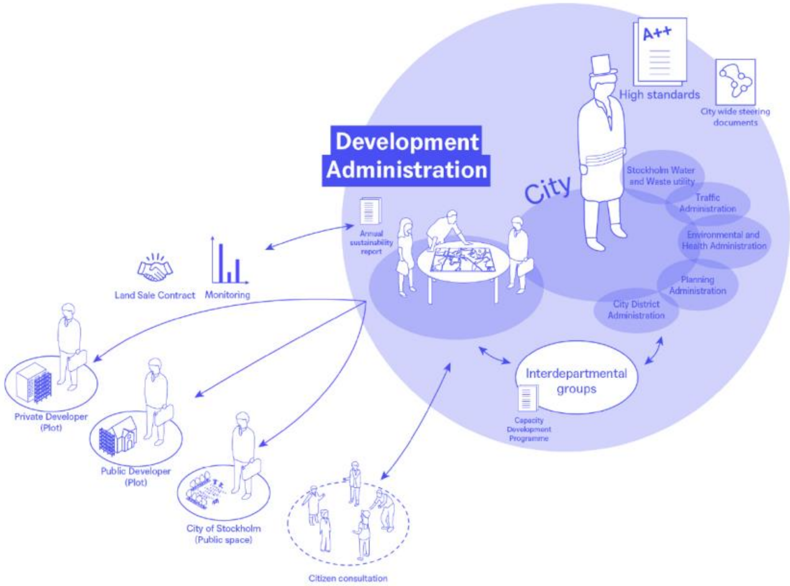


Figure 35 – Archetypical multi-stakeholder governance strategy for developing high target, city-coordinated energy districts, shown by the "Royal Seaport" project in Stockholm, Sweden [22]

6.4.1.2. Developing satellite, company coordinated smart energy districts

These PEDs on the outskirts of large cities are designed to be self-sufficient, bringing together work, living, and recreational activities. They are often developed on brownfields. These PEDs address a given need for housing and offices spaces in a city. Their structure consists of tall buildings surrounded by ample green spaces, water management systems, and areas for biodiversity. High-quality public transportation, (e.g. trains or trams) connects these PEDs to the city center. The comprehensive planning allows to prioritize concepts as reducing parking spaces, promoting electric mobility, and creating pedestrian-friendly public areas.

The PED is characterized by energy-efficient buildings – including a mix of private and social housing - and strict energy performance requirements. The energy concept of the district serves as a testing ground for innovative approaches focusing on smart grids and smart technologies to optimize the energy use of buildings. Real-life experiments are conducted to monitor and replicate effective technologies. Centralized energy systems, like geothermal or district heating, along with complementary technologies such as battery storage, smart meters, and water and air quality management systems, are utilized to meet the district's energy demand.

Being a greenfield development, the ownership structure for the PED is quite centralized: After securing the future PED's real estate the city sells the land to a Special Purpose Company.

This company can be fully or partially owned by the public or a combination of public and private entities. The Special Purpose Company temporarily becomes the owner before selling the land to developers. The revenue generated from selling the land is used to finance infrastructure projects and offset the costs of publicly funded high-quality housing. Land selling contracts ensure that developers are bound to high energy building standards, possibly going way beyond the legal building code. The development process involves project management with private developers, neighborhood management to engage with future residents, as well as research, data collection, and adjustments. These roles are often carried out by separate teams working in coordination with the Special Purpose Company.

Typical stakeholders involved in this PED development strategy are:

- **In case of brownfield developments: Owners of the land to be redeveloped,**
- **various local and/or regional administrative departments,**
- **regional and/or national administrative departments,**
- **Special Purpose Company,**
- **public developer,**
- **private developer,**
- **citizen owned development groups (e.g. "Baugruppen"),**
- **research facilities,**
- **neighborhood management,**
- **private consultants,**
- **future inhabitants.**

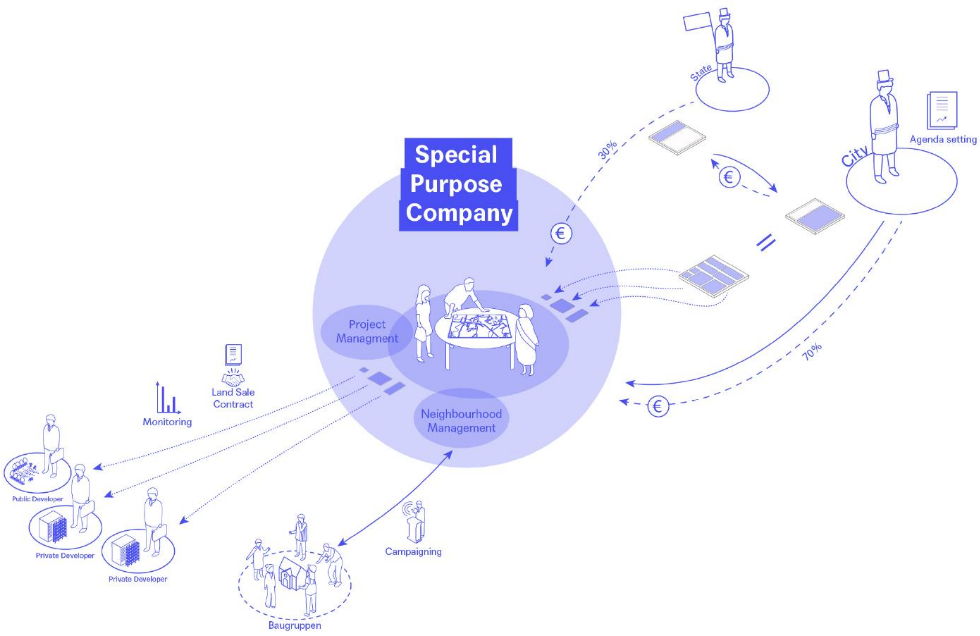


Figure 36 – Archetypical multi-stakeholder governance strategy for developing satellite, company coordinated energy districts, shown by the "Seestadt Aspern" in Vienna, Austria [22]

6.4.2. Typical multi-stakeholder governance approaches for combined brownfield and stock developments

6.4.2.1. Developing mixed-use, company coordinated energy districts

These PEDs are a combination of existing and newly built areas located near the city center in post-industrial or -commercial zones. They are designed to be multifunctional, offering spaces for living, working, cultural activities, and recreation. The districts try to enhance their reputation by including attractions like museums and emphasizing sustainability development initiatives. Often renowned architects are engaged for designing landmarks, making the districts appealing to potential residents. The guiding design principles for these districts include social diversity, architectural excellence, environmental sustainability, user comfort, and quality of life.

Following ambitious energy concepts, these PEDs often combine centralized and decentralized strategies to become energy-positive. They integrate newly built energy-efficient housing into existing urban heat networks while incorporating decentralized technologies – like solar panels and local heat pumps – for the existing building stock. For the latter, a strong focus renovation is set also.

Typically, a public special purpose company, oversees the overall PED development. After acquiring existing brownfields, the city administration hands them over to the public special purpose company. The company establishes planning and design principles that developers must follow to participate in the project, offering incentives like funds, legal benefits, and land contracts. Developers are selected through design competitions. Energy concepts are tested through partnerships and subsidies, with the goal of implementing them autonomously. To guarantee a collaborative approach, public involvement and decision-making is emphasized to engage the community from the beginning and prevent opposition later.

Typical stakeholders involved in this PED development strategy are:

- **In case of brownfield developments: Owners of the land to be redeveloped,**
- **various local and/or regional administrative departments,**
- **public developer,**
- **private developer,**
- **future inhabitants,**
- **existing residents,**
- **private consultants.**

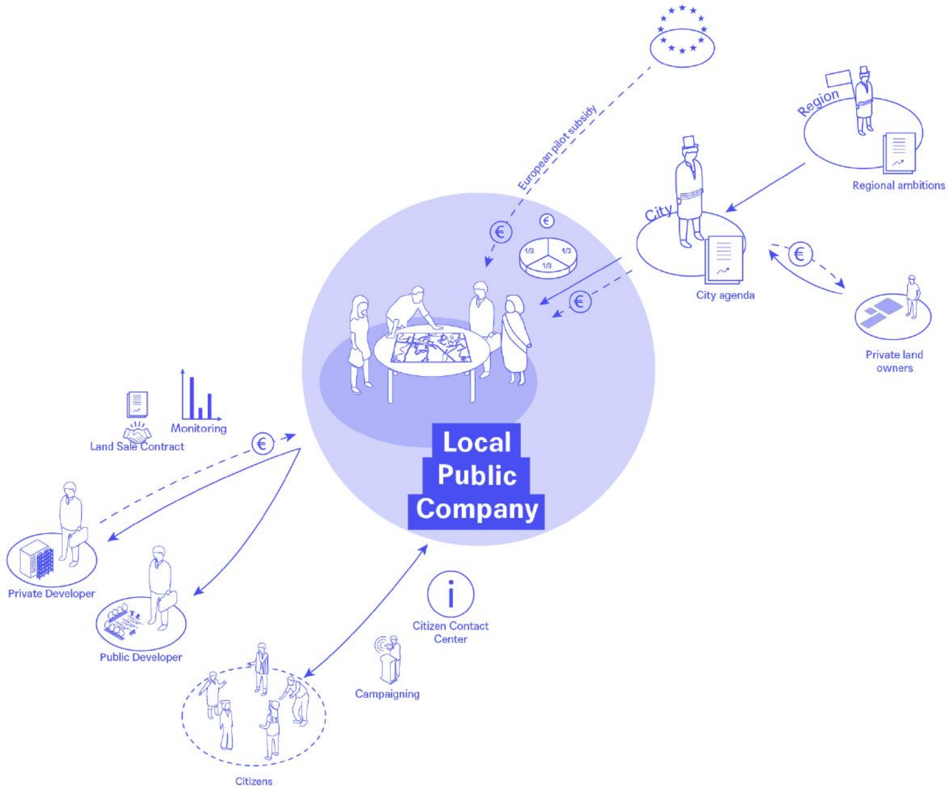


Figure 37 – Archetypical multi-stakeholder governance strategy for developing mixed-use, company coordinated energy districts, shown by the "La Confluence" project in Lyon, France [22]

6.4.3. Typical multi-stakeholder approaches for stock developments

6.4.3.1. Uniform, locally supported district with energy as a lever for further development

These type of PEDs represents districts with a mix of old and modern buildings, often featuring a limited housing typology – like row houses with gardens or apartments with shared courtyards – and rather uniform public buildings like schools or libraries. Most of the buildings are owned by housing corporations. Located on the outskirts of the city, these districts primarily attract socio-economically vulnerable residents. These districts have a car-centric design combined with low-capacity public transportation.

While energy transition may not be the primary concern in these PEDs, solutions are being developed to address multiple societal challenges like improving the overall living conditions. The uniform building structure of these districts and centralized ownership structures enable a feasible implementation of centralized infrastructures (e.g. district heating). Due to the location of these districts on the outskirts of the city, integrating the excess heat of nearby industrial activities is sometimes possible. Complementing these centralized structures, low-cost as well as low-tech solutions that are affordable are implemented gradually. To do so, initiatives like sustainability coaching, cultural projects, insulation programs, and community solar projects are set.

Due to the often-marginalized living conditions, self-organized resident groups and communities that tackle various issues like affordable housing, food distribution, and public spaces in these districts. To align local and broader development interest collaboratively, a usually informal collaborative platform bringing together local networks, city departments, and regional or national administrations is established. Such platforms often involved city administration, neighborhood cooperatives, on site cultural organizations, architects, energy consultants and/or research institutions. Together, they established a shared agenda leading to a Local Energy Action Plan (LEAP). Due to the district's uniformity, representative case studies for reducing the energy demand for schools, apartment buildings etc. can be developed.

Typical stakeholders involved in this PED development strategy are:

- **various local and/or regional administrative departments,**
- **local initiatives (e.g. neighborhood cooperatives etc.),**
- **existing residents,**
- **housing cooperations,**
- **research institutions,**
- **private consultants.**

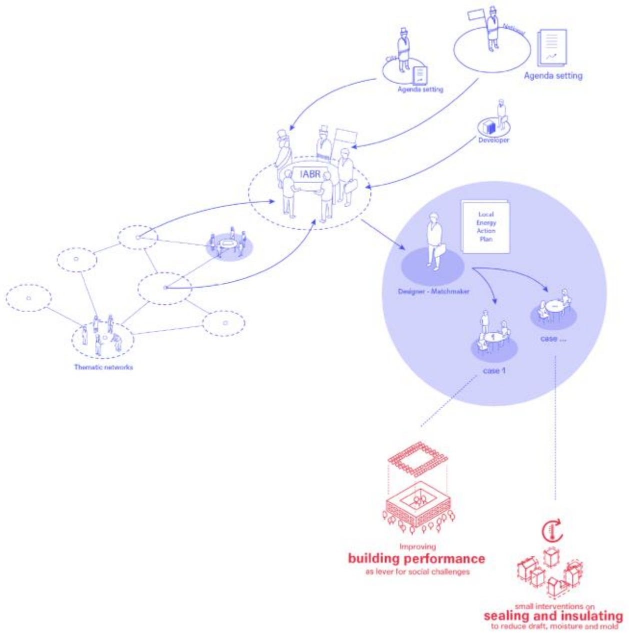


Figure 38 – Archetypical multi-stakeholder governance strategy for developing uniform, locally supported districts with energy as a lever, shown by the "Bospolder-Tussendijken" project in Rotterdam, Netherlands [22]

6.4.3.2. Developing historical, block-by-block, city-coordinated energy districts

Located in the city centers, these PEDs are districts of great historical, cultural, and therefor also touristic significance. Their unique layout and architectural style set them apart. The buildings share similar characteristics – like their building age – and apart from medieval town, they are often arranged in regular patterns. While these districts are typically densely populated and well-preserved, the buildings lack insulation and airtightness. Due to strict heritage regulations, renovating the building stock is a costly endeavor. As a result, few individuals are willing to do so, often leading to a net population loss in these districts over time.

To become energy-positive, these PEDs focus on two things: upgrading the existing local of regional grid and implementing decentralized solutions like solar panels and heat pumps. Due to the poor thermal quality of the building stock, a big focus is on renovation. This approach promotes energy-positivity while enhancing the district's appeal for residents. Since the preservation of the architectural character of the building stock is important, only minor new building modifications are targeted for. Due to the homogeneous building stock, a block-by-block replication approach is implemented: develop a strategy and business case for renovating one block, then replicate this approach in other blocks. Doing so allows for economies of scale, fosters a sense of community, and allows energy-surplus buildings to supply those that are more challenging to renovate.

The city plays a central role in the PED development process by creating the necessary one-stop-shop points of contact, like a Special Purpose Company or a new city department dedicated to sustainable district transformations. The city offers subsidies for renovation and the installation of renewable energy systems. They also take the first steps by investing in (often publicly owned) "anchor buildings" to encourage other building owners in the block owners to join. Pilot projects explore different renovation methods and serve as a blueprint for PED development. Here, the commitment of residents is crucial. Therefore, the activities of the one-stop-shop points of contact are focused on persuading, motivating, and financially supporting residents.

Typical stakeholders involved in this PED development strategy are:

- **local administrative departments,**
- **one-stop-shop point of contact (Special Purpose Company and/or city department)**
- **existing residents,**
- **local initiatives (e.g. trade or touristic),**
- **research institutions,**
- **private consultants.**

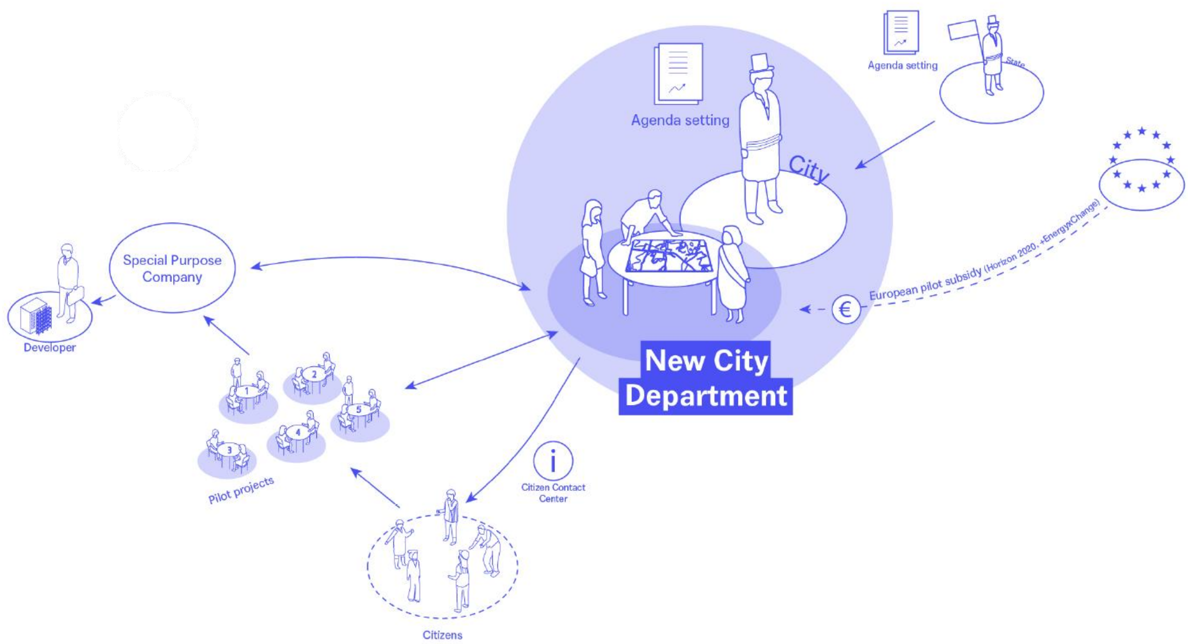


Figure 39 – Archetypical multi-stakeholder governance strategy for developing historical, block-by-block, city-coordinated energy districts, shown by the "Georgian District" in Limerick, Ireland [22]

6.4.3.3. Developing diverse energy districts without central coordination

These PEDs are often located near the city center and are characterized by a diverse range of spatial contexts: Industrial areas, offices, a mix of low- and high-income housing, and a blend of older and newer buildings. Typically, these districts have undergone significant transformations over time, resulting in dispersed ownership, diverse building types, and a wide range of socio-economic groups. Conflicts among residents are often driven by gentrification. Additionally, conflicts between residents and other users of the district – like commuters who only utilize the neighborhood for work purposes – can be observed.

Given the diversity of these districts, the transition to energy-positivity is approached gradually and with a range of methods and partnerships. Thus, decentralized technologies like solar panels, individual heat pumps, local geothermal energy, and/or residual heat are dominant. Often, the district's complementary energy usage and production patterns enables energy exchange and balancing between buildings. For the existing building stock renovation is a significant task. The challenge lies in developing a strategy that accommodates the unique needs of each home or building, including both owner-occupiers and tenants. Further complicating this task, residents are often reluctant to join, due to non-satisfactory approaches to transform the district in the past.

To govern the development process, a local coordination platform is established. This platform brings together various stakeholders, including private investors, utility provider, local and regional investment programs, and existing cooperative projects, to align local interests and opportunities. The platform serves as a space for exchanging ideas, developing a shared agenda, and fostering new partnerships and projects. It is most often overseen by the city, with support from facilitators (like administrative departments, consultants and/or utility providers) and neighborhood managers. Working groups within the platform focus on local opportunities, such as energy communities, heat catalysts, and collective renovation of the building stock. Strategies developed through these working groups can then be replicated throughout the district.

Typical stakeholders involved in this PED development strategy are:

- **local administrative departments,**
- **coordination platform (overseen by the city),**
- **existing residents,**
- **local initiatives,**
- **neighborhood management,**
- **utility provider,**
- **private consultants.**

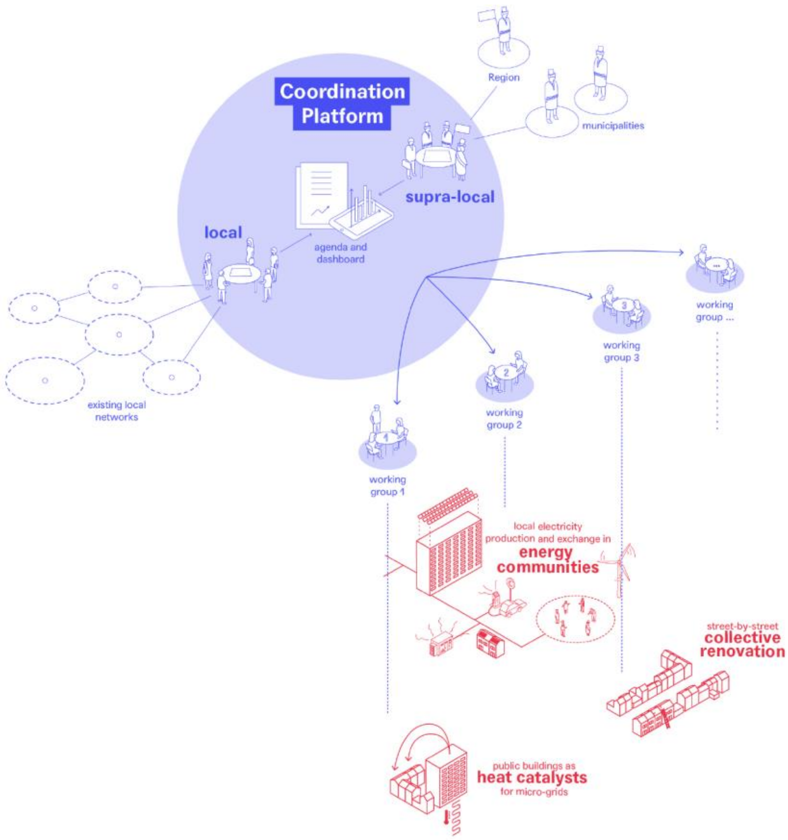


Figure 40 – Archetypical multi-stakeholder governance strategy for developing diverse energy districts without central coordination, shown by the "Northern District" in Brussels, Belgium [22]

6.4.3.4. Developing citizen-owned infrastructure in a village energy district

These PEDs exist in rural areas and have a scattered and low-density buildings structure, dominated by single family homes. Houses are almost exclusively privately owned with limited access to schools, shops, and public transportation. The main development goal is often twofold: Increase the density of these districts and/or integrate them into more efficient systems for services, mobility, and energy. Besides becoming more sustainable districts, these efforts also try to reduce infrastructure costs for the community and residents. Often, these PEDs can be found in municipalities with a stable or declining demographic development.

Due to the rural features of the PEDs, land intensive energy solutions like wind turbines, open-space photovoltaic, deep geothermal energy, and waste-to-energy plants connected to a heat grid are typically considered. Renovating and densifying the existing building stock provides an opportunity to make the necessary connections and adjustments to integrate them into central grid solutions.

The district development is often led by a citizen-owned energy cooperative. The success of this approach relies on the active participation and investment from residents. To do so, a strong emphasis is placed on highlighting fiscal, societal and other co-benefits from local energy production, raising awareness about the energy transition, and building local capacity. The cooperative aims to retain energy bill payments within the community, reinvesting the funds in local energy infrastructure for the benefit of residents and the municipality. Collaboration between the cooperative, the municipality, and private utility companies and consultants is key to implementing the energy infrastructure. Often, the municipality provides support through legal exemptions, usage rights for public land, feasibility studies, and energy consultants to facilitate the development process.

Typical stakeholders involved in this PED development strategy are:

- **local administration,**
- **citizen-owned energy cooperative,**
- **existing residents,**
- **local initiatives,**
- **utility provider,**
- **private consultants.**

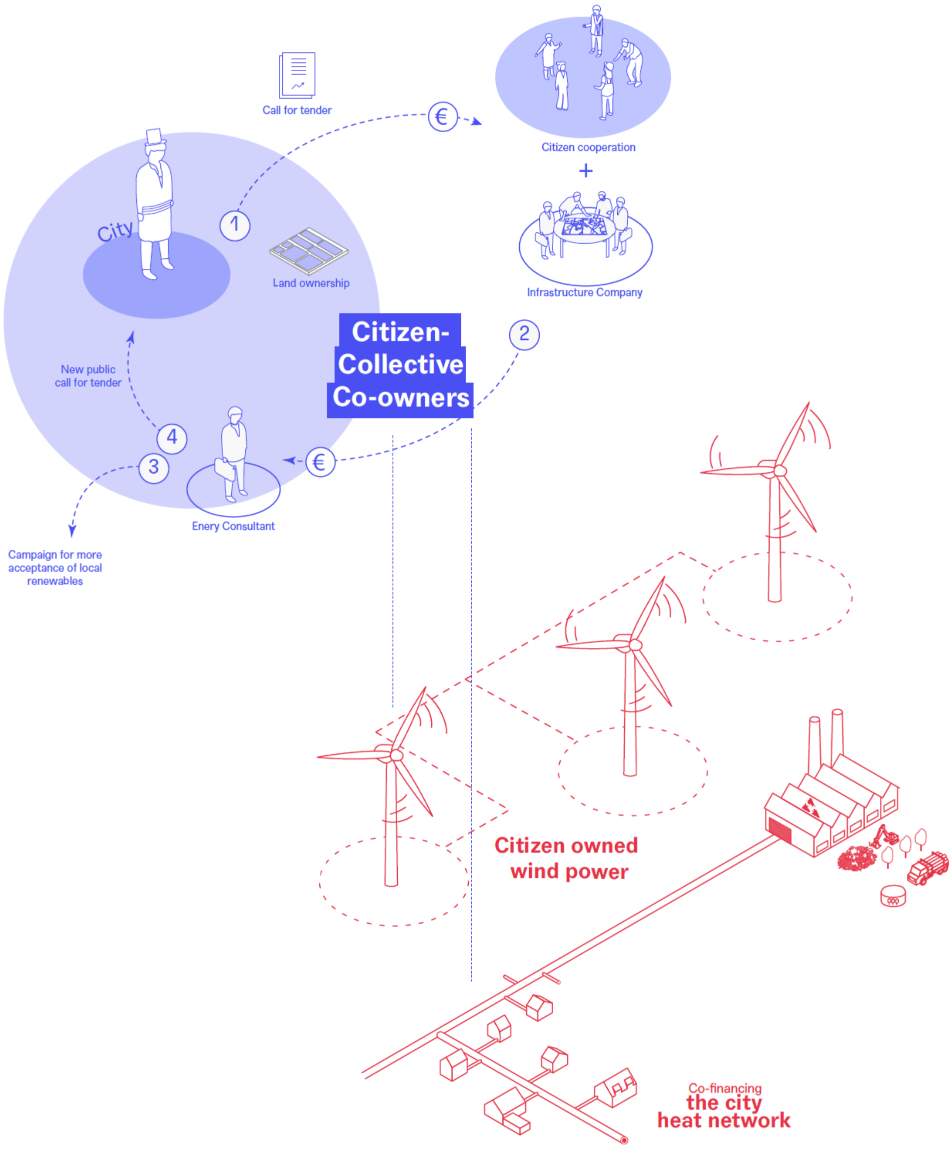


Figure 41 – Archetypical multi-stakeholder governance strategy for developing citizen-owned infrastructure in a village energy district, shown by the "Oostveld" in Eklo, Belgium [22]

7. Conclusions

The stakeholder identification gives an overview of typical stakeholder structures of green field, brown field and stock redevelopments respectively. For the purpose of this project, the last four types (6.4.3) of stock redevelopment are of particular interest: A first comparison with the district description and operation scenarios compiled here shows the following similarities:

- Resita (RO)
  - -> 6.4.3.2: city coordinated, Block-by-block
  - -> 6.4.3.3: High diversity and sometimes energy poverty
- Turin, Settimo Torinese (IT)
  - -> 6.4.3.1: Limited housing typology
- Amsterdam (NL)
  - -> 6.4.3.2: Historic, heritage protected, city coordinated, Block-by-block
- Großschönau (AT)
  - -> 6.4.3.1: Limited housing typology
  - -> 6.4.3.4: Citizen-owned infrastructure, village energy communities

This can serve as a staging ground for further analysis and research. Stakeholders involved in the project can try to use these similarities to find appropriate solutions and adopt them for their individual situation.

Furthermore, the report provides a characterization overview of the districts including parameters which identify energy use profiles within the different types of buildings involved in the project: residential, industrial, commercial and office buildings. The report includes a technical characterization of all the energy related appliances (production, storage, consumption) present in the project focus districts that link to the operational scenarios. The external influential parameters such as meteorological data were collected as well.

What is not in the report is also insightful: The lack of data and information in some sections on certain districts reflect that it was not possible to obtain said data in a form useful for inclusion in the district within six months of project start. This hints at two things:

- Data availability is highly situational and depends mostly on the extent of pre-projects conducted in the district area
- Apart from building energy performance certificates there are no data and information standards that could increase the speed and quality of the data gathering.

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