EUROPE TOWARDS POSITIVE ENERGY DISTRICTS

FIRST UPDATE

February 2020

A compilation of projects towards sustainable urbanization and the energy transition

The booklet has been collected and edited by the PED Programme Management of JPI Urban Europe –
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Interested in joining the European Positive Energy Cities network? Get in contact with us!

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The Strategic Energy Technology (SET) Plan

The SET-Plan, adopted by the European Union in 2008 and revised in 2015, is a first step to establish an energy technology policy for Europe, with a goal of accelerating knowledge development, technology transfer and up-take in order to achieve Energy and Climate Change goals.

The SET Plan focuses on 10 key actions fields, of which **action 3.2 on "Smart Cities and Communities"** aims to **support the planning, deployment and replication of 100 Positive Energy Districts by 2025 for sustainable urbanisation.**

The Joint Programming Initiative (JPI) Urban Europe

JPI Urban Europe's vision is to be the **European platform to create and make available knowledge and robust evidence for sustainable urban development.**

Twenty European countries participate in the initiative, 70+ projects have been funded with approx. 100 million Euro public investment spent for joint calls. JPI Urban Europe has established cooperation schemes with Belmont Forum and China.

PREAMBLE

The **Programme on Positive Energy Districts and Neighbourhoods (PED Programme)** has the ambition to support the planning, deployment and replication of 100 'Positive Energy Districts' across Europe by 2025 for urban transition and sustainable urbanisation. Positive Energy Districts will raise the quality of life in European cities, contribute to reaching the COP21 targets and enhancing European capacities and knowledge to become a global role model.

The Programme on Positive Energy Districts and Neighbourhoods has been established in 2018 by the Action 3.2 on Smart Cities and Communities of the European Strategic Energy Technology Plan. The transnational Joint Programming Initiative (JPI) Urban Europe provides a well-established Programme Management Structure for the PED Programme.

Solid understanding and consideration of cities' strategies towards PEDs, experiences and support needs serve as the base of developing and designing of the programme. This is why the PED programme aims at a strong engagement of city authorities, research organisation, public utility provider and industry and citizens' organisation in the programme implementation.

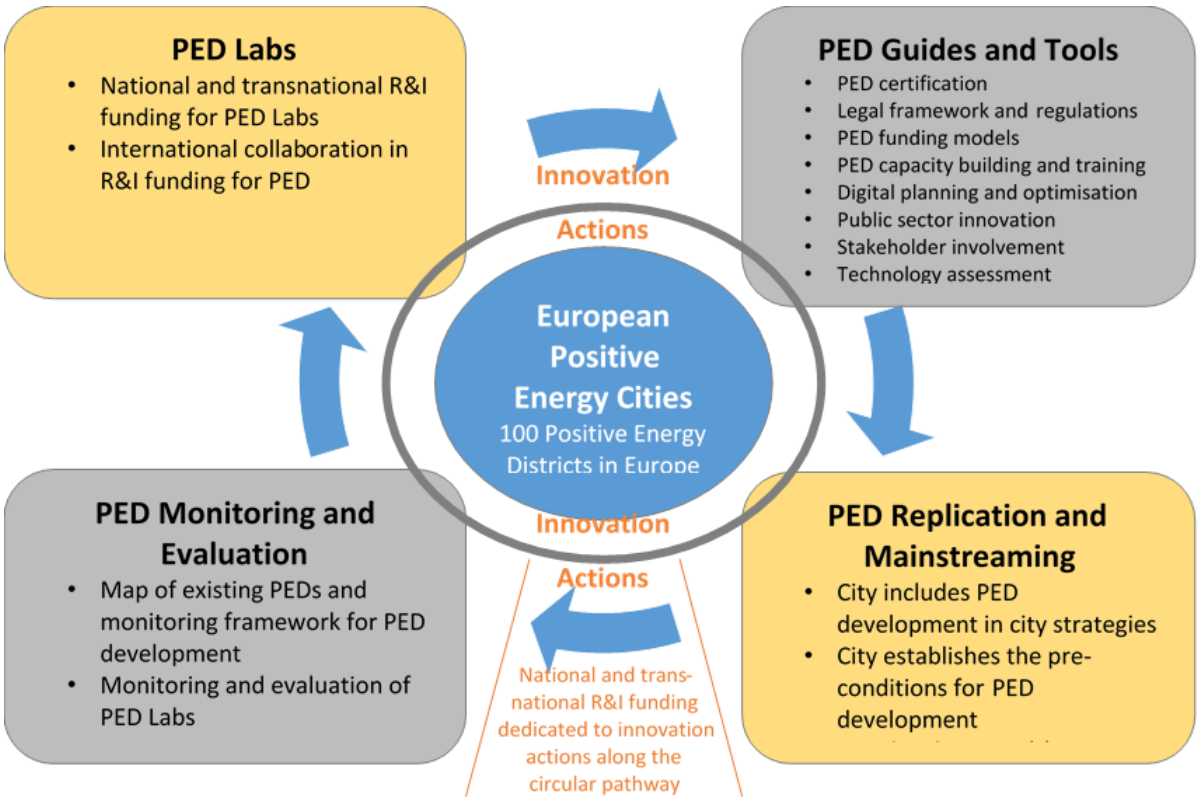

Figure 1. PED Programme implementation pathways, Source: SET-Plan ACTION n°3.2 Implementation Plan

Accordingly, the PED Programme has conducted workshops with city representatives, R&I representatives and urban stakeholders. In 2019, a PED City Panel and a PED Mobilization and Replication Group has been established. For more information on activities and calls of the PED Programme, please get in contact or visit www.jpi-urbaneurope.eu/ped.

The **PED Programme Cities Workshop (3 April 2019, Vienna)** invited cities to co-create the PED Programme in a highly interactive setting and lay the basis for further cooperation. As a preparation for the workshop, the participating cities have been asked about their PED-related project experience. The cases are collected in this booklet. Project descriptions are ordered according to their project status: "implemented/in operation", "implementation stage" and "planning stage".

After publishing a first version of the booklet based on contributions by the workshop's participants, several new cases were added and the booklet updated. The compilation is seen as work in progress, content will be updated regularly and systematic analysis will be conducted.

Projects are divided in two categories: the ones that indicated a PED ambition are described under "PED Projects" section; projects that did not declare a PED ambition but presents interesting features for the PED Programme are described in the "Towards PED Projects" section.

Each project is presented in four sub-sections:

1. General information
2. Overview and description of the project
3. Strategies
4. Success factors and challenges/barriers

An **outlook on the PED Programme** reveals that the workshop findings on support needs of cities will be analysed and turned into

1) a strategic input for a transnational PED Call Programme supported by many European countries starting in winter 2019/2020 and
2) lessons learnt for the design of a Positive Energy Districts Network with dedicated exchange and mutual learning formats.

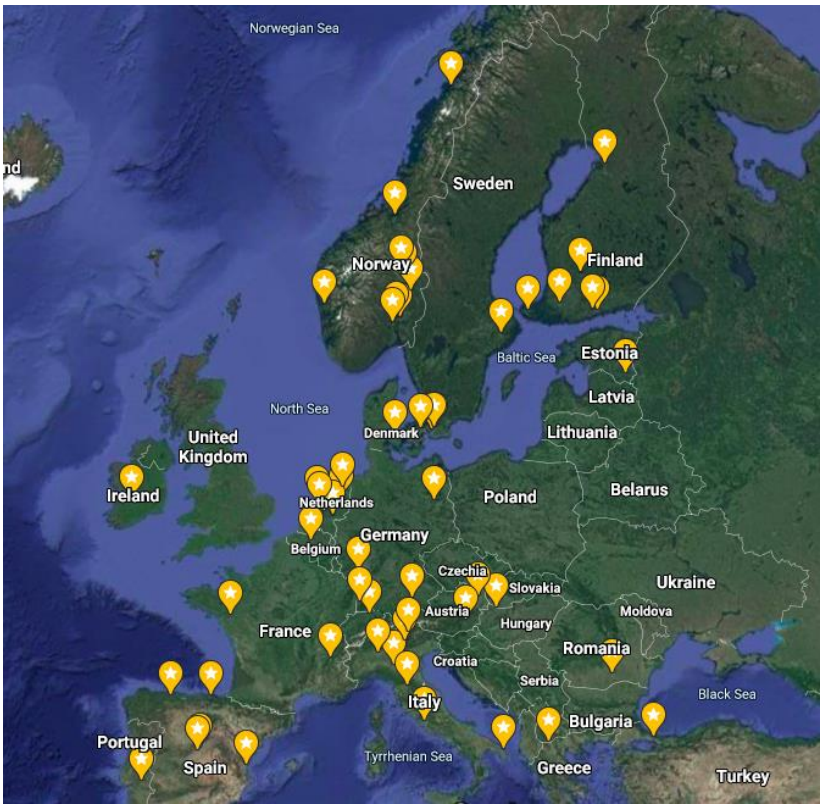

Figure 2. Geographic distribution of projects analyzed in this booklet. Source: google maps (26.02.2020)

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PED FRAMEWORK DEFINITION

The PED Programme has developed a PED framework definition, aiming at creating a common understanding of PEDs and embedding the PED ambition into overarching goals of sustainable urban development, climate action and the energy transition. Version 1 has been consulted with PED Programme supporting countries and stakeholders as well as urban stakeholders and may serve as a reference for projects; the updated version resulting from this consultation process will be published in summer 2020.

Framework Definition of PEDs, version 1

In honouring the economic, cultural and climate-related diversity of European countries and cities, a definition for such PED/PENs should not be just an algorithm for calculating the input and output of energy, but rather a framework, which outlines the three most important **functions of urban areas in the context of their urban and regional energy system**. The first obvious requirement is that PEDs should ultimately **rely on renewable energy only (energy production function)**, which is one of the main contributions towards climate neutrality. Secondly, they should make energy efficiency as one of their priorities in order to best **utilise the renewable energies available (energy efficiency function)**. Thirdly, the awareness that urban areas are bound to be among the largest consumers of energy, and therefore need to make sure that they act in a way which is **optimally beneficial for the energy system (energy flexibility function)**.

Based on such a basic framework, cities should be able to **optimize the different functions and guiding principles against one another**, in order to find a balance, which can best represent the renewable energy resources available in their respective climate zone, together with their specific ambitions and needs.

A framework for PEDs could be defined as follows:

"*Positive Energy Districts are energy-efficient and energy-flexible urban areas which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy. They require integration of different systems and infrastructures and interaction between buildings, the users and the regional energy, mobility and ICT systems, while optimizing the liveability of the urban environment in line with social, economic and environmental sustainability*."

Guidelines for identification of geographic and virtual boundaries of PED are still under discussion in collaboration with other programs[1] with the ambition of making PED/PENs achievable for wide range of possible approaches.

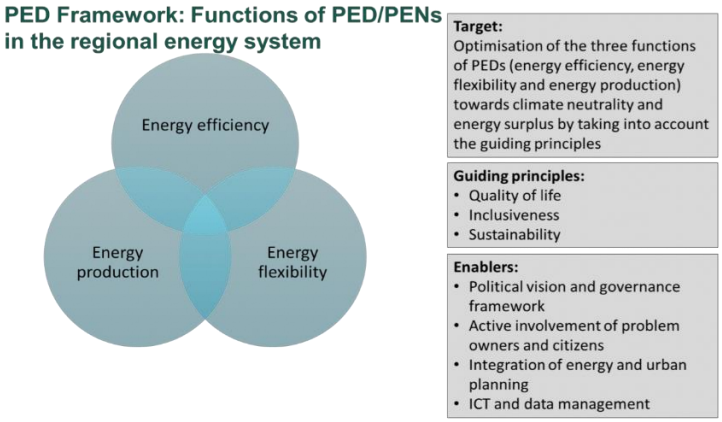


Figure 3: Functions of PED/PENs in the regional energy system

[1]EERA JPSC: https://www.eera-set.eu/eera-joint-programmes-jps/list-of-jps/smart-cities/mapping-positive-energy-districts-neighbourhoods/

Additional description of the PED framework and its functions

The three **main functions, the target, guiding principles and enablers** are described more in detail below.

PED Functions

Energy Efficiency Function. The aim is an optimal reduction of energy consumption within the PED/PENs balancing out the needs of the different sectors, building infrastructure, the use of energy, settlement typology, as well as transport and mobility. Due to its relevance, not only new urban development areas but also the existing building stock needs to be addressed. As an example, mixed use settlements could be an effective instrument towards minimizing transportation needs. By adopting a life cycle approach and assessing the energetic and ecological footprint of goods and services, also "grey energy" will be considered.

Energy Flexibility Function. The main roles and functions of PEDs regarding energy flexibility are:

- to actively contribute to the resilience and balancing of the regional energy system by managing its interactions as one of the main consumers of energy with the optimal benefit for the regional energy system in mind. Demand side management, sector coupling and storage are among the main instruments.
- to manage those interactions between the urban district/neighbourhood and the regional energy system in a way that enables carbon neutrality and 100% renewable energy in the local consumption and an additional surplus of renewable energy over the year.

Energy Production Function (locally and regionally). Locally and regionally produced renewable energy will enable an optimal reduction of greenhouse gas emissions and ensure economic viability. Nevertheless, the local production of renewable energy is highly dependent on local and regional conditions and additionally on the transformation paths for the transition of the regional and European energy system.

Target of a PED. Each PED/PEN will have to find its own optimal balance between energy efficiency, energy flexibility and local/regional energy production on its way towards climate neutrality and energy surplus taking into account the guiding principles.

Guiding Principles for a PED. The development of PED/PENs should also follow three guiding principles to make them attractive for cities and citizens:

- Quality of life
- Inclusiveness
- Sustainability

Enablers for a PED. The development of PED/PENs should make use of the following enablers:

- Political vision and governance framework
- Active involvement of problem owners and citizens
- Integration of energy and urban planning
- ICT and data management

PED PROJECTS

In this Section, 28 projects that declared a PED ambition are described. They are grouped in 3 categories depending on their development phase: Projects Implemented/In Operation (2), Projects in Implementation Stage (18) and Projects in Planning Stage (8).

Figure 5 shows geographic distribution of projects with PED ambition in Europe while table 1 summarizes selected features of PED projects based on information provided by the projects and/or available on their websites.

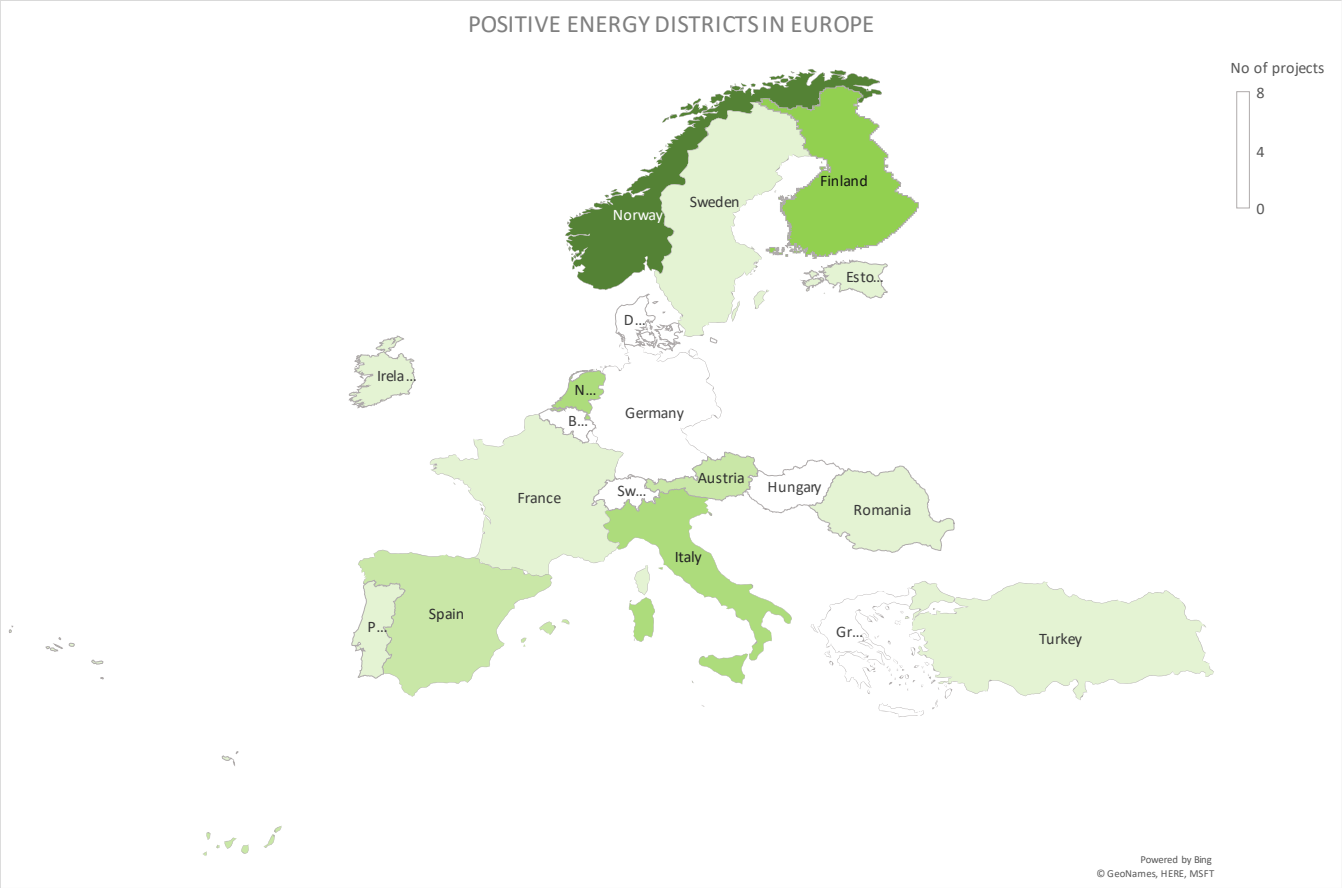


Figure 4. Europe distribution of projects of this booklet with PED ambition

PROJECT No	CITY	STATE		ENERGY EFFICIENCY			ENERGY PRODUCTION	ENERGY FLEXIBILITY	ENVIRONMENTAL SUSTAINABILITY		SOCIAL SUSTAINABILITY		ECONOMIC SUSTAINABILITY	
			PED AMBITION	BUILDING/ INFRASTRUCTURE	MOBILITY	SUSTAINABLE CONSUMPTION	LOCAL/REGION RENWABLE ENERGY PRODUCTION	REGIONAL ENERGY SYSTEM	ENVIRONMENTAL IMPACT	ZERO EMMISION/ CARBON FREE/ CLIMATE NEUTRAL	SOCIAL/SOCIETAL IMPACT	CITIZEN/OWNER INVOLVEMENT	ECONOMIC IMPACT	BUSINESS MODELS
1	Åland Island	FI	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
2	Carquefou/Nantes	FR	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
3	Alkmaar	NL	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
4	Amsterdam	NL	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	-	✓
5	Baerum	NO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-
6	Bilbao	ES	✓	-	✓	✓	✓	-	✓	✓	-	✓	✓	-
7	Bodø	NO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	Elverum	NO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	Évora	PT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10	Graz	AT	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
11	Groningen	NL	✓	✓	✓	✓	✓	-	✓	✓		✓	-	✓
12	Istanbul-Kadıköy	TR	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓
13	Limerick	IE	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
14	Lund	SE	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
15	Măgurele	RO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16	Oslo	NO	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	✓
18	Oulu	FI	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18	Rome	IT	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
19	Stor-Elvdal	NO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
20	Trondheim	NO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
21	Trondheim	NO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
22	Võru	EE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
23	Bergen	NO	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓
24	Espoo	FI	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
25	Parma	IT	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
26	Paterna (Valencia)	ES	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
27	Tampere	FI	✓	✓	-	✓	✓	-	✓	✓	-	-	✓	✓
28	Trento	IT	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	✓
29	Vienna	AT	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	✓

Table 1. Summary of selected features of projects with PED ambition

1 Åland Island, Finland – Smart Energy Åland

General information	
City	**Åland Island, Finland**
Project name	**Smart Energy Åland - A society scale demo of an energy system running on renewables**
Project status	planned ☐ under construction ☐ realized ☐ **in operation** ☒
Project start – end	2014 - 2019
Contact	Berndt Schalin
Project website	**https://flexens.com/the-demo/**
Size of project area	Åland Islands, Area: 13,300 km^2, Population: 30,000
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use	n/a
Financing	Smart Energy Åland is a public – private – people partnership.

Overview description of the project

The energy transition requires a place where to pilot and demonstrate a fully renewable energy system which is sustainable both technically and economically. Flexens has identified the opportunity to develop and build a full society scale energy system based on renewables on Åland – an island with ideal wind and solar conditions, an ambitious climate- and energy strategy as well as a population dedicated to sustainability. All the island will be here the experimental/demonstration area.

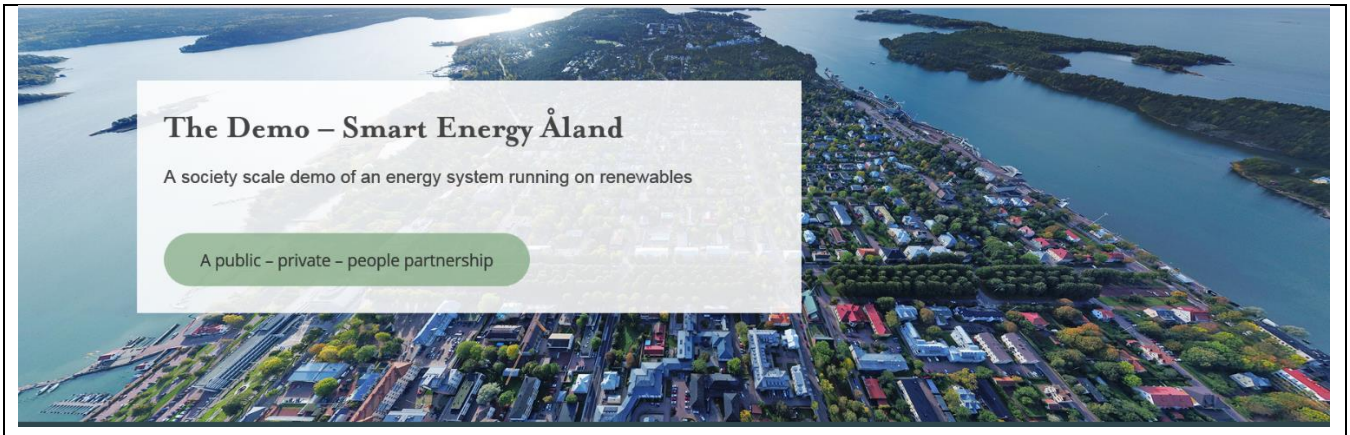
The area will become a unique place for companies to test new energy solutions, and it will also act as a reference for the Finnish export industry. In addition, it can provide a unique piloting platform attracting international investments, operators and technology providers.

Smart Energy Åland is a public – private – people partnership.

Key goals and priorities:

- To demonstrate a society based on 100% renewable electricity Flexens will work actively to promote further investments in renewable generation capacity and decarbonising the heating and transportation systems. The basis for successful renewables integration in an open and competitive market is a flexibility trading platform – this demo will be high on the agenda.
- The success of the demo will depend on citizen engagement and promotion of the prosumer concept. Cost efficiency and affordability of the implemented technologies is in focus.
- The demo will include technology piloting with focus on storage technologies and new digital services.
- The demo is also a platform to develop new business ventures.

https://flexens.com/the-demo/



Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐ Other: Supports the goals of the climate strategy recently prepared for the Åland Islands. The landscape's energy and climate strategy for Åland until 2030 shows how political energy and climate work will be managed in the coming years, as a contribution to meeting the goals of the Paris agreement. Smart Energy Åland becomes a tool for Åland in implementing this strategy. The main goal of the strategy for 2030 is to: • Reduce carbon dioxide emissions by at least 60% compared to 2005. • Increase the proportion of renewable energy to at least 60%. • Increase the proportion of locally produced renewable electricity to at least 60%. • Reduce emissions from road traffic by at least 50% compared to 2005. https://smartenergy.ax/om-smart-energy-aland/
Indicators/expected impact	Smart Energy Åland brings many direct and indirect benefits to Åland. • Jobs are created during the construction of new facilities. • Åland's profile as a tourist destination and settlement is increased. • New companies are created with the development of new products and solutions for energy distribution. • For participating private actors and companies, Smart Energy Åland becomes an important reference, a platform for innovation and an opportunity to develop new business ideas. • Smart Energy Åland becomes a tool for Åland in the realization of the landscape government's Climate and Energy Strategy. https://smartenergy.ax/om-smart-energy-aland/
Overall strategies of city/municipality connected with the project	The Åland landscape government is pursuing an ambitious climate and energy policy and has set up Åland's sustainability and development agenda with seven objectives that must be met before 2030 and the energy and climate strategy for Åland until 2030. With the autonomy, Åland has its own energy legislation and can therefore adapt more quickly to innovative market concepts. https://smartenergy.ax/om-smart-energy-aland/ https://www.regeringen.ax/infrastruktur-kommunikationer/el-energi/energi-klimatstrategi-aland-ar-2030

Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ Mobility ☐ Buildings ☐ Materials ☐ Refurbishment ☐ Sustainable production ☐ Sustainable consumption ☐ **(Local) Governance** ☒ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	The Government of the Province of Åland CLIC Innovation Oy Business Finland In order to realize the project, the stakeholders have founded the company, Flexens Oy Ab, with the ambition to commercialize the expertise created in the implementation of Smart Energy Åland on the world market for energy systems. Flexens will, in the longer term, operate both in Åland and elsewhere. https://smartenergy.ax/om-smart-energy-aland/ https://tem.fi/artikkeli/-/asset_publisher/keskustelu-ahvenanmaasta-alykkaan-energiajarjestelman-testialue-
Typology of energy supply	Åland is an island with ideal wind and solar conditions and a separate independent electricity system. Installations of solar panels on both private and commercial buildings are steadily increasing and in wind power, Åland is a pioneer, with a wind power park that started to be built in 1994. Already today, our wind turbines can produce about 20 percent of annual energy consumption. Focus of energy supply: Solar, Wind, Heat and CHP, bioenergy, wave power, geothermal, E-Storage  Picture taken and slightly adapted from Smart Energy Åland (https://smartenergy.ax/energimolnet/)

Success factors	Challenges/barriers
Strong support from the Finnish national innovation agency, Business Finland. Highly committed population and local government.	

2 Carquefou (Nantes), France – Fleuriaye West

General information	
City	**Carquefou (which is one of the 24 cites of Nantes Metropole), France**
Project name	**Fleuraye west**
Project status	planned ☐ under construction ☐ **realized** ☒ in operation ☐
Project start – end	1995 – 2022
Contact	Nantes Metropole, Benoit Cuvelier
Project website	www.quartierlafleuriaye.fr
Size of project area	37 ha - Fleuriaye West project
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use	For both Fleuraye Est and West projects **Surfaces** • Waterproof area 320 000 m² • Vegetated surface (roof included) 700 000 m² • Area of public spaces: 510,000 m² **Built surfaces** • Office floor area 50,000 m² • Floor area shops 5,000 m² • Floor surface Public facilities: 40,000 m² • Floor area of houses: 100,000 m² • Number of accommodations: 1,600 (of which 620 for Fleuriaye West project) • Number of social housing units: 350 • Green spaces / hab 233.33 m² / liv • Public spaces / hab 170 m² / living space

Financing	Total investment cost 270 M € excluding taxes (for both Fleuriaye West and East project)
	• Of which for Fleuriayre West : 123 M€ of which 100 M€ pour buildings, 20 M€ for public space, 3 M€ for renewable energy
	• Total grants: € 168,000 excluding taxes
	  ○ for Fleuriayre West: Communicating R & D, Passive Design, Communicating Terminal, Project Engineering.
	  ○ for Fleuriayre East: Collective self-consumption study, project engineering.

Overview description of the project

NANTES METROPOLE / CITY OF CARQUEFOU CASE

The district of La Fleuriaye, in the City of Carquefou, (which is part of Nantes Metropole) was developed in two phases:

I. The district is composed of two sub districts:

1. The Fleuriaye East district is 65 Hectares, built between 1995 and 2010. Compositon of the district on the eastern part: 120 tertiary companies over 55,000 m², 1000 dwellings, a theatre, a University Institute of Technology (IUT), a music school, cultural activities.

2. The **Fleuriaye West** district of 37 Hectares, under construction since 2013. Composition of the district on the western part: 600 housing units (320 delivered today); 10,000 m² of tertiary and service, an equestrian centre, a Medical-Educational Institute (EMI)

II. Objectives of the district

- to provide a living environment and comfort of use in order to guarantee the good health of the inhabitants. It is for this purpose that all of the new housing units in the neighbourhood have been built following the Passivhaus label, thus extending the objectives of urban development (living environment, comfort, health) within very qualitative housing.

- The second major axis is to be able to propose on La Fleuriaye West a neutral impact assessment in energy and environment. It is made possible by:
  - specific work on biodiversity, water and landscape,
  - the construction of passive housing very sober energetically,
  - a renewable energy production equal to or greater than the consumption of the district thanks to the generalization of solar photovoltaic on all of the south roofs.
  - At the end, on La Fleuriaye West part, the district will reach a renewable energy coverage rate greater than 100% and about 42% on the entre perimeter (Fleuriaye Est and West projects).
  - Concerning La Fleuriaye Est, an objective of controlling energy consumption and renewable energy production is also being developed as an extension of the actions initiated on La Fleuriaye West, notably with the future realization of collective self-consumption projects.

- The third axis concerns the implementation of a transposable economic model, limiting the use of public funding.

The Fleuriaye West district: a positive energy district

La Fleuriaye West is aiming for the goal of 100% renewable energy. To do this it is primarily a question of reducing the general consumption of the district, then to compensate the totality of the consumptions by a coherent set of production of renewable energies. On the whole programming, it was decided to generalize the passive standard reconciling minimization of consumption, maximizing summer and winter thermal comfort and real air quality. It concerns:

- 620 homes ranging from single-family homes to community buildings
- 10,000 m² of tertiary sector and activity,

Which will make it the most important passive district of France.

L'extension ouest du quartier de La Fleuriaye (à gauche) vient parachever un bassin de vie de 102 ha avec une mixité harmonieuse de fonctions.

Look at the district by drone: https://www.youtube.com/watch?v=h-MuQgKqWWs

More information (in French) on https://www.construction21.org/france/city/fr/quartier-de-la-fleuriaye-a-carquefou.html

Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ **Energy neutral** ☒ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒ **Preserving biodiversity** This is one of the essential components of the western extension of La Fleuriaye: preservation and enhancement of existing landscape heritage, spontaneous flora, edges bordering hedges, preservation of fauna and flora migration corridors with a very innovative passage to open sky on which vehicles will roll. Special care was also taken in the collection of runoff water through a network of valleys and ponds. **Energy** The optimal orientations of the buildings on La Fleuriaye West, coupled with the passive envelope, make it possible to obtain a temperature of 20° C in dwellings in winter without heating while allowing in the summer, a real comfort without overheating thanks to the good management of the solar contributions and a ventilation system double flow, very effective to cool the houses by means of the nocturnal ventilation. All passive housing also includes quality equipment in order to limit consumption related to "specific" uses (office automation, household appliances, etc.), which represents a significant share of consumption in housing, all the more when the very important energy performance of the latter makes it possible to reduce other consumption items such as heating, domestic hot water.

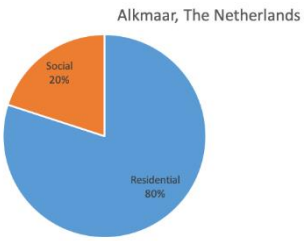
	To conclude, beyond the technical system and the performance of the building, the major player in the management of the resources remains the inhabitant, that is why meetings of sensitization with the good practices were carried out in order to inform the inhabitants and fight against any misconceptions. Moreover, all the buildings are instrumented with digital energy meters allowing a good interpretation of the consumption by the users and encouraging the control of these. Following the same principle, the TOTEM which will be installed in the centre of La Fleuriaye West and which will indicate the consumptions and productions of the district will have a real pedagogic impact with the whole of the users. **Social** 68 social passive house with no extra costs
Indicators/expected impact	Indicator 1: proportion of certified batiments passivhaus ➔ 100% of buildings certified with passive label Indicator 2: Neighbourhood Renewable Energy Coverage Rate ➔ Renewable energy coverage rate > 100% Indicator 3: Carbon footprint of buildings Indicator 4: Investment cost of buildings by typology Indicator 5: Evolution of the distribution of competences by function (command / control / production / use) in the production of a sustainable city. Indicator 6: Level of perception and implication of the users of the sustainable city Indicator 7: Number of barriers identified and raised to achieve objectives Indicator 8: Effectiveness of the organization process and the level of communication of the project with regard to the results achieved
Overall strategies of city/municipality connected with the project	• Urban Renewal Strategies • Energy and environment strategies
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ Refurbishment ☐ **Sustainable production** ☒ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ **Business models** ☒ **<u>Local renewable resources</u>** The **Fleuriaye West district project** aims for a neutral energy balance with a renewable energy contribution equivalent to all-purpose consumption. To do this it will be at the end more than 2.3 MWp which will be installed on the buildings of the Fleuriaye West. By the end of 2018, there was about 1.2 MWp connected to the Fleuriaye West, representing a renewable energy coverage rate of more than 100% for a self-consumption rate close to 55%. Numerous projects on individual homes in La Fleuriaye West also provide for the use of biomass through the wood stove that allows the use of another form of renewable energy and contributes to achieving our goal 100% renewable energy. **Concerning La Fleuriaye Est**, two self-consumption projects are in development involving private and public partners and totalling 200 kWp of solar photovoltaic production capacity for collective self-

	consumption. These operations are associated with a search for the reduction of energy consumption with first tracks that can lead to up to 30% decrease in consumption on average **<u>Buildings</u>** Regarding the buildings o**f La Fleuriaye West**, the entire neighbourhood targets the label Passivhaus, all buildings will produce as much renewable energy than they will consume energy. Today the delivery of the first 320 housing units has positioned the area as the largest positive energy Passivhaus district in France. With the delivery of 300 additional dwellings by 2022 on different typologies (individual housing, small collective) the district will consolidate even more its innovative character. **<u>Soft mobility</u>** Pedestrian paths are present on the whole district. The Renaudières alley also offers the opportunity to cross the site quickly as it crosses from east to west to join the nautical base of Carquefou at the edge of the Erdre 800m to the west. In order to promote soft mobility and the achievement of the neighbourhood's environmental objectives, the Loire-Atlantique Development-SELA developer, who is also the DIVD pilot, offers, as part of the marketing of free lots, a high-end electric assistance bicycle for any buyer achieving the ambitious environmental goals of the neighbourhood. It should allow residents to make the most of this type of vehicle to reach the town centre of Carquefou 2 km or reach the city centre of Nantes 30 minutes. **<u>Materials and circular economy:</u>** The mobilization of local sectors in the choice of equipment was a priority on the operation. A close link was made to all passive projects between real estate operators and equipment suppliers, particularly in the following areas: • Exterior wood furnishings, • Double flow ventilation systems, especially in the individual house, • Local photovoltaic solar generator. On the waste side, a specialized service provider is mobilized to rationalize the recovery of all waste generated by individual housing projects. The plants come from local nurseries in the Loire Atlantique and Maine et Loire.
Innovative stakeholder involvement strategies	**Involvement of stakeholders and citizens** • The project involves a consortiium of 18 partners bringing together the entire value chain: ○ Nantes Métropole: Decision-making local authority ○ City of Carquefou: Territory hosting the demonstrator, co-decision ○ Loire-Atlantique Development SELA: Urban Developer, Energy Developer and General Pilot of demonstrator ○ ENEDIS: Electricity Distribution Network Manager ○ Armorgreen: expert in renewable energies ○ The Fleuriaye Technopôle: Group of Economic Interest of La Fleuriaye ○ AMOCITE: Surveyor Legal Expert ○ ENERGELIO: Passive designer ○ MAGNUM: Architect ○ PELLEGRINO ASSOCIES DESIGN WORKSHOP: Architect ○ SAMO: Social housing company ○ Vilogia: Social housing company ○ ARTELIA: Infrastructure and Smart Grid Study Office ○ AUP: Urban planner ○ EIFFAGE CONSTRUCTION: General contractor ○ Claude FIGUREAU: Ecologist - Albdo: Bureau of Energy Studies of the Building ○ LEGRAND: Developer of electrical optimization solutions

	• In order to have competent professionals both in collective housing and individual homes, as well as the tertiary sector in the passive sector, we have put construction professionals and specialized trainers in contact with one another so that they can acquire the sharp technical bases induced by passivehaus buildings. • A special collaboration with the Distribution Grid Manager ENEDIS has also been set up in order to optimize the electrical infrastructure as much as possible and to promote the strong control of consumption in their dimensioning. • In order to make the users aware of the objective "neutral energy" a communicating terminal will also display consumption and production of the neighborhood in near real time. • Concerning the existing part of the district (East part), a strong mobilization was necessary with the 100 companies of the perimeter, of the University of Nantes through its IUT, of the city of Carquefou through the theatre, the school of music in the goal of launching operations aimed at the development of collective self-consumption • Social housing and promoters have been put in place accompanying measures for residents to sensitize them to the particularities passive housing and provide them tips to guarantee optimum comfort
Typology of energy supply	**At the end 15 000 m² of photovoltaic panels** – currently 8,000 m² of panels cover the south roofs of collective buildings.

Success factors	Challenges/barriers
Involvement of stakeholders towards collaboration and replicability Each actor in the construction chain has taken responsibility for limiting the cost of construction and the cost of housing management. • The developer: by defining the sizes of critical operations to make real estate operators benefit from scale effects, • The planner: by defining parcels limiting the effects of masks and optimizing the free solar capture by their orientation and a form of roof predefined from the specifications • Donor and developer real estate operators: by comparing a wide variety of construction systems and technical equipment; by using design / build arrangements; by making their roof available to solar investors without a fee, • The consulting firms that are experts in passive design or biodiversity directly associated with the urban project management or the buildings, at the request of the developer, • The unique photovoltaic system to offer solar investors economies of scale, • Condominium trustees and specialized surveyors, associated upstream to estimate their fair value for future common expenses and help guide the choices to be made during the design phase	**Legal and tax challenges** • to improve the economic value of renewable energy produced locally • to facilitate the development of collective self-consumption PV projects **Raising competences** • to upgrade skills of building companies and other staff related to passivhaus works and design **Business models** • how to make the construction of passive or positive energy buildings more economical and more replicable • How to optimize the production of renewable energy while reducing costs

3 Alkmaar, The Netherlands - PoCiTYF

General information	
City	Alkmaar, The Netherlands
Project name	**PoCiTYF**
Project status	planned ☐ **Implementation stage** ☒ realized ☐ n/a ☐ Notes: project is part of a Horizon 2020 project, call 'Smart cities and communities'; Alkmaar is one of the Lighthouse cities (Évora is the other light house city)
Project start – end	2019-2024
Contact	**Peter van den Dries (Municipality of Alkmaar), Petra Bijvoet (Inholland University of Applied Sciences)**
Project website	Under construction
Size of project area	Ha: n/a
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use (%)	• Residential: 80% • Social: 20%. Ice rink and sports stadion 
Financing	• Private: 60% • Public: 30% • Research funding: 10% • Other: €6 million European funding; €35 million total project budget

Overview description of the project
Smart cities shape their future by leading in technology adoption, resource efficiency and citizen/ stakeholder engagement. On this basis, the POCITYF smart city project mobilises two Lighthouse (LH) cities (Evora-PT and Alkmaar-NL), and six 6 Fellow (FC) cities (Granada-ES, Bari-IT, Celje-SI, Ujpest-HU, Ioannina-GR and Hvidovre-DK) which already share knowledge, coordinate their efforts, and ride on the same four Energy Transition Tracks (ETTs) to shape their own, unique bold city visions by taking care of their cultural heritage. The later can be critical for environmental sustainability as energy efficiency goals seem to contradict with the protection of historical buildings. POCITYF's city leaders have embraced the smart city concept with enthusiasm and seized the opportunity with the aim to transform their cities into more efficient, healthy, open, accessible, sustainable, prosperous, and thus, more attractive living environments. Building upon already implemented pre-pilot activities, Evora and Alkmaar will demonstrate integrated solutions for: positive energy blocks (ETT#1), grid flexibility (ETT#2), e-mobility integration into the grid and city planning (ETT#3) and citizen-driven innovation supported by the integration of innovative apps into enhanced City Information Platforms (ETT#4). In total, four mixed-use districts – among them the historical city centre of Evora, characterised as a World Heritage Site by UNESCO - have been selected for the demonstration activities in LH cities representing an area of 739 Ha hosting 17,500 residents.

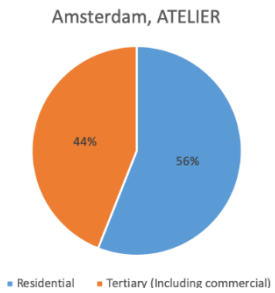
Demonstration will be performed in 21 building complexes covering a total floor area of 87,480 m^2 with current energy needs of 13.25 GWh/year. For this purpose, overall 10 integrated solutions (IS) have been defined for demonstration, comprising 73 individual innovative elements (technologies, tools, methods) that have been identified as a result of an intensive and laborious collaborative process. The respective technology providers have been included in the two LH ecosystems shaping a scheme of 25 LH partners. A number of appropriately designed citizen and community engagement strategies, along with open innovation and co-creation activities will be in parallel deployed to ensure the success of demonstration activities, as well as long-lasting adoption. To further strengthen and facilitate demonstration activities, POCITYF will introduce IS-specific business models applied at sharing, barter and circular economy settings. Along with the LH cities, the FCs ecosystem of 13 partners will work on the preparation of the targeted replication activities. As a first step for wide scale replication, FCs have identified over 140,000 m^2 of floor area where POCITYF's IS will be replicated, including already identified 18 historical buildings. The project's monitoring, evaluation and impact assessment activities will ensure effective demonstration, fast replication and wide scale roll out within POCITYF cities and across Europe. This will put POCITYF in the position to accomplish: a) Local RES penetration of 16.2 GWh/year within the districts; b) 144% coverage of total net energy needs by local RES; c) Waste heat recovery of 5,880MWh; d) Thermal storage at district level equivalent to 2,052MWh. All the above, along with e-mobility uptake, will result in an estimated total of 9,743 GHG reduction (in tons CO2/year). In total, 2.32 GWh annual savings will be achieved by the two LHs by 2024 within their PEBs. The two LHs PEBs will be overpositive with a total outcoming energy of 2.1 GWh/y for all Evora's PEBs and 5.7 GWh/y for Alkmaar. To achieve the above, on top of the POCITYF budget of 22,4M€, the two LH cities and the six FCs have planned investments of 40M€ and 350M€ respectively up to 2024, while they expect to attract an additional amount of €1bn for the period of 2025-2029.

Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒
Indicators/expected impact	• Environmental • Societal • Social • Services • Economic • Spatial
Overall strategies of city/municipality connected with the project	• Smart City Strategies • Urban Renewal Strategies • Energy Masterplanning Notes:implementation of innovative solutions that can be replicated to other cities in Europe
Which factors have been included in implementation strategies?	• Local (renewable) resources • Regional energy system • Mobility • Buildings • Materials • (Local) Governance • Legal framework • Business models
Innovative stakeholder involvement strategies	• Citizens • Business • Research

Typology of energy supply	• Solar Thermal Energy • Geothermal energy • Heat pump system • District heating/local heating • Photovoltaic

Success factors	Challenges/barriers
• Involvement of a variety of stakeholders at higher management / political level + the track record on policies and projects in sustainable energy and smart city technologies	• Investment readiness within the time frame of the H2020 project

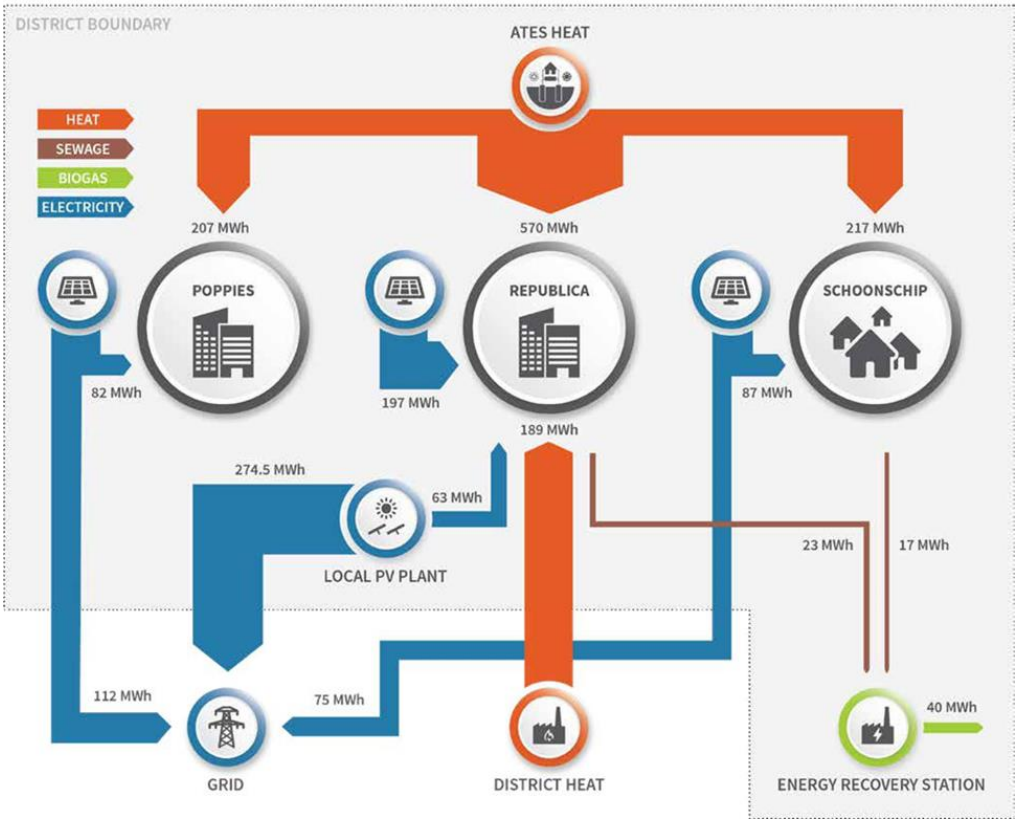
4 Amsterdam, The Netherlands - ATELIER

General Information	
City	Amsterdam, The Netherlands
Project name	**ATELIER**
Project status	**planned** ☒ **implementation phase** ☒ realized ☐ in operation ☐ Notes: the ATELIER project started 1/11/2019
Project start – end	2019-2024
Contact	**Municipality of Amsterdam Frans Verspeek**
Project website	https://smartcity-atelier.eu/
Size of project area	In total 28,500 m^2 GFA. Two new building blocks: Republica (16,000 m^2) and Poppies 6,000 m^2 constitute the major share of the project area
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use	• Residential: 56% (15,900 m^2) • Tertiary (including commercial): 44% (12,600 m^2) • Waste water energy recovery station • Local PV plant 
Financing	Private: 98% (Companies) Public: 0.1% Research: 2% (EU grant H2020)

Overview description of the project
ATELIER is an EU-funded Smart City project aiming to create and replicate Positive Energy Districts (PEDs) within two Lighthouse Cities and six Fellow Cities. The Positive Energy District in Amsterdam will be developed in six locations in Buiksloterham. The PED consists of a number of very ambitious building groups (in total being 28,500 m^2 GFA). Two of those are new build in the project. These are Republica and Poppies (total of 22,000 m^2). The third is Schoonschip, finished in 2019. This building group is added because of the connection to the energy recovery station, the implementation of the smart grid and the participation in the Buiksloterham Energy Community, all elements of the project. The fourth is De Ceuvel, an existing energy community with a smart grid, participating in the energy trading activities of the project. The energy recovery station and the local PV plant are situated on the other two locations. The largest building groups are of a mixed nature, a combination of tertiary buildings (approximately 12,600 m^2) with residential (approximately 15,900 m^2). ATELIER will demonstrate PEDs in Lighthouse cities through the use of renewable energy, storage, and digitalisation, including integration of electro- mobility for future storage and balancing capacity. Both new-build and refurbished buildings have applied highly energy efficient materials in their façades (optimal insulation), glazing (triple windows) and green roofs, that ultimately will meet energy performance levels and go beyond the existing building codes. In Amsterdam far-reaching smart urban solutions are facilitated through a special derogation from Dutch energy laws, exempting the PED from a number of potential legal obstacles that could otherwise hamper or even forbid the development of an innovative efficient energy system. This derogation enables those to whom it is

granted to experiment with highly innovative solutions, such as the 'Local Energy Market Platform', that enables energy communities to efficiently exchange electricity and balance the local energy system. A smart microgrid will be deployed in building blocks Republica and Poppies based on the experience with smart microgrids at the Ceuvel and Schoonschip (Grid-friends.com). The micro grids will be used to simultaneously control production, storage and use. Through demand response, the load on the public grid can be managed (congestion management) and peak loads can be avoided (peak shaving). The micro grid also enables local storage of RES produces to prevent curtailment. The Energy Market Platform will allow residents and other users to trade peer-to-peer, community-to-community or with the wholesale energy markets. Finally, the PED will integrate an e-mobility hub for 15-20 electric cars, as well as facilities for charging electric bikes and specific urban vehicles. The e-mobility hub will not only reduce CO_2 emissions, improve local air quality, contribute to balancing the grid and reduce car ownership in the area.

AMSTERDAM DEMONSTRATOR



Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒
Indicators/expected impact	- Environmental - Societal - Social - Services - Spatial - Regulatory
Overall strategies of city/municipality connected with the project	- Smart City Strategies - Urban Renewal Strategies, - Energy Masterplanning
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ Refurbishment ☐ **Sustainable production** ☒ Sustainable consumption ☐ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	- Citizen - Industry - Investor/real estate - Business - Research
Typology of energy supply	- Solar thermal energy - District heating/local heating - Heat pump system - Photovoltaic

Success factors	Challenges/barriers
1) Strong starting point for the PED as the innovations (micro grid and local energy management) are already tested at a small scale in the district. 2) Strong level of stakeholder involvement in the district.	1) The timely development and construction of the two main new to be built building groups. 2) Securing the energy and climate impact of the key innovation in the PED. 3) Upscaling and roll-out of the PED throughout the wider district and city.

5 Bærum, Norway - Fornebu

General information	
City	Bærum, Norway
Project name	**Fornebu[2], Bærum – ZEN Pilot Project**
Project status	**planned** ☒ **under construction** ☒ realized ☐ in operation
Project start – end	2018-2025
Contact	**NTNU:** Arild Gustavsen **SINTEF Community:** Judith Thomsen
Project website	https://www.baerum.kommune.no/politikk-og-samfunn/barum-2035/stedsutvikling-i-barum/nye-fornebu/
Size of project area	n/a
Building structure	**Newly built** ☒ Existing neighbourhood ☐ **Mixed** ☒
Land use	n/a
Financing	n/a

Overview description of the project

The ZEN Research Centre[3] pilot projects serve as innovation hubs where researchers, together with building professionals, property developers, municipalities, energy companies, and building owners and users, test new solutions for the construction, operation, and use of neighbourhoods in order to reduce the greenhouse gas emissions to zero on a neighbourhood scale. In total, the ZEN pilot projects encompass more than 30,000 people, more than 1 million m^2 built area, and more than 5.5 million m^2 land area.

Fornebu is a peninsula in the Oslo Fjord, covering a land area of about 3.1 km^2. It is located about 9 km south of the centre of Oslo, and about 8 km from the local centre Sandvika. From 1939 to 1998, the area served as a regional/international airport. By the end of 2017, the area contained 2,400 dwellings and about 25,000 workplaces. The area contains a shopping mall (Fornebu S) that encompass 80 shops, cafes and various services. The area is still under development, and large green/brownfield sites are awaiting development. However, most of the technical and green infrastructure have been established. The municipality of Bærum has put forward 2 possible pilot projects at Fornebu: the development projects at Oksenøya and Tårnet community centres. Bærum municipality will facilitate these development projects to become areas for research and innovation and knowlegde sharing.

In Spring 2018, the Fornebu area was appointed a laboratory and test area for reduction of greenhouse gas emissions. In the 'Climate Strategy 2030" of the municipality of Bærum, it is written that Fornebu shall be established as a zero-emission area by 2027. In the coming years, several low carbon projects will be conducted by public and private actors.

Within 2025, fossil free public transport solutions to and from the area, will be established. The planning of a light rail path connecting the area to the centre of Oslo, has already started. The Fornebu area will contain urban structures that will facilitate low and zero carbon mobility within the area, including pedestrian walking, bicycling and electrical vehicles.

[2] https://fmezen.no/fornebu-baerum/
[3] https://fmezen.no/

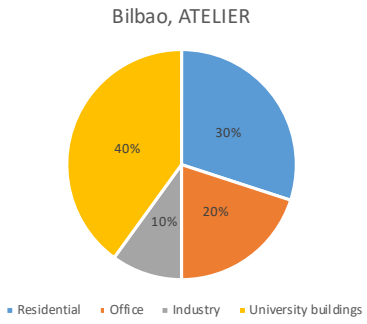
Fornebu is a pilot project within the Research Centre on Zero Emission Neighbourhoods in Smart Cities (https://fmezen.no/).

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐ Other: At Oksenøya, the municipality plans to construct a kindergarten, a primary school, and a residential/health care centre for elderly. The construction of these building will be finished by fall 2022. The project is a part of the Futurebuilt program, and will be certified as BREEAM-NOR Excellent. A design-built competition was announced in spring 2018, and a team will be selected in August 2018. **The environmental goals and measures that have been identified for the Fornebu project include:** • All buildings should be certified according to BREEAM-NOR Excellent. • Integrated energy strategy with the aim of testing smart solutions for power management, storage and exchange of energy between buildings. Local renewable energy production that is designed to keep import and export of energy as low as possible. Visualizations of energy and power performance to the users. • Near Zero energy buildings, minimum passive house standard and energy class A. • Reduction of carbon footprint of 50% compared to a reference project, including materials, energy use and transport. • Long lasting and low maintenance materials. • Fossil free construction site. • Area efficient buildings. The development of Tårnet centre is expected to start as soon as the community plan KDP3 is accepted during spring 2019. In the early phases of development, the municipality wishes to explore

	the potential for developing innovative solutions with respect to smart and sustainable mobility, spatial qualities, sustainable behavior, and new processes of cooperation
Indicators/expected impact	ZEN KPIs (https://fmezen.no/wp-content/uploads/2018/11/ZEN-Report-no-7-Bilingual.pdf)
Overall strategies of city/municipality connected with the project	n/a
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ **Refurbishment** ☒ Sustainable production ☐ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ Business models ☐
Innovative stakeholder involvement strategies	Important stakeholders for the development of the Fornebu area include several private developers (OBOS, Selvaag, Aker and KLP), as well as energy and transport companies.
Typology of energy supply	n/a

Success factors	Challenges/barriers
n/s	n/s

6 Bilbao, Spain - ATELIER

General information	
City	Bilbao, Spain
Project name	**ATELIER**
Project status	**planned** ☒ **implementation phase** ☒ realized ☐ in operation ☐ Notes: the ATELIER project started 1/11/2019
Project start – end	2019-2024
Contact	**Jordán Guardo Vázquez**
Project website	https://cordis.europa.eu/article/id/411499-atelier-smart-city-project-to-turn-amsterdam-and-bilbao-into-citizen-driven-positive-energy-d
Size of project area	Ha: 65
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒ Most of the buildings will be refurbished, but a limited amount of newly built residential blocks will be included.
Land use	• Residential: 30% • Office: 20% • Industry: 10% • University buildings: 40% 
Financing	Private: 40% Public: 30% Public-Private: 10% Research funding: 20%

Overview description of the project
A new neighbourhood built on an industrial brownfield, that will include several 19th century private homes, newly built residential homes, and old industrial buildings that are being recovered mostly for training centers. The ATELIER project will look into the energy part of the new neighbourhood, including 3 pilots located in different areas of this new neighbourhood.

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ Energy neutral ☐ Energy efficient ☐ **Carbon-free** ☒ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐

Indicators/expected impact	- Environmental - Economic
Overall strategies of city/municipality connected with the project	- Smart City Strategies - Energy Masterplanning - Mobility
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ Buildings ☐ Materials ☐ Refurbishment ☐ Sustainable production ☐ Sustainable consumption ☐ (Local) Governance ☐ Legal framework ☐ Business models ☐
Innovative stakeholder involvement strategies	- Citizen - Industry - Investor/real estate - Business - Research
Typology of energy supply	- Geothermal energy - District heating/local heating - Heat pump system - Photovoltaic Note: The Geothermal system will include a secondary system that might help during high demand periods based on Hydrothermal power (from the water of the Nervion Estuary)

Success factors	**Challenges/barriers**
Involving local citizens is key: only if a group of citizens experience first-hand new technologies and ways of managing their energy, and have a taste of what becoming an active player regarding energy is, will this project be able to be extended to the rest of the city, and eventually, the Basque Country as a whole.	Working across several departments of the public administration, both between different administrations and within the city hall

7 Bodø, Norway - NyBy

General information	
City	**Bodø, Norway**
Project name	**NyBy – Ny Flyplass (New City – New Airport), Bodø[4] – ZEN Pilot Project**
Project status	**planned** ☒ **under construction** ☒ realized ☐ in operation
Project start – end	Ongoing planning, construction might start mid-2020s
Contact	**NTNU:** Arild Gustavsen **SINTEF Community:** Judith Thomsen
Project website	https://nyby.bodo.kommune.no/ny-by-ny-flyplass/category8230.html
Size of project area	3,400,000 m^2
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use	Multifunctional city centre extension with residential and business areas. An area of 2,200,000 m^2 will be used for the civil airport development. The remaining 3,400,000 m^2 – the same size as the current city centre – is dedicated to expanding the existing city centre and will include residential and business areas, as well as a logistic hub (flight, railway, shipping) close to the airport. Specification of land use is currently an on-going process in the Municipality. The share of the total area will be concluded in 2022.
Financing	Public and private; work in progress

Overview description of the project
The ZEN Research Centre[5] pilot projects serve as innovation hubs where researchers, together with building professionals, property developers, municipalities, energy companies, and building owners and users, test new solutions for the construction, operation, and use of neighbourhoods in order to reduce the greenhouse gas emissions to zero on a neighbourhood scale. In total, the ZEN pilot projects encompass more than 30,000 people, more than 1 million m^2 built area, and more than 5.5 million m^2 land area. Bodø's former civil and military airport is planned to be replaced by a smaller civil airport, located 900 m southwest of the existing one. Today the site is approx. 5,600,000 m^2 and located in close proximity to the city centre. An area of 2,200,000 m^2 will be used for the civil airport development. The remaining 3,400,000 m^2 – the same size as the current city centre – is dedicated to expanding the existing city centre and will include residential and business areas, as well as a logistic hub (flight, railway, shipping) close to the airport. The planned multifunctional urban area, known as NyBy, will be developed within the next 60 to 80 years. The site is located south of the city centre, within walking distance to the centre. The area lies on a peninsula and is surrounded on three sides by water. A residential area with detached houses to the north forms a small belt between the old airport and the city centre. A commercial area with a shopping centre connects to the residential area to the east. A green zone with a camping ground and a low-density residential area borders the site to the northeast. Ny By – Ny flyplass is a pilot project within the Research Centre on Zero Emission Neighbourhoods in Smart Cities (https://fmezen.no/).

[4] https://fmezen.no/category/pilot-projects/
[5] https://fmezen.no/

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ **Energy neutral** ☒ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒ Other: Smart City The goal is to develop a dense, mixed-used urban neighbourhood, which is environmentally friendly and citizen-centred. The environmental goals are to minimize the neighbourhood energy demand and greenhouse gas emissions. Buildings are planned to be built according to the ZEB standard6. The neighbourhood development is expected to function as a catalyst for the business sector in Bodø, which is mainly characterized by the construction, and consultant sectors, the IT sector, and an export sector based on agricultural products and food. The municipality has imbedded the NyBy project in a broader vision, which is to become the world's smartest city. NyBy is planned as a citizen-centred development with a strong focus on citizen participation in the planning process. The goals are planned met using the following measures: • Development of a design and planning toolbox to integrate energy and emission aspects into the planning process and the evaluation of different option based on scenarios. • Integration of citizens in the planning process, e.g. through the living lab methodology: The application of co-creation processes in collaboration with citizens, the research and the business sector. • Knowledge transfer by building up national and international networks with business and research partners as well as other cities and through participation in several research projects. • Development of knowledge and gaining experience through the design and construction of the municipalities' own buildings according to ZEB-standard in the near future. • Creating a local network of partners.
Indicators/expected impact	ZEN KPIs (https://fmezen.no/wp-content/uploads/2018/11/ZEN-Report-no-7-Bilingual.pdf)

[6] https://www.zeb.no/index.php/en/about-zeb/zeb-definitions

Overall strategies of city/municipality connected with the project	<u>Smart City Strategy</u> The neighbourhood development is expected to function as a catalyst for the business sector in Bodø, which is mainly characterized by the construction, and consultant sectors, the IT sector, and an export sector based on agricultural products and food. The municipality has imbedded the NyBy project in a broader vision, which is to become the world's smartest city. NyBy is planned as a citizen-centred development with a strong focus on citizen participation in the planning process.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ Refurbishment ☐ Sustainable production ☐ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	The stakeholders involved are the project group from Bodø municipality, with a project manager and members from different departments (e.g. city planning and environment). The defence department for the military airport and AVINOR for the public airport are both represented. The National Road Authority, responsible for the interregional street system, is also involved in the early planning stages. Bodø municipality has been working with Urbanetic Pte Ltd to develop a modern urban planning tool for designing and managing sustainable green cities. The tool gives the urban planners and stakeholders the ability to design for sustainability and significantly improves the understanding of the built environment with the complex and dynamic nature of interrelationships of its components. One of the main goals of the project is to incorporate future ZEN metrics and KPIs directly into the planning tools. This will give urban planners, architects, and communities the tools needed to design climate neutral neighbourhoods and greener cities.
Typology of energy supply	Norway is about 98 % renewable in its power production. (94.3% hydro, 3.4% wind 2.3% other RES in 2017). Moreover, a unique feature of the Norwegian power supply is the high share of flexible renewable production capacity (hydropower), i.e. 75%. Moreover, the large storage capacity (50% of Europe's reservoir storage capacity). Norway has the highest share of Renewable energy sources (RES) in its power supply in the EU and the lowest share of emissions in Europe. In 2016, Norway reached a record high power production equal to 149 TWh. In 2018 the total power production equalled 148.7. Bodø Municipality is located in an area with excess power-production. However, distribution grid remains a challenge in various parts of the region. Hence, in developing the new urban area the focus is placed on energy efficiency, reducing peak loads, constructing a robust and sustainable energy system. Efforts will be made to develop an energy system that relies on various sources of renewable energy, local renewable energy production, sharing energy within areas/neighbourhoods/districts and optimisation of local energy systems within a larger a larger regional/national/Nordic/EU energy system. Security of supply is at the core, as well as clean affordable energy for consumers. Today, Norway's thermal power plants accounts for about 2.2% of total production capacity (2017). Many of the thermal power plants are located in large industrial installations that use the electricity generated themselves. Production therefore often depends on the electricity needs of industry. These power plants use a variety of energy sources, including municipal waste, industrial waste, surplus heat, oil, natural gas and coal. The urban development in Bodø will demand that thermal power is generated from renewable sources. Thus, are solar thermal energy, geothermal energy, district heating/local heating, heat pump system and industrial waste heat all relevant sources of energy supply.

Success factors	Challenges/barriers
n/a at this stage (still early phase)	Based on qualitative interviews with Bodø Municipality and the local energy utility company, 10 major challenges and risks have been identified in the planning process so far: 1. Steering of the project development: Most of the former airport area is owned by the military and will be sold in the near future. The interview partners see the establishment of a real estate corporation as the project developer as a priority. The ownership - and thereby influence and steering opportunities – is seen as an important factor if the local authorities are to realize the goals to establish a ZEN. 2. Setting appropriate system boundaries with regard to the scope of activities that are included in the calculations and evaluation by ZEN. The greenhouse gas emissions generated by the use of data, business and industrial activities within the neighbourhood are of particular interest. 3. Data synchronization for scenario-based planning: The planning authorities need an evaluation tool for planning alternatives with regard to e.g. energy, emissions, and transport. Most of the data required for the calculations already exists in the municipality, but due to the existence of different data systems in the several departments, the alignment between them is time- and cost-intensive. 4. Coherent development of the area: The re-location of the airport to the southern part of the site will create a medium-term brownfield between the new airport and the city centre. The challenge is to develop the whole site – the airport, the city, and the brownfield - at the same time and create functional connectivity between them despite the long timeframe for the development (60 to 80 years). The brownfield's geographical location and the development sequence are important factors for a successful development. 5. Re-use of existing buildings and infrastructure vs. demolition: The former unique use of the buildings and infrastructure for military and airport poses challenges with regard to re-use with other functions. Little is currently known about the alternatives for re-use vs. the demolition of buildings and infrastructure with regard to emission assessment and user-demand. 6. Flexibility for adaptation: A challenge is to create a planning frame that sets high environmental standards and is simultaneously capable of adapting to new circumstances (e.g. technology, population and business sector growth and digitalization) over the long development period. The allocation of the technical infrastructure at an early stage of the site development and the construction phase of the new civil airport could be barriers to later adaptation. 7. Commitment to the project and its ambitions: To develop a neighbourhood with ambitions higher than existing laws and regulations requires political commitment and resolve among the involved partners to follow these ambitions. 8. Organisation and cooperation: The uniqueness of the project and its ambitions need an integrated and interdisciplinary approach, which requires new forms of process organisation as well as cooperation and communication between the stakeholders. 9. Time pressure (Risk): The civil airport's recently renewed taxiway has an estimated lifespan until 2024, when the new airport is planned completed. The construction of the new airport has to start already in 2019 to be in line with the schedule. This short timeframe places pressure on the planning and design process for this part of the area. 10. Uncertainty about deposits on the site and environment-friendly cleaning and decontamination methods (Risk): Military use has had an impact on the site, but little is known about the condition. Contamination could be a challenge with regard to costs and the tight time schedule. The adaption of environment-friendly cleaning and decontamination methods with low greenhouse emissions is desired by the municipality.

8 Elverum, Norway - Ydalir project

General information	
City	Elverum, Norway
Project name	**Ydalir project**[7]**- ZEN Pilot Project**
Project status	**planned** ☒ **under construction** ☒ realized ☐ in operation
Project start – end	2016-2030
Contact	**NTNU:** Arild Gustavsen **SINTEF Community:** Judith Thomsen
Project website	www.ydalirbydel.no
Size of project area	430 000 m^2
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use	Residential: 100,000 m^2 Office: Industry: Other: School 5,000 m^2 and a kindergarten 500 m^2
Financing	Public and Private

Overview description of the project
The ZEN Research Centre pilot projects serve as innovation hubs where researchers, together with building professionals, property developers, municipalities, energy companies, and building owners and users, test new solutions for the construction, operation, and use of neighbourhoods in order to reduce the greenhouse gas emissions to zero on a neighbourhood scale. In total, the ZEN pilot projects encompass more than 30,000 people, more than 1 million m^2 built area, and more than 5.5 million m^2 land area. The Ydalir project aims to develop a new neighbourhood with high energy and emission ambitions in the town of Elverum in Hedmark. The estimated timeframe for completion is 2030. 800 to 1,000 residential units are planned to be developed (approx. 100,000 m^2). The residential units are planned as a combination of detached houses and apartment buildings, and are built around a school for approx. 300 students (approx. 5,000 m^2) and a kindergarten with eight units (approx. 1,500 m^2). The area is approx. 430,000 m^2 and is located 1.5 km to the northeast of the city centre. It is currently in use as a gravel depot and this activity will continue in some areas until 2019, when all the buildings connected to the depot will be demolished. The site is surrounded by existing residential areas, small commercial sites, and park areas, and a ski jump. Ydalir is a pilot project within the Research Centre on Zero Emission Neighbourhoods in Smart Cities (https://fmezen.no/).

[7] https://fmezen.no/ydalir-elverum/

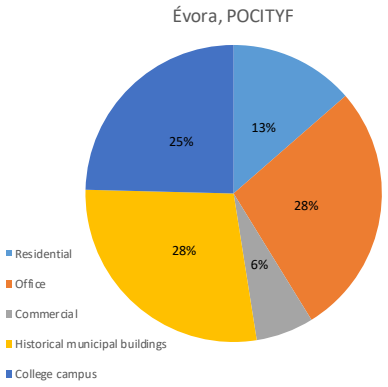
Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ **Energy neutral** ☒ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐ Other: The goal of the project is to plan and develop a major neighbourhood development in a new way, and to reduce the mobile and stationary energy demand and greenhouse gas emissions. Project goals will be achieved through the implementation of measures associated with five thematic areas: • A planning and design process that transfers the methodology of «Integrated (Energy) Design» from building to neighbourhood level. The masterplan for Ydalir is developed in cooperation with the involved stakeholders. • Minimising the demand for energy within the building stock and basing energy production on local sources (such as solar, groundwater, biofuels, district heating). Energy storage in batteries or within the bedrock is a possibility (not yet decided). • The building materials should have a long lifespan, include recirculated materials, and have a low carbon footprint. The preferred building materials are locally sourced wood or recycled materials. In general, the amount of building materials should be reduced and optimized. • The traffic infrastructure should enable and encourage residents to use public transport or individual transport by foot or bicycle. Investment in good public transport with four bus departures per hour, good walking and cycling paths, and a restricted car policy, with communal parking spaces some distance from the houses, making transport alternatives with low emissions more attractive. • The planning of a public space which supports an emission-friendly lifestyle

Indicators/expected impact	ZEN KPIs (https://fmezen.no/wp-content/uploads/2018/11/ZEN-Report-no-7-Bilingual.pdf)
Overall strategies of city/municipality connected with the project	*n/a*
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ Refurbishment ☐ Sustainable production ☐ Sustainable consumption ☐ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	The stakeholders involved are the project owner Elverum Tomteselskap, a semi-public organisation, which aims to enable population growth in Elverum, by developing land for housing and businesses at a reasonable price. 80% of the land in Ydalir is owned by this development agency. Two private landowners count for the remaining 20% of the area. Other stakeholders involved are Elverum municipality, seven local private developers, consultant agencies, a transportation agency (Hedmark Trafikk), an energy utility company that will deliver district heating and grid connection (EIDSIVA), and the waste management company SØIR IKS.
Typology of energy supply	*n/a*

Success factors	**Challenges/barriers**
Collaborative planning and developing process for the masterplan of Ydalir	Based on qualitative interviews with Elverum municipality, the local energy utility company and private developer, 6 major challenges and risks have been identified in the planning process so far[8]: 1. Setting of appropriate system boundaries: The combined heat and power (CHP) unit is planned to be installed in the district heating plant a few kilometers away from the area, due to practical and economic reasons. 2. 2. Planning of an energy system based on several energy sources (solar, ground heat, district heating based on biofuels) which are combined in an appropriate way without being too complicated. 3. 3. A predictable sequence of construction and timeframe. The timing of the development of the construction sites in the coming 10-15 years is important as the ongoing construction could influence the attractiveness of the neighbourhood. 4. 4. Demand for housing and political commitment (Risk): The size of the Ydalir project covers the estimated demand for housing in Elverum for the coming 10-15 years. The recent designation of another building zone in the eastern part of the city could jeopardize the implementation of the project within the contemplated timeframe. 5. Continuation in process management (Risk): The land development agency in Elverum is the project owner and normally their responsibility ends when selling the plots. The further management of the process has not yet been designated. (Risk) 6. Disagreement among the private landowners could jeopardize the project goals (Risk).

[8] https://fmezen.no/wp-content/uploads/2019/01/ZEN-Report-no-10.pdf

9 Évora, Portugal - POCITYF

General information	
City	**Évora, Portugal**
Project name	**POCITYF – A Positive Energy City Transformation Framework**
Project status	planned ☐ **implementation phase** ☒ realized ☐ in operation Notes: Solutions are being fully characterised in terms of requirements. Implementation plans (monitoring and citizen-engagement-related) are being defined
Project start – end	2019 - 2024
Contact	**José Miguel Costa, EDP**
Project website	https://pocityf.eu
Size of project area	Ha: 6.11, divided in three Positive Energy Districts
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒ Notes: Évora demonstration activities will include newly built, retrofitted and old buildings
Land use	- Residential: 13.6%. - Office: 27.6%. - Commercial: 6.3%.. - Other 1: 27.9%. Historical municipal buildings, including: market, venue, theatre, two schools and Évora town hall - Other 2: 24.6%. College campus 
Financing	- Private: 64.6%. - Public: 13.5%. - Research funding: 21.9%

Overview description of the project
POCITYF is a smart city-oriented project, whose major goal is to deliver a set of Positive Energy Blocks – a limited geographic area whose average local renewable generation is greater than its consumption – in the Lighthouse cities of Evora (PT) and Alkmaar (NL) and their Fellow cities Granada (ES), Bari (IT), Celje (SI), Ujpest (HU), Ioannina (GR) and Hvidovre (DK). With the creation of Positive Energy Blocks and Districts, POCITYF aims to transform those cities' mixed-urban environments, with a strong emphasis on cultural and historical protected areas, into cheaper, healthier, more accessible and reliable spaces for their citizens. In one word, to improve, in a sustainable and citizen-driven manner, the wellbeing in the 8 mentioned cities. To achieve the previously mentioned objectives, POCITYF will deploy a total of 10 integrated solutions, comprising 73 individual innovative elements (technologies, tools, methods), rooted under existing City Information Platforms. The project will be carried out along 4 Energy Transition Tracks (ETT), namely: ETT#1: tackling the transformation of existing and new building stock into energy positive; ETT#2: focusing on the application of grid flexibility strategies and storage systems, supported by DSM platforms for optimizing energy flows to maximize self-consumption and reduce grid stress; ETT#3: addressing the integration of e-Mobility to promote the decarbonisation of the mobility sector and alleviate inner-city traffic; ETT#4: as an enabling layer of the above

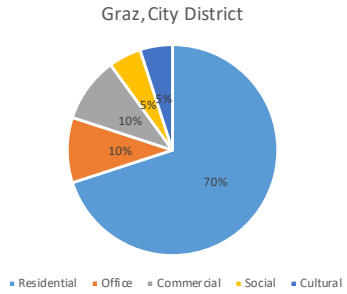
transition tracks, this intends to offer inclusive and holistic services for interdisciplinary citizen engagement and cocreation strategies with the city stakeholders and industry, towards the development of each city's own bold city-vision up to 2050.

Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒ Other ☒: POCITYF foremost goal, concerning Évora demonstration activities, is to endow the city (a UNESCO World Heritage site) with tools that enable their citizens to be more sustainable, while respecting regulatory frameworks.
Indicators/expected impact	- Environmental - Societal - Economic - Regulatory
Overall strategies of city/municipality connected with the project	- Smart City Strategies - Urban Renewal Strategies - Energy Masterplanning - Other: Évora intends to capitalise on POCITYF results by building a suitable regulatory framework that will enable their citizens to deploy sustainable solutions
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ Sustainable production ☐ **Sustainable consumption** ☒ (Local) Governance ☐ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	- Citizens, - Business - Research
Typology of energy supply	- Photovoltaic Notes: Évora demonstrators will make use of already installed residential storage systems and water heaters. Within the course of the project, around 10 2nd life residential storage systems will be installed in households with PV systems.

Success factors	**Challenges/barriers**
1) Demonstrate solutions at building and district level that enable the increase of energy self-consumption, energy savings and high share of locally produced renewable energy – leading to energy positive districts, located in mixed use urban districts, including cultural heritage sites; 2) Demonstrate a P2P transactive platform that will enable historical sites' citizens to build up a virtual energy wallet, amongst other use cases; 3) Demonstrate the integration of electro-mobility solutions as an enabler to grid flexibility;	1) Restrictions in installing PV roofs and/or facades in old and historical protected areas; 2) Prohibited to have PVsystem with more capacity than the contracted power (only if owner gets a license to be mini-generator – long and complex process); 3) Constraints related to GDPR – data sharing and privacy issues that can circumvent thecreation of knowledge on top of available city and citizens' data;

4) Demonstrate the integration of the latest generation of ICT solutions within existing city platforms over open and standardized interfaces for the development of new innovative services from partners within the consortia and outside it, via the planned Open Innovation Calls; 5) Demonstrate active citizen engagement services and solutions providing an open innovation ecosystem for citizens to participate in co-creation, decision making, planning and problem solving; 6) Design bankable business models and robust investment concepts that consider the whole PED lifecycle, and test them to reduce technical and financial risks for investors; 7) Strengthening the links and cooperative innovation with other SCC Projects in a large number of Member States with a wide coverage of cities; 8) Measure, validate and evaluate the demonstration results after a 2-year large-scale demonstration at district level; 9) Demonstrate solutions that facilitate the energy transition of historical and cultural heritage city areas; 10) Identify related regulatory barriers, legal aspects and data security/protection and propose practical recommendations on how to overcome them.	4) Industrial buildings want to increase consumption, since it's normally coupled with economic growth; 5) Retrofit old buildings that cannot be significantly changed, aesthetically speaking; 6) Lack of market framework and rules for commercial, residential and SMEs to participatewithin the ancillary services market and local P2P trading; 7) Absence of a broker figure to aggregate individual consumers' flexibility and build up a flexibility-based product; 8) Engage citizens in the co-creation, co-development and co-implementation process; 9) Circumvent honeymoon period of citizens' when using customized tools to monitor, control its energy consumption and generation (find behavioural-based mechanisms that are effective and long-lasting).

10 Graz, Austria - City District Development Graz-Reininghaus

General information	
City	**Graz, Austria**
Project name	**City District Development Graz-Reininghaus**
Project status	planned ☐ **implementation phase** ☒ realized ☐ in operation
Project start – end	01.10.2012 (Innovation- and Research Project / ECR Energy City Reininghaus 31.12.2014 (Innovation- and Research Project) Completion of the whole city district 2025
Contact	Bernd Schrunner, City of Graz
Project website	http://www.smartcitygraz.at/projekte-ebene-03_graz-reininghaus/ https://xn--reininghausgrnde-vzb.at/
Size of project area	Ha: 100
Building structure	**Newly built** ☒ Existing neighbourhood ☐ **Mixed** ☒ Notes: mixed used city district
Land use	- Residential: 70%. Housing for all generations - Office: 10%. Offices for companies and research institutes - Commercial: 10%. Super Market, Shopes, etc. - Social: 5%. Reininghaus School Campus - Cultural: 5%. Culture Center Reininghaus (Tennenmälzerei) 
Financing	- Private: ca. 80%. Financing of residential buildings, partial financing of public spaces - Public: 20%. Financing of the Energy- and Mobility - Infrastructure, financing of public space (streets, squares, parks) School Campus

Overview description of the project
On the basis of the solidarity between the City Planning Department (Stadtbaudirektion) of the City of Graz, the Graz University of Technology and the Federal State of Styria, the processing of the flagship project has been conceived. Main project-issue was the scientific work and the demonstration of the vision of the energy self-sufficient, CO2- neutral city-district Graz-Reininghaus. With the Framework-Plan ECR an awareness-raising process towards energy-efficient and sustainable city-development was stimulated. Contents and goals of the project The Framework Plan Energy for the Energy City Graz-Reininghaus provided: • conception of an energy-self-sufficient city district Graz-Reininghaus • initiation and supervision of the development-process for the energy-optimized and sustainable city district Graz-Reininghaus 

- development of energetically specific values as statutory basis in private-legal contracts between the City of Graz and future investors
- concepts for the integration of the energetically specific values in suitable manner in local plans/ regulations (City Development Concept STEK Graz, City-District-Development-Concept Graz-Reininghaus and Development Plans for the 20 city-quarters)
- drawing-up of recommendations for future energy-optimized city developments in Graz and Styria and
- foundation of a knowledge base for future energy-optimized City- developments in the Federal State of Styria.

Pilot Project +ERS - Plus Energy Network Reininghaus Süd

The multifunctional neighbourhood "+ERS - Plus Energy Network Reininghaus Süd" was realized within the urban planning area of Graz-Reininghaus. The project aim was to optimize the energy concept of the single buildings as well as of the building cluster in order to achieve a plus-energy standard within the residential neighbourhood.

The project ERS demonstrated, that energy networks in the building sector are an important contribution to reach energetic and climate change policy targets. Enlarging the energetic system borders from single buildings to multifunctional building assemblies opens new possibilities for the increase of energy efficiency in the building sector. The project ERS showed, that besides technological challenges for design and operation of energetic building assemblies, especially on organizational and legal level a lot of opened question are remaining. The development of innovative business models and legal conditions will support landlords, property developers, planers and municipalities implement energy networks in the future.

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ **Energy neutral** ☒ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐
Indicators/expected impact	- Environmental - Societal - Social - Services - Economic - Spatial - Regulatory First smart city District in Graz and Austria
Overall strategies of city/municipality connected with the project	- Smart City Strategies - Urban Renewal Strategies - Energy Masterplanning
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ Refurbishment ☐ Sustainable production ☐ Sustainable consumption ☐ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	- Citizens, - Investors/real estate - Business - Research

Typology of energy supply	- Geothermal energy - District heating/local heating - Heat pump system - Industrial waste heat - Photovoltaic

Success factors	Challenges/barriers
- Conception of the self-sufficient energy supply of the district Graz-Reininghaus - Initiation and support of the development process for the energy-optimised sustainable district Graz-Reininghaus - Development of energetic target values to be anchored in private-law contracts between the City of Graz and future investors, supported by incentive systems such as bonus cubatures / increased building densities upon implementation.Realization of the pilot project Pilot Project +ERS - Plus Energy Network Reininghaus Süd	- At the beginning of the project, limited knowledge for the initiation and development of smart city districts - Complexity of a transdisciplinary urban development process - Social barriers - barriers in the national building regulatory frameworks - Long-term nature of an urban development process

11 Groningen, The Netherlands - MAKING CITY

General information	
City	**Groningen, The Netherlands**
Project name	**MAKING City**
Project status	planned ☐ **implementation phase** ☒ realized ☐ in operation
Project start – end	Start December 1st 2018. Ends December 1st 2023
Contact	Groningen municipality: Jasper Tonen, Anna Tahaparij
Project website	http://makingcity.eu/ (not yet completed)
Size of project area	The buildings in the district that participate in the project are: District North: - Energy Academy Europe Building (9.636 m2) - Nijestee Highrise 1 (3,748 m^2) - Nijestee Highrise 2 (3,748 m^2) - 3 Terraced houses (combined: 400 m^2) – The implementation is in cooperation with the local citizens initiative Paddepoel Energiek and Grunneger Power. District South: - Mediacentrale (14,400 m^2) - Powerhouse (7,800 m^2) Sportscomplex (5,315 m^2)
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use	n/a
Financing	The actions that will be implemented depend on the owner of the building. In this project both public and private money is invested, combined with EU subsidies.

Overview description of the project
Coordinated by the CARTIF Foundation, MAKING-CITY is a 60-month Horizon 2020 project launched in December 2018. It focuses on addressing and demonstrating the urban energy system transformation towards smart and low-carbon cities, following the Positive Energy District (PED) concept. Today, cities have an essential role to play in tackle climate change by significantly reducing their carbon emissions. The PED operational models developed in MAKING-CITY (tested in the two "Lighthouse cities" Groningen and Oulu and replicated then in 6 "Follower cities"), will help European and other cities around the world adopt a long-term City Vision 2050 for energy transition and sustainable urbanisation whilst turning citizens into actors of this transformation. As MAKING-CITY is an Innovation Action (IA), technologies selected to be implemented are mature or even into the market. Moreover, the PED concept appears as a step beyond the current European building regulations by bringing major structural, societal, economical and technological changes in the cities. In the lighthouse City of Groningen the district energy approach will be tested. The methodology is replicable for all sorts of districts. In two districts, that vary a lot in types of buildings, occupation, social status etc., several buildings have been selected that (combined) should become energy positive at the end of the project. Various innovative technical solutions will be implemented and the effectiveness will be tested.

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ Energy neutral ☐ Energy efficient ☐ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐ Other: Project is part of Groningen's District energy approach
Indicators/expected impact	• CO2 neutral. • Energy positive on yearly basis and incorporating building related consumption • Other KPIs are yet to be formulated, but will include the ones mentioned
Overall strategies of city/municipality connected with the project	• Energy Masterplan: Groningen energyneutral in 2035. • The NEXT City. City Vision for the midterm.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	A consortium of 10 partners is working on this project: • TNO, Applied scientific research institute • Grunneger Power, Community owned energy cooperative • New Energy Coalition, regional development and cluster organization • Waarborg vastgoed, Real estate investor • Nijestee, Housing corporation • CGI, business consulting, system intergration and managed services • Sustainable Buildings, young award-winning high-tech software company • University of Groningen, faculty of spatial sciences • Hanze University of Applied Sciences, technical and social developments • Warmtestad BV, local heatgrid owner All relevant stakeholders (citizens, industry, investors/real estate, business, research) are involved.
Typology of energy supply	PV, PVT, BIPV, PV on water, Solaroad, Waste digestion, Geothermal or Waste heat (from a data hotel), Geothermal heatpumps, District heating

Success factors	Challenges/barriers
This cannot be said yet, since the project has just started.	• Realising an actual PED in practise. • Overcoming legal and law related barriers, for instance the Dutch energy law. • Financial hurdles. The innovation actions have not yet been proven to be effective, so it is difficult to get funding. • Realising replication and scaling up the plans. • Make citizens problem owners as well and make them see the benefits instead of only looking at the direct costs.

12 Kadıköy (Istanbul), Turkey - MAKING CITY

General information	
City	**Istanbul-Kadıköy, Turkey**
Project name	**Making City – Follower City Kadıköy**
Project status	planned ☐ **implementation phase** ☒ realized ☐ in operation
Project start – end	2019 – 2024
Contact	Ömer Akyürek
Project website	https://smartcities-infosystem.eu/sites-projects/projects/making-city
Size of project area	n/a
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use	TBD
Financing	The project is a funded project under H2020

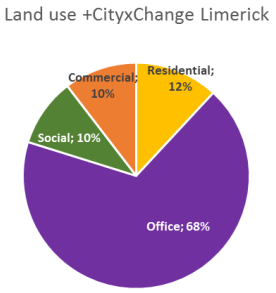
Overview description of the project
Kadıköy is one of the follower cities in the EU H2020 funded project MAKING-CITY. MAKING-CITY is a large-scale demonstration project aiming at the development of new integrated strategies to address the urban energy system transformation towards low carbon cities, with the positive energy district (PED) approach as the core of the urban energy transition pathway. The project will be intensively focused on achieving evidences about the actual potential of the PED concept, as foundation of a highly efficient and sustainable route to progress beyond the current urban transformation roadmaps. Although in principle a PED approach seems a solid and ambitious strategy, this should be complemented with long term urban planning to ensure upscaling and fostering higher impacts. Currently city energy plans are starting to be designed with a 2030 horizon, according to the standard city commitments, as for instance those reflected in the SECAPs and other more specific city plans. Project will address methodologies to support cities in their long term urban planning towards an adequate energy transition, paving the way of the planning, implementation and up-scaling process. Cities of Groningen (Netherlands) and Oulu (Finland) will act as lighthouses. These cities are currently working intensively in ambitious transformation planning whose approaches fit perfectly with the project objectives. Both have committed to deploy a demonstration of at least one positive energy district. León (Spain), Bassano del Grappa (Italy), **Kadiköy (Turkey)**, Poprad (Slovakia), Vidin (Bulgaria) and Lublin (Poland) will be the follower cities. Under this project, Kadıköy has commited to develop a solid execution project of Positive Energy District and foster high level of replication of the solutions demonstrated in Groningen and Oulu.

Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ Carbon-free ☐ Climate neutral ☐ Sustainable neighbourhood ☐ Social aspects/affordability ☐
Indicators/expected impact	The project is expected to have a wide range of impacts covering; - environmental - social - economic - regulatory.

Overall strategies of city/municipality connected with the project	Kadıköy Municipality is directly a partner to the project activity as the follower city.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	To maximise citizens' awareness and to empower citizens in this city transformation process, citizens' engagement strategy will be defined to turn citizens into active actors of the city energy transition. Following a user-centric approach, this model will also include the co-creation and co-design of smart city services towards energy transition with citizens via social networking (Facebook, LinkedIn, Twitter, youtube), city apps, public consultations and participative workshops (social media strategy). The co-creation processes will be linked with events with high interest to attract participation.
Typology of energy supply	Although the discussions are ongoing, the typology will potentially involve solar thermal, solar PV, wind, local heating and heat pump technologies for Kadıköy.

Success factors	**Challenges/barriers**
This will be worked in detail throughout the project.	This will be worked in detail throughout the project.

13 Limerick, Ireland - +CityxChange

General information	
City	**Limerick, Ireland**
Project name	**+CityxChange**
Project status	planned ☐ under construction/**implementation** ☒ realized ☐ in operation ☐
Project start – end	01/11/2018 – 30/10/2023
Contact	Terence Connolly
Project website	**https://cityxchange.eu/**
Size of project area	1.5 hectares (serviceable floor area)
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	• Residential: 1,927 m^2 • Office: 1,1026 m^2 • Social: 1,585 m^2 • Commercial: 1,686 m^2 
Financing	• *Retrofit Public-private:* Living City Tax Incentive: The LCCC Urban and Village Renewal Department administers and actively promotes the Living City Initiative (LCI), a tax incentive scheme for Special Regeneration Areas (SRA) in Limerick City Centre. The scheme is designed to bring life back into the heart of cities by offering tax relief for qualifying expenditure incurred on the refurbishment or conversion of certain buildings where conditions are met. • *Retrofit Public:* Structures at Risk Fund and the Built Heritage Investment Scheme: The LCCC Built Heritage and Conservation Department distributes funds for urgent works necessary to safeguard Protected Structures, Proposed Protected Structures, and Structures within Architectural Conservation Areas. • *Retrofit Public-private:* Public Interest Development Support: Working closely with the Dereliction and Vacancy Team, the Property Development Support Team actively addresses vacancy and dereliction in LCCC with the aim of establishing the structures for an intensive engagement process with property owners to encourage and enable reuse, redevelopment and refurbishment of vacant and derelict properties, in a targeted place based manner. • *Retrofit Research:* Living Georgian Limerick (LGL) Residential Development Template Pilot Project (Smart Aging Homes Project): LCCC are developing prototypes for enabling occupancy in the Georgian Terraced Houses and testing these against development equations and emerging residential cooperatives such as Smart Aging Homes etc. The team enables active discussions with owners of properties in the Georgian area of the City and with potential development partners in the Irish Smart Aging Exchange (ISAX). A submission has been made under Pillar 5 of the ReBuilding Ireland programme of the Department of Housing, Planning and Environment to facilitate the pilot project. • *Retrofit Public-private:* Living Georgian Limerick (LGL) Demonstration Projects: Five pilot demonstrator typologies have been identified to represent the diverse development market for historic Georgian properties. Property owners have been approached to act as champions for revitalization of the historic Georgian Core properties. The aim is to publicize and assist like-minded property owners, investors, tenants and residents in revitalizing the historic centre. • *Retrofit Research:* Urban Prototypes- Living Georgian Limerick Liveability Solutions: This Project will see the launch of an open challenge to urban innovators and entrepreneurs to address issues around renovation and renewal of the Georgian building stock in Limerick as well as the shared public spaces in these areas.

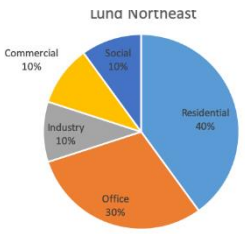
Overview description of the project
+CityxChange is a smart city project, that has been granted funding from the European Union's Horizon 2020 research and innovation programme in the call for the topic 'Smart cities and communities'. The Norwegian University of Science and Technology (NTNU) is the lead partner together with the Lighthouse Cities Trondheim Kommune and Limerick City and County Council. The +CityxChange project is developing a framework with supporting tools to enable a common energy market supported by a connected community. This is leading to recommendations for new policy intervention, market (de)regulation and business models that will deliver positive energy communities integrating e-Mobility as a Service (eMaaS). The project is structured to specifically develop value-added solutions that support replication in other EU cities as well as exploitation to commercial markets well beyond the project duration. In Limerick City, Limerick City and County Council (LCCC) are leading the implementation and testing of 11 demonstration projects under the headings of integrated planning and design, common energy market, and community exchange. These projects are taking place in close alignment with the deployment of demo projects in Trondheim. The outcomes this work in Limerick and Trondheim will guide the Follower Cities (Alba Iulia, Pisek, Sestao, Smolyan, and Voru) to replicate and scale the successful solutions, adapted to their respective local conditions.

Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐
Indicators/expected impact	• *Societal*: 1 politically-approved Bold City Visions with guidelines, roadmaps, and action plans • *Social*: 38 community participation events/actions organized • *Economic*: new jobs created • *Spatial*: 1 innovation labs/playgrounds contributing to the creation of DPEB • *Environmental*: 100% increase of total RES • *Environmental*: 1.5 Tonnes/year reduction in NOx emissions. • *Societal/Environmental*: 10% modal shift from fossil-fuel vehicles to EMaaS • *Economic/Environmental*: 20 new organisations with new sustainable energy approaches • *Social*: 20 Positive Energy Champions trained • *Regulatory*: 5 changes in regulation • *Environmental*: 1188 Tonnes CO2eq per year • *Regulatory*: 20 study visits by regulatory authorities • *Economic/Environmental*: 13 new DPEB prototypes enabled by a regulatory sandbox. • *Economic/Environmental:* 3 new DPEBs realised
Overall strategies of city/municipality connected with the project	1. Limerick 2030 Economic and Spatial Plan: http://limerick2030.ie/ 2. Corporate Plan 2015-2019: https://www.limerick.ie/council/services/your-council/corporate-plan/corporate-plan 3. Smart Cities Strategy: Building Ireland's First Digital City: https://www.limerick.ie/council/newsroom/news/limerick-become-irelands-first-digital-city 4. Project Ireland 2040: http://npf.ie/ 5. Ireland's Transition to a Low Carbon Energy Future 2015 – 2030: https://www.dccae.gov.ie/en-ie/energy/publications/Pages/White-Paper-on-Energy-Policy.aspx
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒

Innovative stakeholder involvement strategies	New forms of integrated spatial, social, political, economic, regulatory, legal, and technological innovations will deliver citizen observatories, innovation playgrounds, regulatory sandboxes, and Bold City Visions to engage civil society, local authorities, industry, and RTOs. • *Citizen Observatory*: This is a digital platform for increased citizen understanding, ownership and active participation including interactive mapping which will be put in place, enabling a 2-way dialogue regarding the aims, goals, motivations and ambitions of the communities with the urban authorities. • *Innovation Playground*: Innovative ideas developed by citizens, entrepreneurs, creatives and other organizations will be prototyped and piloted in specially designated Innovation Playgrounds. Successful prototypes will enter in a third stage via crowdfunding campaigns that will not only be used as funding mechanism but also as market validation tool and user feedback process. • *Regulatory Sandbox*: Examples of solutions that are to be trialled are peer-to-peer trading, integrated energy system optimisation/balancing between electricity, thermal, and liquid fuels, EV integration, demand response/flexibility and new markets for delivery of consumer-driven decentralised energy systems. • *Bold City Vision*: This cross-cutting approach will ensure that the +CityxChange solutions will lead to PEB/Ds and will enable the follower cities to provide input and to receive support for their implementation plans. In order to develop this roadmap, a review of the existing city, regional and national strategies and the vision statements and goals under different thematic headings will be carried out. Where possible, these will be aligned with the 2030 Sustainable Development Goals.
Typology of energy supply	• *Retrofit*: Improve the building envelope: ensure an air tightness level of <3m3/m2/hr @50 Pa, wall UValue of 0.26W/m2K, roof U-Value of 0.18W/m2K and glazing U-Value of 0.85W/m2K • *Retrofit*: Add advanced ventilation: for example, Mechanical Heat Recovery or Demand Controlled Ventilation solutions • *Heat Pump System*: Replace Fossil Fuels: for example, install an air to air heat pump to replace gas or oil boilers. • *Solar thermal*: Incorporate building integrated renewables: for example, solar thermal to produce Domestic Hot Water supply and/or PV to provide electricity to the building. • *Energy Management*: Install Building Energy or Home Management System: install a simple Building Energy Management System (BEMS) or a Home Management System (HMS), which will interact with the community grid trading and control system and enable energy trading and interaction with the community grid. • *Vehicle to Building*: The Gardens International building will be used to demonstrate the eMaaS solution incorporating Vehicle to Building charge.

Success factors	**Challenges/barriers**
We will deem the first year of the project a success if the following 3 targets are achieved: 1. All planning permits are in place and the project is starting to run. From October 2019 we expect installations to commence. We will have a full understanding of the energy consumption of the city. 2. We will have community support, and community interest in the project. 3. We will have a good understanding of the Financial models necessary for the project, and a roadmap to implement them.	• The Regulatory Dispensation/adaptation/licenses for the demos will need to be secured for the project to be a success. • Local energy generation will need to be sufficient to take the block from negative to positive. We may require a greater variety of energy generation techniques, or to expand the energy generation environs. • There are number of challenges for building owners to find a good enough business model to invest in their buildings. The Financial challenge will be key to this project.

14 Lund, Sweden - Lund Northeast

General information	
City	**Lund (Sweden)**
Project name	**Lund Northeast**
Project status	planned ☐ **Implementation stage** ☒ realized ☐ n/a ☐
Project start – end	2009-2049
Contact	**Eva Dalman, Project Manager**
Project website	www.lund.se/brunnshog
Size of project area	Ha: 225
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use (%)	• Residential: 40% • Office: 30% • Industry: 10% • Commercial: 10% • Social: 10% 
Financing	• Private: 90% • Public: 10%

Overview description of the project

The site Brunnshög is located in the north-eastern part of Lund –one of Sweden's oldest university cities. Lund is part of the expansive region of Greater Copenhagen, with Malmö and the Danish capital within close proximity. Brunnshög shall provide a flourish of activities for all different tastes, in the form of parks and courtyards, and passageways and research facilities. In Brunnshög, there will be offices and homes in a variety of forms, as well as a diverse range of services, recreation, education, pharmacies, shops, gyms, cafés, restaurants and culture. Everything that a local community might need – right on the doorstep. VISION: A world-leading environment for life, innovation and research. This encapsulates the vision for Brunnshög. Compared to today, the city of the future will face completely different demands for sustainability. Brunnshög realises the ambition of a city that is able to produce more energy than it needs. It is also a place where we can continue to cultivate the land, even as the urban landscape expands. Public transport by tram, cycling and walking will replace the majority of car journeys, and– together – we will make the best collective use of resources. Close access to recreation: In the area between Brunnshög and the Kungsmarken nature reserve, a completely new park is being built – The park of knowledge. This park will represent a green oasis with plenty of space for the natural environment, recreation and exercise. At its centre, Brunnshög will also feature Nobelparken – an oval-shaped city park where the hard border between street and park is removed. A winding, looping path will lead joggers, dog-walkers and casual strollers on a route passing between green islands and open fields. Here visitors can enjoy what nature has to offer, together with large, leafy areas for playing and exercise. Built around research ESS is a research facility that will become a European centre for the study of the in-depth structure and function of materials. The facility is being financed by 17 countries and will open in 2023. Right next door is the nationally funded MAXIV, where accelerators produce x-rays that are so intense and of such high quality that they enable researchers to see what has previously been invisible. Researchers from all around the world will be drawn towards the two research facilities. This will give Brunnshög an organic international and multilingual flavour. To make optimal use of the surplus heat generated by ESS and MAX IV, the world's biggest low-temperature district heating system is being built. This energy, which would otherwise have been wasted, will be reused in an innovative and efficient way – fully in line with Brunnshög's vision of sustainable urban development.

Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐
Indicators/expected impact	• Environmental • Social • Services
Overall strategies of city/municipality connected with the project	• Growing City
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ **Sustainable production** ☒ Sustainable consumption ☐ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	• Citizens • Industry • Investor/real estate • Business • Research
Typology of energy supply	• Solar Thermal Energy • Heat pump system • District heating/local heating • Industrial waste heat • Photovoltaic Notes: A large scale low temperature district heating network is being established, where heat from the research facilities MAX IV and ESS (European Spallation Source) will be recovered. The first deliveries of LTDH started in September 2019 and the grid will in title be 6,5 km long. The waste heat from the facilities will be more than enough to provide heating to the whole area. See COOL-DH project (https://www.cooldh.eu/)

Success factors	Challenges/barriers
• The city is landowner and energy supplier and can have a strong impact on the built environment and the sustainability.	• The project is financed with private money

15 Măgurele, Romania - Laser Valley – Land of Lights

General information	
City	**Măgurele, Romania**
Project name	**Laser Valley – Land of Lights (ELI-NP, Magurele)**
Project status	planned ☐ **under construction** ☒ realized ☐ in operation
Project start – end	
Contact	Cosmin Holeab, Elena Simion
Project website	http://landoflights.ro
Size of project area (hectare)	Smart technological development centered on the city of Măgurele • Măgurele City: 4.500 ha • Măgurele Science Park: 20-60 ha • Măgurele Science Village: 5-10 ha • Urban regeneration (Măgurele city centre): 60-80 ha
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use	Mix of • housing, • office space/business, • schools, university/science, • cultural facilities, • natural facilities (river, forests, Neajlov River delta)
Financing	• Public • Public-Private • Research funding • Green financing • Other (business angels)

Overview description of the project

Laser Valley - Land of Lights is about capitalising on the uniqueness of the scientific and technological Pan-European research infrastructure Extreme Light Infrastructure - Nuclear Physics (ELI-NP), about valorising the scientific, technological and talent hub already existing in the city of Măgurele, Ilfov County, about taking advantage of the geographic location, neighbouring the Southern area of Bucharest and close to the Danube River, about creating an economic growth pole as a regional science, innovation and entrepreneurship ecosystem, about integrated disruptive development ('game changer') and about an accelerator of territorial transformation.

In essence, it is about an accelerator for Romania's development.

Laser Valley - Land of Lights targets an entire territory, covering several counties in Romania with high implications for the development, transport and Europeanmobility Axis represented by the Danube, with expectations regarding its association as a strategic, flagship project to the EU Strategy for the Danube Region (EUSDR). The years 2018 (the centennial of Romania's Great Unification) and 2019 (Romanian EU Council Presidency) are opportunities and challenges for Laser Valley as well. Due to its uniqueness, size, complexity and potential socio-economic impact, the project is among the most challenging in post-1989 Romania - certainly the largest in terms of smart territorial development.

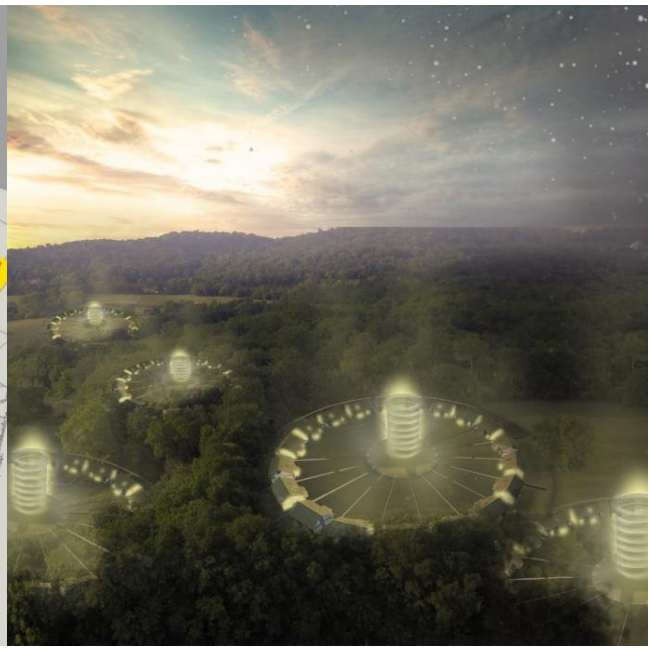
Considering the recommendations from the Socio-Economic Impact Study on ELI-NP developed by PwC in partnership with Aspen Institute Romania and in dialogue with international funding bodies - EIB, EBRD and WB, we concluded that a sound substantiation of joint decisions and actions for the development of Laser Valley - Land of Lights requires governance

mechanism, preferably an open method of coordination. This mechanism should coordinate the development of the science, innovation and entrepreneurship ecosystem in Laser Valley - Land of Lights by:

- providing a public-public and public-private dialogue platform;
- providing the necessary institutional framework to prepare the development strategy and the implementation plan;
- substantiating an Integrated Territorial Intervention in Măgurele, around ELI-NP and the hub of facilities and talents, to contribute to the development of a knowledge region;
- coordinating communication and dialogue with the international funding institutions; informing the Government, Parliament, local public administration, businesses and citizens on a regular basis.

Resources:

- Office space, housing, schools, university
- Mix of housing, business, science, cultural facilities and natural facilities (river, forests, Neajlov River delta)
- Environmental target for all development projects (fossil fuel-free by 2030)
- Energy target for all developments
- An 'understood' territory, ready for smart territorial development
- A Science village which will attract more than 500,000 students / year, starting with 2020
- A science park with a core of 20 ha; a hub of public research facilities; companies, business incubators and accelerators, a cognitive computing and cyber security research pole.



Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☐ Environmental target for all development projects: fossil fuel-free by 2030
Indicators/expected impact	Areas of impact: • Environmental • Societal • Social • Economic

	• Spatial
	• Regulatory
	Impact expected:
	  • More than 12,000 new jobs
	  • EUR 1.26 billion annual turnover
	  • EUR 500 million taxes collected to the state budget yearly

Overall strategies of city/municipality connected with the project	• Smart City Strategies • Urban Renewal Strategies • Energy Masterplanning • Growing City • Entrepreneurship ecosystem support policies
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	• Citizens • Industry • Investor/real estate • Business • Research
Typology of energy supply	• Geothermal energy • Solar thermal energy • District heating/local heating

Success factors	Challenges/barriers
The success of Laser Valley - Land of Lights depends on the successful action of the state, as an entrepreneurial state, on the public-public partnership (local - central administration), on the public- private partnership and on the private initiatives, both individually but, especially, orchestrated. The public commitment at Government level, the local administration commitment, the stakeholders' involvement and national and international communication are also key drivers for concrete results. The need for an open governance structure for the development of Laser Valley is a major conclusion of 2016. This structure is instrumental for the coordination of interventions, for the exploitation of the exceptional potential and for delivering positive impacts on competitiveness and welfare. As ELI-NP is an example of continuity, ever since 2009, when it was assumed by the Government, we strongly believe that Laser Valley - Land of Lights already has the necessary dynamics to be on the agenda of any Government, at least for the next decade.	Ambitious planning based on existing and planned resources. Considering the recommendations from the Socio-Economic Impact Study on ELI-NP developed by PwC in partnership with Aspen Institute Romania and in dialogue with international funding bodies - EIB, EBRD and WB, we concluded that a sound substantiation of joint decisions and actions for the development of Laser Valley - Land of Lights requires governance mechanism, preferably an open method of coordination. This mechanism should coordinate the development of the science, innovation and entrepreneurship ecosystem in Laser Valley - Land of Lights by: providing a public-public and public-private dialogue platform; providing the necessary institutional framework to prepare the development strategy and the implementation plan; substantiating an Integrated Territorial Intervention in Măgurele, around ELI-NP and the hub of facilities and talents, to contribute to the development of a knowledge region; coordinating communication and dialogue with the international funding institutions; informing the Government, Parliament, local public administration, businesses and citizens on a regular basis.

16 Oslo, Norway - Furuset project

General information	
City	**Oslo, Norway**
Project name	**Furuset project**[9] **- ZEN Pilot Project**
Project status	**planned** ☒ **under construction** ☒ realized ☐ in operation
Project start – end	The estimated timeframe for completion is 2030.
Contact	**NTNU:** Arild Gustavsen **SINTEF** **Community:** Judith Thomsen
Project website	https://www.futurebuilt.no/Forbildeprosjekter#!/Forbildeprosjekter/Furuset
Size of project area	870 000 m^2
Building structure	Newly built ☐ **Existing neighbourhood** ☒ **Mixed** ☒
Land use	Residential: yes Office: yes Industry: Other: Sport facilities (ice skating hall), shopping center, public libary
Financing	Public

Overview description of the project
The ZEN Research Centre pilot projects serve as innovation hubs where researchers, together with building professionals, property developers, municipalities, energy companies, and building owners and users, test new solutions for the construction, operation, and use of neighbourhoods in order to reduce the greenhouse gas emissions to zero on a neighbourhood scale. In total, the ZEN pilot projects encompass more than 30,000 people, more than 1 million m^2 built area, and more than 5.5 million m^2 land area. The Furuset project aims to combine the physical upgrading of the neighbourhood center of Furuset from the 1970's with high environmental ambitions. The renewal includes the infrastructure taking into consideration energy, waste and water, traffic, green landscaping and social issues, the extension of the number of residential units and work places, and the development of an attractive urban space. Furuset has good transport connections with two metro stations, four bus lines and close proximity to the E6. The local center offers a broad range of shopping and service facilities. An ice stadium, a school and kindergarten complement the social infrastructure in the neighbourhood. The exact number of the planned 1,700 – 2,300 housing units and 2,000 – 3,400 workplaces depends on the realization of a covered E6 highway. The estimated timeframe for completion is 2030. Furuset is a pilot project within the Research Centre on Zero Emission Neighbourhoods in Smart Cities (https://fmezen.no/).

[9] https://fmezen.no/category/pilot-projects/

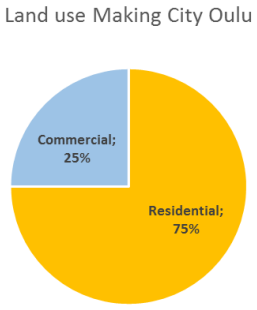
Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ **Energy neutral** ☒ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒ Furuset is a multi-functional local neighbourhood centre in the eastern part of Oslo. The refurbishment area incorporates about 3,800 residential units (90% are in apartment blocks) and 1,500 workplaces. The overall goal – to develop a climate-friendly and attractive neighbourhood – incorporates several sub-goals such as the creation of attractive urban spaces, strengthening of the green infrastructure with blue-green connections, a broad and varied supply of residential units, and a well-functioning traffic hub. These goals are facilitated by area regulation adopted in 2016. In addition, the development of a micro energy system aims to establish a local energy system with zero-emissions. In addition to the area regulation, a separate action plan describes the planned measures: • Investment in social infrastructure with the building of the Verdensparken skole (World Park School) and the nursing home, Furuset Hagelandsby. • Creation of a mobility centre and attractive urban spaces in a central location at Trygve Lie's place. • Development of a micro energy system: The establishment of a common waterborne energy system which utilizes – among other things – the surplus heat of the local ice stadium. This system will guarantee an environmentally friendly, economically feasible and flexible system, that will gradually extend during the forth-coming years. • Climate friendly construction of buildings: Energy consumption in buildings should be reduced and optimized by applying a standard Greenhouse Gas (GHG) accounting method in the planning and utility phase. The municipality has this focus when developing public-owned estates such as schools and nursing homes.

Indicators/expected impact	ZEN KPIs (https://fmezen.no/wp-content/uploads/2018/11/ZEN-Report-no-7-Bilingual.pdf)
Overall strategies of city/municipality connected with the project	Urban Renewal Strategies
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ **Refurbishment** ☒ Sustainable production ☐ Sustainable consumption ☐ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	The main stakeholders involved are the municipality with several departments, the administration of the city district Alna and the FutureBuilt Programme from public side. The planning department was the leading actor during the planning phase. The climate department (Klimaetat) took over in 2016. Several consultant agencies participated in different stages of the process. Other stakeholders involved are 12 housing cooperatives, private landowners, the transportation agency Ruter and the energy utility company Fortum Oslo Varme. Furuset lies within Fortum Oslo Varme's concession area for district heating.
Typology of energy supply	n/a

Success factors	**Challenges/barriers**
n/s (planning phase)	Based on findings from the PI-SEC project[10] report and three additional qualitative interviews with Oslo municipality, six major **challenges and risks** in the planning process so far have been identified[11]: 1. Evaluation and consideration of alternative energy system solutions: The design and planning process of the local energy system is dominated by a few stakeholders and thereby a limited number of alternatives is considered. This is linked to the concession as well as the high public stakeholder presence and lack of incentives to include more energy stakeholders. Furthermore, the in-house municipal capacity on energy in urban planning is unexplored. 2. Conflict between the plan for a 'highway lid' over E6: This structural measure would make the area more attractive, quieter, and add more space for buildings. It is desired from the municipality and the residents. Due to financial considerations, the National Road Administration has rejected this measure. 3. Pressure to speed-up construction activities: There is a mismatch between the urgent need for more housing in Oslo and the perceived slow process from planning to implementation in Furuset. 4. Knowledge transfer: The planning and design of the neighbourhood and in particular the micro energy system needs a fast and current knowledge transfer. There is a particular need for knowledge within the field of legal/juridical questions and the application of an integrated planning approach that connects the different technological solutions. 5. Acceptance of physical measures among the residents (Risk): The construction phase, providing a connection between two central roads, as part of the re-modelling of the transportation system was delayed due to protests from residents. This emphasises the importance of communication and the integration of residents during both the planning and implementation phases. (Challenge/risk) 6. Low interest from private stakeholders (Risk): Due to the relatively low real-estate prices in the neighbourhood, the interest of private stakeholders in the construction of residential and commercial buildings is limited. This can jeopardize the estimated construction scope and time frame. The development of the sites owned by private landowners is crucial for the establishment of a comprehensive energy system.

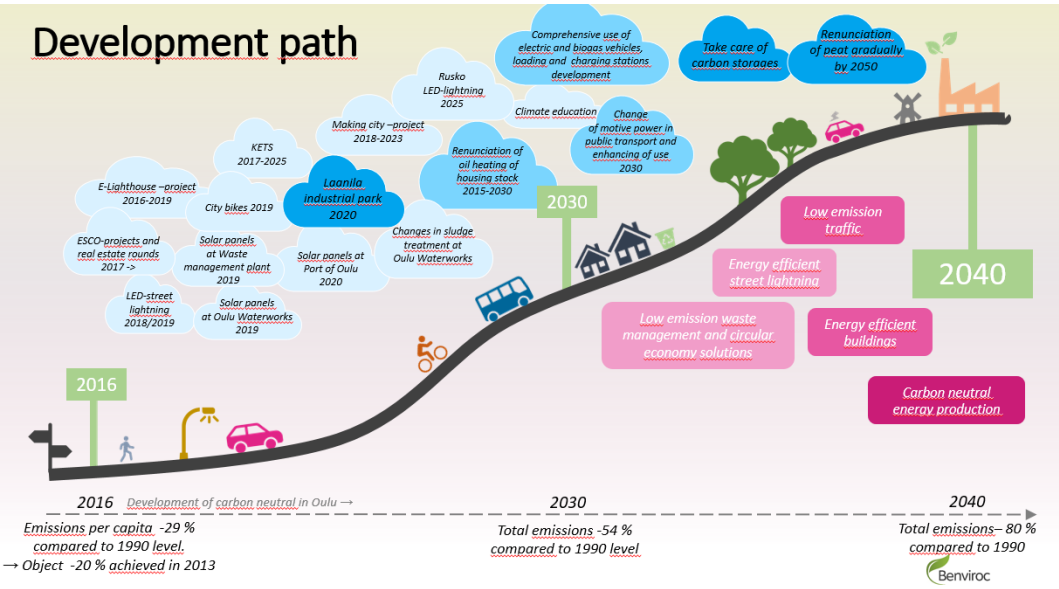
[10] https://www.ntnu.edu/smartcities/pi-sec
[11] https://fmezen.no/wp-content/uploads/2019/01/ZEN-Report-no-10.pdf

17 Oulu, Finland - MAKING CITY

General information	
City	**Oulu**
Project name	**Making-City**
Project status	planned ☐ **implementation phase** ☒ realized ☐ in operation ☐
Project start – end	12/2018 – 11/2023
Contact	Samuli Rinne
Project website	Under construction
Size of project area	4 hectare
Building structure	**Newly built** ☒ **Existing neighbourhood** ☒ **Mixed** ☒
Land use	• Residential: 3 hectare (75 %) • Office: - • Industry: - • Other: Commercial 1 hectare (25 %) 
Financing	• Total investment: 32,5 milj. € • 3,143 milj. € (municipal funds) • 28,29 milj € (company co-financing) • 1,127 milj € (EC)

Overview description of the project
MAKING-CITY is a large-scale demonstration project aiming at the development of new integrated strategies to address the urban energy system transformation towards low carbon cities, with the positive energy district (PED) approach as the core of the urban energy transition pathway. The project will be intensively focused on achieving evidences about the actual potential of the PED concept, as foundation of a high efficient and sustainable route to progress beyond the current urban transformation roadmaps. Located 3 km away from the city center of Oulu, the district of Kaukovainio has been selected to implement the PED concept developed in MAKING-CITY. The retrofitting of residential buildings, geothermal technology, and energy storage tanks are the main solutions that will be implemented as part of the PED concept. Besides promoting sustainable energy solutions, the PED method is expected to attract new families, foster community spirit, advance equality between population groups. Overall, the PED implementation in Kaukovainio will be driven by the 2012 Master Plan for "land use, environmental, and transport" which is based on open meetings gathering residents, key players and Oulu representatives. Firstly, the retrofitting of residential buildings (windows, home energy controllers to monitor air quality and the energy consumption…) will allow to maximise infrastructure performance.

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ **Energy neutral** ☒ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒ City of Oulu is doing ambitious work for climate change mitigation. The framework is embedded in the City strategy Oulu 2026: https://www.ouka.fi/documents/52058/17394318/ENG_Oulu2026_kaupunkistrategia.pdf/f9b8f26b-43a4-4b64-838a-fe0dde2a52eb As extension work of the city strategy a new environmental programme will be decided in the city government in April. The main object of the programme is that city of Oulu is carbon neutral in 2040. SECAP (Sustainable Energy and Climate Action Plan) is part of the programme and accepted by the city government in December 2018.
Indicators/expected impact	Project and City level KPIs are under construction. The indicators are chosen by technical, economical, environmental, societal and social points of view.
Overall strategies of city/municipality connected with the project	The City of Oulu was connected to the energy agreement and climate agreement of Covenant of Mayors for Climate and Energy in 2016 in which the 40% of the 1990 level reducing of the lighthouse gas emissions of the city has been bound itself by the year 2030. The main object reducing of greenhouse gas emissions of the agreement is through the measures which reduce energy consumption and energy efficiency and the increasing of the use of the recurring forms of energy. According to the plan of action, the City of Oulu will reduce its lighthouse gas emissions by 27 measures which have been divided into buildings and functions, service buildings, residential buildings of the city, to street lighting, traffic and waste management according to the SECAP sectors by the year 2030. Furthermore, it has been presented to the power and heat production and increasing of the use of the energy of the one recurring and the operations models to the changes joining measures and to whole urban structure. The emissions of the industry have been marked off outside the agreement.

	Vision of Carbon Neutral Oulu 2040: 
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ Sustainable production ☐ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒ Other: Energy distribution
Innovative stakeholder involvement strategies	• City of Oulu, enabler and coordination, new forms of participations of citizens • Jetitek Oy, innovative heat pumps (Industry, Business) • Oulu Energy, new forms of heat production and distribution (Industry, Business, Investor) • Arina Oy, recirculation of waste heat (Business, Investor) • Sivakka Oy, refurbishments (Investor/real estate) • YIT Oy, innovative housing (Investor, Business) • VTT Oy, design support (Research) • University of Oulu, design support (Research)
Typology of energy supply	Geothermal technology and PV panels will support the existing heating district system. One other innovative feature is the installation of geothermal heat pumps and thermal borehole energy storage under the Arina shopping centre. Coupled with PV panels covering the roof of this building and excess heat from refrigeration, the tanks will assure a seasonal energy storage: on summer, the extra energy produced will be redistributed into the district network (heating and hot water) or stored for winter energy demand peaks.

Success factors	Challenges/barriers
The project technical actions are carried out within the first 3 years with an additional monitoring period of two years, during which time the energy consumption data is collected and energy savings potential further evaluated. The results and lessons learnt will be taken to practice on district level in other areas of the city. In order to get real emission reduction techniques must be tailored to suit different cases.	Financial viability may be questionable especially for the transition period. Also the knowledge of the issues may be lacking.

18 Stor-Elvdal, Norway - Campus Evenstad

General information	
City	Stor-Elvdal Municipality, Norway
Project name	**Campus Evenstad[12]- ZEN Pilot Project**
Project status	planned ☐ **under construction** ☒ **realized** ☒ in operation
Project start – end	n/a
Contact	**NTNU:** Arild Gustavsen **SINTEF Community:** Judith Thomsen
Project website	https://fmezen.no/campus-evenstad/
Size of project area	61 000 m^2
Building structure	Newly built ☐ **Existing neighbourhood** ☒ **Mixed** ☒
Land use	Residential Office Other: building stock of 10 000 m^2 in total, mainly office and residential use.
Financing	Public

Overview description of the project
The ZEN Research Centre[13] pilot projects serve as innovation hubs where researchers, together with building professionals, property developers, municipalities, energy companies, and building owners and users, test new solutions for the construction, operation, and use of neighbourhoods in order to reduce the greenhouse gas emissions to zero on a neighbourhood scale. In total, the ZEN pilot projects encompass more than 30,000 people, more than 1 million m^2 built area, and more than 5.5 million m^2 land area. The Department of Applied Ecology and Agriculture of the Inland Norway University of Applied Sciences (Høgskolen i Innlandet) is located at the Campus Evenstad. It is located in a rural area in the Stor-Elvdal municipality. The campus accounts for 61,000 m^2 of land with 17 buildings (10,000 m^2 gross internal area (GIA)) with different uses: administration, education, and sport, student housing and building operation. The construction of a new administration and education building with ZEB-COM standard and a GIA of 1 141m^2 between 2015 and 2016 was one of the ZEB Centre's nine pilot projects. Campus Evenstad is a pilot project within the Research Centre on Zero Emission Neighbourhoods in Smart Cities (https://fmezen.no/).

[12] https://fmezen.no/campus-evenstad/
[13] https://fmezen.no/

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ **Energy neutral** ☒ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐ Other: The goal is to develop a ZEN with regard to campus operation. This goal incorporates the optimization of energy production, management and use. Campus Evenstad aims to be a regional energy hub and a demonstration plant for renewable energy - the Campus Evenstad Energy Centre (CEEC). The goal will be achieved using the following measures: • Development of a smart energy management system to reduce the peaks in energy consumption and thereby the load on the net. The aim is to increase the amount of self-produced energy. • Optimize the interplay between different electricity (solar cells, CHP, net) and heat (CHP, solar collectors, bio-based and electric boiler) sources. • Energy storage in batteries in a network of buildings with variable power requirement during the day, week and year. • Application of the living lab methodology to engage campus users in activities which minimize energy consumption and greenhouse gas emissions.
Indicators/expected impact	ZEN KPIs (https://fmezen.no/wp-content/uploads/2018/11/ZEN-Report-no-7-Bilingual.pdf)
Overall strategies of city/municipality connected with the project	n/a
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ Mobility ☐ **Buildings** ☒ Materials ☐ Refurbishment ☐ Sustainable production ☐ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ Business models ☐

Innovative stakeholder involvement strategies	The Campus is owned by the Norwegian state with Statsbygg as the public owner, and responsible for the administration of the real estate. The Inland Norway University rents the area from Statsbygg. The student organization Studentsamskipnaden owns the two dormitory houses on campus, which are built with passive house standard and include in total 117 residential units for students.
Typology of energy supply	The demand for heat on the campus is covered by on-site heat production through the newly established CHP plant, and one-third of the electricity demand is covered.

Success factors	**Challenges/barriers**
n/s	Legislation: Another landowner owns part of the Campus, the existing law and regulation framework therefore limits the establishment and operation of a comprehensive energy system with just one interface to the net owner.

19 Trondheim, Norway - NTNU Campus within the Knowledge Axis

General information	
City	Trondheim, Norway
Project name	NTNU Campus within the Knowledge Axis, Trondheim – ZEN Pilot Project
Project status	**planned** ☒ **under construction** ☒ realized ☐ in operation
Project start – end	2016-2025
Contact	**NTNU:** Arild Gustavsen **SINTEF Community:** Judith Thomsen
Project website	https://www.ntnu.no/campusutvikling
Size of project area	136,000 m^2 of floor area
Building structure	**Newly built** ☒ **Existing neighbourhood** ☒ **Mixed** ☒
Land use	n/a
Financing	Public

Overview description of the project

The ZEN Research Centre pilot projects serve as innovation hubs where researchers, together with building professionals, property developers, municipalities, energy companies, and building owners and users, test new solutions for the construction, operation, and use of neighbourhoods in order to reduce the greenhouse gas emissions to zero on a neighbourhood scale. In total, the ZEN pilot projects encompass more than 30,000 people, more than 1 million m^2 built area, and more than 5.5 million m^2 land area.

The Knowledge Axis is a north-south bound route in Trondheim that includes a high concentration of knowledge-intensive institutions involved in research, education, business and public sectors. NTNU is one of the primary actors along the axis and the re-location of the social sciences campus currently found at Dragvoll, to the Gløshaugen Campus will strengthen this position. The relocation encompasses a spatial demand of 136,000 m^2 of floor area and, after the completion in 2025, 17,000 additional users. In total 36,316 students and 7,550 employees will use the campus on a regular basis.

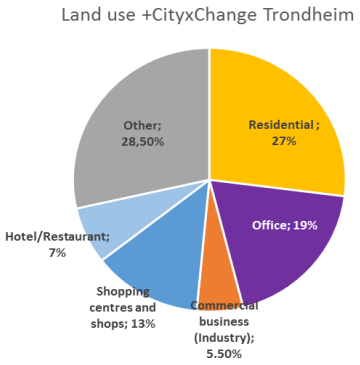
NTNU is a pilot project within the Research Centre on Zero Emission Neighbourhoods in Smart Cities (https://fmezen.no/).

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ **Energy neutral** ☒ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐ The main goal of the campus consolidation project is to develop a campus, which provides the best environment for excellent research, education, dissemination and innovation. The vision rapport for NTNU (2014:88) describes the option to expand the vision of zero energy building «to a campus perspective, which means that all activity on and adjacent to the campus will be at a zero energy level in 2060». The main measures to meet the goals involves the application of a detailed project plan and relevant quality principles: • Development of a vision, quality principles and the identification of the appropriate construction area; Phase 1 «Vision» (2016) • Development of a master plan, design concepts and the detailed planning of the units and the academic communities; Phase 2 «Definition» (2017) • Development of a program for room use and functionalities, for the design and for the construction; Phase 3 «Design» (2018-2020) • Development of quality assuring solutions, rules for use and the localization of users; Phase 4 «Construction» (2021-2025) • Evaluation and adaptation; Phase 5 «Use» (from 2025) • Application of six quality principles to ensure that the new campus has the required quality characteristics. The principles are unifying, wit, urban, network of hubs, effective, sustainable and living laboratory. These principles shall be applied to all phases of the project development.
Indicators/expected impact	ZEN KPIs (https://fmezen.no/wp-content/uploads/2018/11/ZEN-Report-no-7-Bilingual.pdf)
Overall strategies of city/municipality connected with the project	Smart cities strategies, Mobility
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	The two main stakeholders are Statsbygg and the project owner NTNU, which have established a project organization for the campus development that is part of the NTNU administration. Other stakeholders are the Trøndelag regional municipality and the Norwegian state, as owner of the NTNU. A smaller part of the Campus, Elgesetergate 10, is owned by Statsbygg and will in the near future be developed as a new education and service centre. The student organization SiT is an important actor with regard to student involvement and on campus service supply for students.
Typology of energy supply	*n/a*

Success factors	Challenges/barriers
n/s (planning phase)	Based on seven qualitative interviews with different departments at NTNU and Trondheim Municipality, six challenges and risks have been identified in the planning process so far[14]: - Anchoring of ambitions: The goals in relation to the campus project are described in several leading documents (Trondheim Kommune, 2012, Trondheim Kommune, NTNU, 2014, NTNU, 2014), but the scale of the project, the time pressure, and conflicting goals are perceived as obstacles to the high ambitions. In addition, the two main partners, NTNU and Trondheim Municipality, are huge organizations where responsibilities are distributed among several departments and employees. This can result in a lack of ownership and accountability when following the ambitions related to the establishment of a ZEN. - Competence for an integrated approach: The broad level of professional and organizational challenges to establish a ZEN sets high requirements for the steering of the project development with regard to interdisciplinary teamwork and the application of an integrated approach. - Appropriate involvement of available knowledge: The involved partners distribute the knowledge to develop a ZEN, but due to the size of the involved partner organizations, it is difficult to integrate it properly in the development. - Involvement of citizens: The project owner NTNU naturally focuses on the involvement of their own users - students and employees. The involvement of citizens and especially the closest neighbours, is not so obvious. There is already a resistance from neighbours and from the politicians against the planned construction. Other important groups who need to be involved are the business sector and landowners, especially those located close to the campus. - Conflict of goals: Some interview partners describe the possibility that the goal to develop a campus that provides the best environment for research, education, dissemination and innovation should be prioritized before the goal to develop a ZEN. - Several landowners (Risk): Several landowners have stakes in the campus area and the possible construction area in the Elgeseter district. Disagreement among landowners could jeopardize project development. An open question from the project owner is to identify the appropriate owners for the buildings with regard to the management of the energy system. - Financing (Risk): The financing of the project is not yet guaranteed and is among other things dependent on the sale of the Dragvoll Campus. If this area is regulated for another purpose, such as housing, a higher market price could be realized.

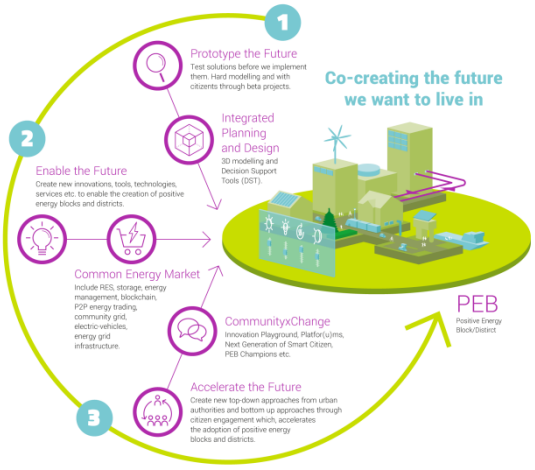
[14] https://fmezen.no/wp-content/uploads/2019/01/ZEN-Report-no-10.pdf

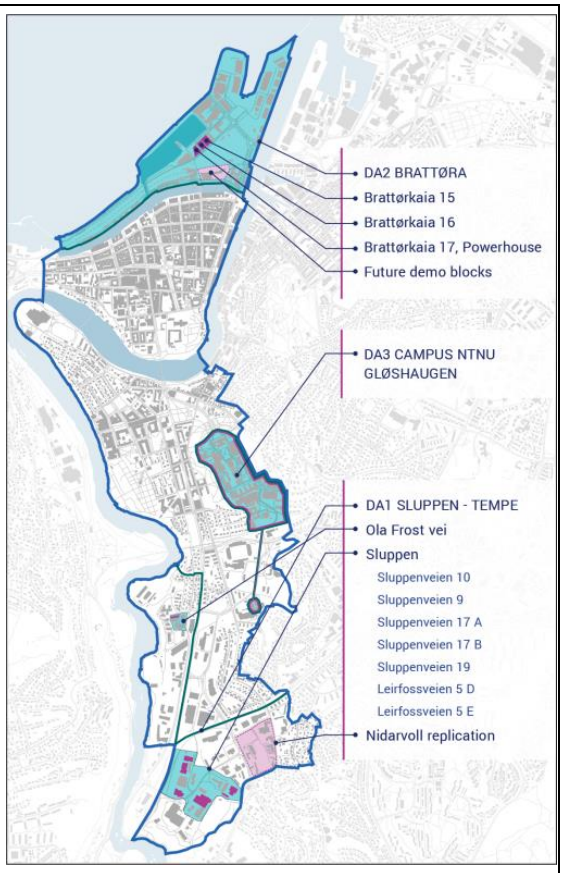
20 Trondheim, Norway - +CityxChange

General information	
City	**Trondheim** (Norway)
Project name	**+CityxChange**
Project status	planned ☐ under construction/**implementation** ☒ realized ☐ in operation ☐
Project start – end	01.11.2018 – 31.10.2023
Contact	Silja Rønningsen (Project Coordinator)
Project website	https://cityxchange.eu/
Size of project area (hectare)	Two PEBs scheduled in Trondheim (see also map below): Brattøra (30.04.2021), Sluppen (31.10.2021). Brattøra: 60 ha. Sluppen: 16 ha
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use	- Residential: 27% - Office: 19% - Commercial business (Industry): 5.5% - Shopping centres and shops: 13% - Hotel/Restaurant: 7% - Other: 28.5% 
Financing	Not able to specify exact percentages on each financing type. - Public (EU and national funding instruments) - Public-private risk sharing and investment schemes - Private stakeholder financing - ESCO or similar scheme

Overview description of the project
LightHouse city LHC Trondheim (Central Norway), together with LHC partner Limerick (IE), Fellow Cities Pisek (CZ), Võru (EST), Alba Iulia (RO), Sestao (ES), and Smolyan (BUL), universities of Trondheim and Limerick (NTNU and UL), and 23 industry partners and non-profit organizations make up H2020 SCC-1 funded +CityxChange project. Overall vision of +CityxChange is „Co-creating the future we want to live in“, through 3 main steps: Prototyping, enabling, and accelerating. LHC Trondheim will within October 2021 deploy two PEBs (Brattøra and Sluppen), perform grid optimizing of city campus Gløshaugen (campus being its own concession area for thermal/EL), and connect the three areas for exchange/trade of energy and capacity/effect. Important in the +CxC innovation is to establish a plug&play architecture that with some changes/amendments may be deployed in other cities.

Working in detail within smaller, defined geographical areas – called community grids, we have introduced the level CSO (Community System Operator), below the DSO level. The CSO will for our PEBs in Trondheim be our EL DSO, for campus it is NTNU. In other places/cities with other preconditions and frame conditions, the CSO may be another type of organization/ company. Dividing the concession area into smaller units or energy ecosystems, and then building the whole, integrated energy system „from below“ is for +CxC a sensible and viable approach towards EU Common Energy Market, and establishment of PEBs, then upscaled into PEDs.



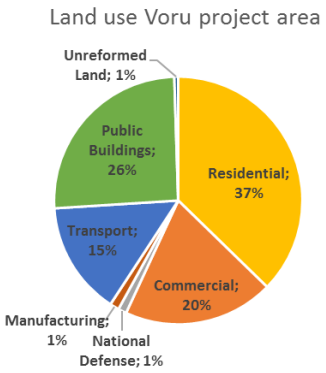


Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒ Other: - Generate, test and verify new business models with lower risk, decreased payback times, and focus on ROI. - Increased community awareness, engagement and involvement
Indicators/expected impact	Environmental, Societal, Social, Community participation and behavioural influence, Economic, Regulatory, Technical, Energy related, Upscaling & Replication. A total of 33 KPIs; examples: GHG and NOx emissions, RES share, RES efficiency, RES integration, RES flexibility, RES curtailment, RES traded, optimized self-consumption, total new investments in RES, reduction in grid investments, decrease in simple payback time, ROI, # new jobs, changes in regulation, # new PEB prototypes, etc.
Overall strategies of city/municipality connected with the project	- Trondheim Master Plans (Societal Plan and Area Plan) - Energy and Climate Action Plan - City Development Strategy - Strategic Business Development Plan (comprising Trondheim Region, not only city)
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒

	Other: - Distributed Energy Resource Management Systems (DERMS); energy systems integration - P2P trading of energy and flexibility (virtual and physical) - Our own designed Local Energy Market (Energy Trading Platform) and Local Flexibility Market
Innovative stakeholder involvement strategies	- Risk sharing and investment models comprising public sector and core private stakeholders such as thermal and EL DSOs, building owners, and private financing institution. - Tuned EPCs for two cases: Corporate, and private tenants - Innovation Playgrounds involving both citizens, businesses, NGOs etc - Testing and experimenting of several citizen arena approaches including use of advanced digital tools for stakeholder engagement - "Next Generation Smart Citizen" strategies and activities focusing on children/youths
Typology of energy supply	- Grid electricity (mainly hydropower with emission factor approx 21 g CO2eq/kWh, 95-100% hydro); since we follow EU definition of PEB (and BEST Table generation), grid EL is not included in local, primary energy. - District Heating (close to 100% domestic/household waste, incineration based) - PV - Several heat pumps and HP systems integration. Two new large HPs: One will extract waste heat from local data centre, one to utilise waste heat from local, large cooling/freezing facilities. All HPs to do local distribution of additional heat as well as redistribution and storage at larger district heating system. - V2B (energy/peak shaving and possibly frequency alignment) - New, distributed energy system requires 3 batteries of approx 500 kWh: Sluppen (2), Brattøra (1).

Success factors	**Challenges/barriers**
- Full anchoring and ownership at top level adm and political level; CEO formal project owner - Solid anchoring at all key departments within municipality - Highly skilled personnel also within municipality, on core topics such as project coordination/management, energy, business development, ICT, citizen involvement - Pro-active and innovative external partners that covers all crucial topics to realise PEBs/PEDs. DSO level totally necessary to have on board - The possibility of setting up local regulatory sandboxes with some-several dispensations from national regulator - Open, local trade of energy, effect, flexibility, frequency etc. - Viable business, investment, and risk sharing models that focuses on improved/adequate ROI for the private stakeholders involved	- To obtain the "correct"/necessary dispensations from national energy/grid/ concession legislation. Deregulation of monopolies, possibilities for P2P trading - Willingness from building/asset owners to invest - Local stakeholder engagement and involvement – including both citizens, businesses, NGOs etc. - Impact of innovative interventions difficult to quantify; scarce historic data and track records for PEB/PED cases - Will new business concepts and models float? How to get to commercially viable models on shorter term

21 Võru, Estonia - +CityxChange

General information	
City	**Võru (Estonia)**
Project name	**+CityxChange** (Positive City ExChange)
Project status	planned ☐ **under construction/implementation** ☒ realized ☐ in operation ☐
Project start – end	1 November 2018 – 1 November 2023 (the duration of the action will be 60 months)
Contact	**Tiina Hallimäe**, female, is development adviser of Võru town (13 years of experiences in project management and local authority development plans). Master degree in Economics. In the present project the role is to coordinate activities which are connected with Võru town. **Diana Vene**, female, head architect of Võru town (since august 2017), TTK University of Applied Sciences- architecture, Tallinn University of Technology –architecture. Main field is urban planning and coordinate activities which are connected to this topic in Võru.
Project website	https://cityxchange.eu/
Size of project area	The Võru Demostration area covers an area of **0,22 km²** (the total area of Võru is 14 square km).
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	The composition of land purpose is: - Residential: 37.3% - Commercial: 19.6% - National defence: 1.1% - Manufacturing land: 1.2% - Transport: 14.8% - Public buildings land: 25.5% - Unreformed land: 0.5% 
Financing	Grant

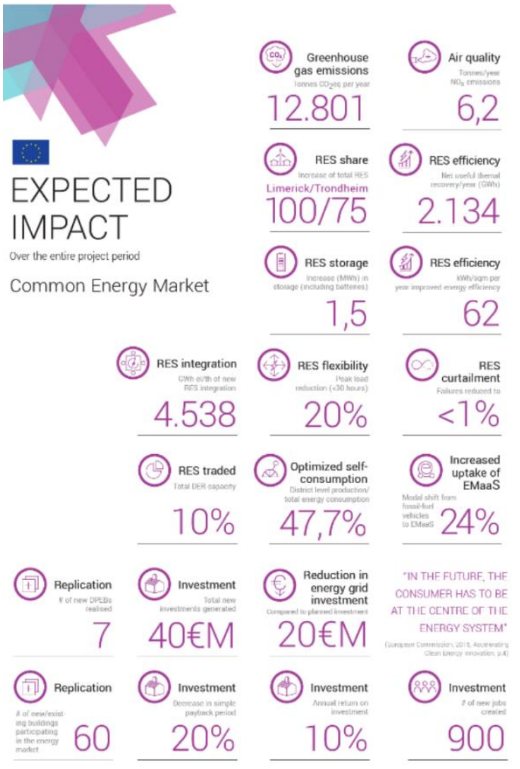
Overview description of the project
+CityxChange (Positive City ExChange) is a smart city project, that has been granted funding from the European Union's Horizon 2020 research and innovation programme in the call for the topic 'Smart cities and communities'. Norwegian University of Science and Technology (NTNU) will be the host and lead the +CityxChange consortium together with the Lighthouse Cities Trondheim kommune and Limerick City and County Council. The +CityxChange vision is to enable the co-creation of the future we want to live in. This will include the development of a framework and supporting tools to enable a common energy market supported by a connected community. This will lead to recommendations for new policy intervention, market (de)regulation and business models that will deliver positive energy communities integrating e-Mobility as a Service (eMaaS). Trondheim, Limerick, Alba Iulia, Pisek, Sestao, Smolyan and Voru and their industry and research partners are joining forces to co-create the future we want to live in. As aspiring Lighthouse and Follower Cities, respectively, they have detailed out their ambitions into the +CityxChange proposal, which describes a structured approach on how to develop and deploy Positive Energy Blocks and Districts and scale these out as part of the Clean Energy Transition. The approach combines: Prototyping the Future through Integrated Planning and Design; Enabling the Future through Creation of a Common Energy

Market; and Accelerating the Future through CommunityxChange with all stakeholders of the city. New forms of integrated spatial, social, political, economic, regulatory, legal, and technological innovations will deliver citizen observatories, innovation playgrounds, regulatory sandboxes, and Bold City Visions to engage civil society, local authorities, industry, and RTOs to scale up from PEBs to PEBs to Positive Energy Cities, supported by a distributed and modular energy system architecture that goes beyond nZEB. On top of this, the consortium will create a new energy market design coupled to consumer-driven innovation, developed in close working cooperation with national regulators, DSOs/CSOs, property developers, and local energy communities. Flexibility will be put at the core of the distributed energy system by creating new micro-grid operation, prosumer-driven Community System Operators, and new markets for peak shaving/RES trading to reduce grid investment needs and curtailment. Their aim is to realize Europe-wide deployment of Positive Energy Districts by 2050 and prepare the way for fully Positive Energy Cities.

The role of Võru in this project is Follower City, performing mainly the replication tasks indicated in WP6 leading T6.10. In addition, Võru will participate in the Follower City activities in the WP7-WP10.

Võru town would like to focus on its historical part (0,37 km2, approximately 1100 inhabitant, houses are built in the period of 1784-1940) in order to find innovative solutions for decreasing CO2 emission, also to change people's habits and behaviour. Võru town would like to increase the attractiveness of this area and bring is as an example of a best living environment. As it needs bigger approach Võru town would like to make bold city vision which includes general plan of the Võru town, analysis about Võru heritage and visions for heritage area, also technical documents for innovative solutions, 3D, intelligent platform especially for heritage area.

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ **Energy neutral** ☒ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒ Other: **Sustainable Development**
Indicators/expected impact	a. Technical implementation i. detailed specifications with respect to the technologies that were installed ii. the size of the technologies iii. design of the overall solution, iv. the company(s) that installed it, v. how long it took etc. b. Social implementation, i.e. information with respect to how the DP was implemented with respect to the citizens in the block/district, i. what engagement activities were carried out, ii. anecdotal evidence on what was successful and why etc. c. Legal implementation – information regarding any i. regulation barriers that had to be overcome ii. planning applications that had to be submitted iii. how any technologies or services were procured iv. what stakeholders (public and private) had to be consulted etc. d. Economic implementation i. costs of the overall Demonstration Project ii. breakdown of capital equipment, materials, installation costs etc. iii. any investments that were obtained, how they were obtained, where they came from etc. e. Environmental implementation i. the impact of the DP to the block/district, ii. how it improved the environmental capacity of the block and iii. what impact it had from an environmental perspective

	 Figure 27: Expected Impact  Figure 28: Expected Impact (Continued)
Overall strategies of city/municipality connected with the project	Võru town would like to be a growing smart intelligent small city (energy, innovation, renewal strategies). The strategy is currently developed to achieve our goals.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	City planners, building owners/managers, energy managers, investors, designers, policymakers, citizens, communities, grid operators, urban stakeholders, media, project stakeholders, local stakeholders

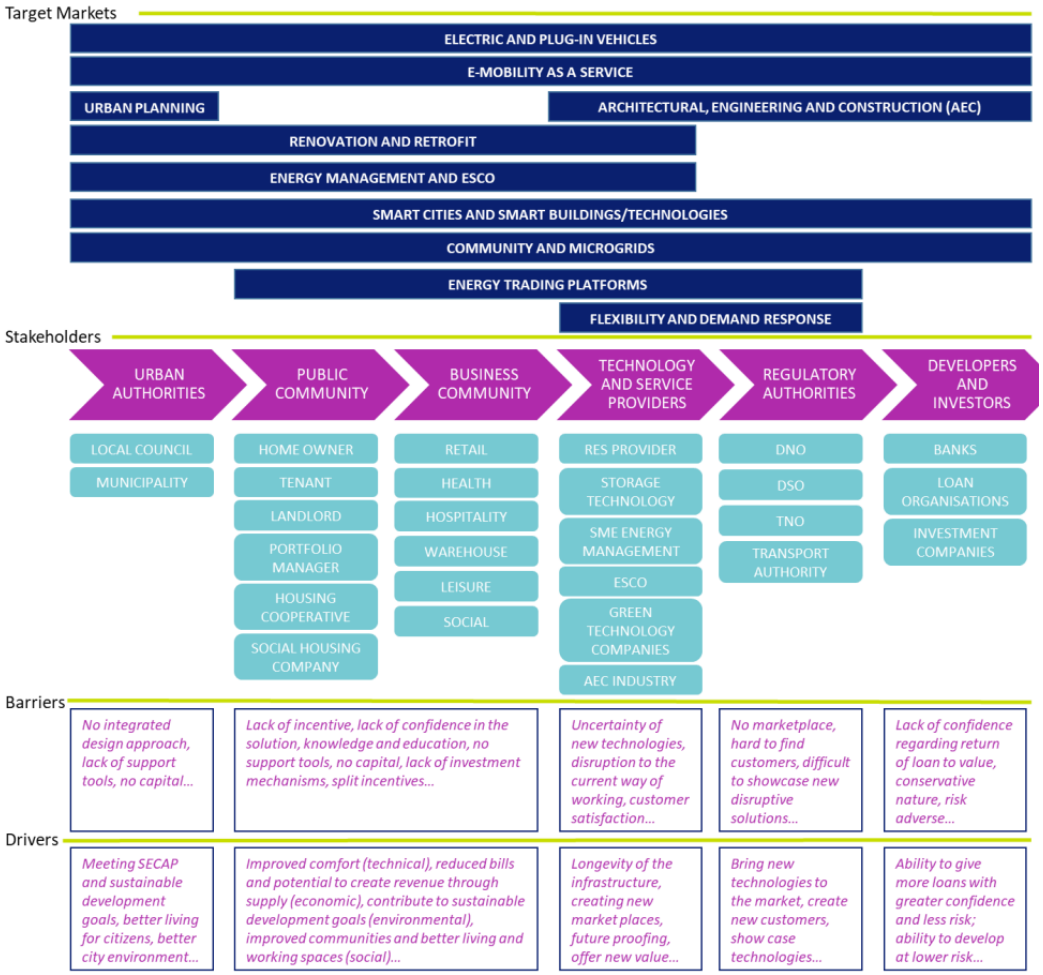


Figure 32: +CityxChange Stakeholder Value Chain

Typology of energy supply	- District heating (woodchip technology) - Renewable materials, solar thermal energy

Success factors	Challenges/barriers
- First and big thing is that the project got foundation → work could be started	- It is difficult to start with innovative projects in the rural area. People are against everything new. - The project is not taking seriously because this is new for this area. - Actually it is a big challenge how to get people believe in that. - The barriers are political and financial. - +CityxChange project one of the challenges to transit to clean energy, and realize positive energy districts, lies with the regulatory framework that governs DSOs, TSOs, and energy companies throughout Europe. One of the core challenges faced in the wide-scale roll-out of Positive Energy Blocks is the physical/spatial constraints of continuity between adjacent buildings and DER resources available within the local energy system.

ANNEX: Background information on Võru

Võru was founded on 21-st of August 1784 and is situated in the South-Eastern part of Estonia and is the capital of Võru county. The total area of Võru is 14 square km2. The total population of Võru is 12 367 (In Estonia 1 315 635) – constituting 0,94% of the total population in Estonia. Võru is the 11th biggest city by its population in Estonia. Võru is the capital of Võru region with 12.367 inhabitants (2017). Võru region has 33.505 inhabitants. Võru county's main economic sectors are forestry and wood processing, furniture and food industry and also tourism. The biggest foreign owned companies based in Võru county are AS Toftan (wood processing), AS Barrus (wood processing), AS Antsla Inno (furniture production), AS Rauameister (metal processing), AS Võru Juust (food processing) and Danpower GmbH (energy production). The county enjoys an advantageous location due to its relative proximity to Pskov in Russia (100 km) and Riga in Latvia (220 km). Accessibility is provided by several transport corridors running through the county. One of the most important transit routes in Estonia, Tallinn-Tartu-Pskov, passes the county. The South East corner of the county is crossed by the Riga-Pskov-St Petersburg major road. County is strategically placed on trade routes between the East and West. According to statistics (2015) Võru county GDP is 278,9 m euros (which is 1,4 % from GDP), in Võru county GDP per capita is 8 308,1 euros. In 2016 there were 221 companies exporting (turnover 112,3 m euros) and 371 companies importing goods (turnover 60,9 m euros). There are 4148 entrepreneurs running their businesses in Võru region.

Most of the people in Võru town are working in service sector (schools, hospitals, military, etc). The biggest industries in town are wood and food processing factories (Cristella VT, Valio).

In Võru county there are 95,3% Estonians, 3,3% Russians and 1,4% other nationalities. Two indigenous ethnic groups live in Võru county – the Võro people and the Setos. Both ethnic groups have their own language (Võro, Seto) and cultural heritage in traditions. The population in town and region is ageing; 75 % of the population lives in multi-flat buildings. There are 883,36 inhabitants per km2 (average in Estonia is 29,8). In Tallinn there are 2 676,4 and in Tartu 2 389,6 inhabitants per km². Võru region made joint procurement to provide public transport in Võru region (In town and in region). With new service provider Võru region started to CNG busses and an LNG-CNG gas station was built for that. Võru took part in a national programme aiming to reduce the usage of fossil fuels in public transport. Võru has 16 km of light traffic roads. The most problematic issue for Võru town is that people are moving out from Võru town to surrounding municipalities or bigger cities in Estonia. Also the centre of Võru and heritage area is week and poor from activities. People are moving to live from the city centre to the suburb areas of the town. As there are no universities in town, young people move to other towns in Estonia or abroad. Insufficient public transport. There is urgent need to bring people and life back to city centre and to reconstruct buildings to make them more energy efficient.

Võru is a really small city only 14km2 and 12367 inhabitants. The population and region is mainly ageing. It is a big thing to become noticeable even in Estonia.

A problematic issue for Võru is that people are moving out from Võru town to surrounding municipalities or bigger cities in Estonia. Also the centre of Võru and the heritage area are weak with poor activities. People are moving from the city centre to live in the suburbs. As there are no universities in town, young people move to other towns in Estonia or abroad. There is insufficient public transport. There is urgent need to bring people and life back to city centre, to make heritage area attractive place to live and have business and to reconstruct buildings to make them more energy efficient.

For a bigger and more integrated approach Võru town aims to build the bold city vision which includes a general plan of the Võru town, analysis about Võru heritage and visions for heritage area, linked with technical documents for innovative solutions, 3D approaches, and intelligent energy systems especially for the heritage area. A new plan for Võru town will focus on how to bring life back to the city centre (includes citizen participation, innovation, energy efficiency etc.) and include analyses, visions, and virtual plans for the historical area in the frame of energy efficiency, innovation and positive or neutral energy blocks, where technical reconstruction documents for the houses and quarters of the energy blocks will be created.

22 Bergen, Norway - Zero Village Bergen (ZVB)[6]

General information	
City	**Bergen, Norway**
Project name	**Zero Village Bergen (ZVB)[15]- ZEN Pilot Project**
Project status	**planned** ☒ under construction ☐ realized ☐ in operation
Project start – end	The estimated timeframe for completion is 2025.
Contact	**NTNU:** Arild Gustavsen **SINTEF Community:** Judith Thomsen
Project website	https://zerovillage.no/
Size of project area	378,000 m^2
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use	Residential: 92 000 m^2 Office
Financing	Private developer The main stakeholder in the ZVB project is the private project owner ByBo, a Bergen based developer that focuses on the development of low-energy and environmental-friendly buildings and neighbourhoods.

Overview description of the project
The ZEN Research Centre pilot projects serve as innovation hubs where researchers, together with building professionals, property developers, municipalities, energy companies, and building owners and users, test new solutions for the construction, operation, and use of neighbourhoods in order to reduce the greenhouse gas emissions to zero on a neighbourhood scale. In total, the ZEN pilot projects encompass more than 30,000 people, more than 1 million m2 built area, and more than 5.5 million m^2 land area. The Zero Village Bergen project encompass the development of a new neighbourhood on the outskirts of Bergen. The planning consists of approximately 720 dwellings (92,000 m^2), divided between terraced houses (68% of total floor area) and apartment blocks (25%). 7% of the floor area is dedicated to non-residential purposes such as offices, shops and a kindergarten. In addition, a common parking garage using mainly wood as building material, is planned. The estimated time frame for the project is 10-20 years. The key innovative elements are photovoltaic generation with excess power used for EV and public facilities, low carbon construction materials, local thermal hub, and smart energy management. The energy demand for all purposes shall be covered to the greatest possible extent by renewable energy sources without loss of natural diversity. The area is located 1.6 km south of Bergen in proximity to the Flesland international airport (3 km) and the business area of Sandsli/Kokstad with about 15,000 workplaces. The closest centre is Blomsterdalen, a distance of 750 m. A forest and a lake, as well as, a residential area and a road surround the area. The planned development area is currently in use as a greenfield site with some semidetached houses on it. The closest public transportation hub is the light rail, 1.5 km to the north, but there is a bus stop on the site with buses approx. every 15 minutes.

[15] https://fmezen.no/category/pilot-projects/

The main stakeholder in the ZVB project is the private company ByBo, a Bergen based developer that focuses on the development of low-energy and environmental-friendly buildings and neighbourhoods.

Several private consultant agencies such as Norconsult, Multiconsult and Snøhetta and researchers from the ZEB and ZEN Centres have been involved in the planning of the project.

Zero Village Bergen is a pilot project within the Research Centre on Zero Emission Neighbourhoods in Smart Cities (https://fmezen.no/).

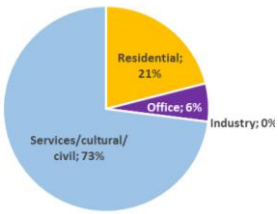
Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐ The goal is to construct residential buildings within a neighbourhood with net zero greenhouse gas emissions during the operation phase of the buildings on an annual basis (ZEB-O Standard, ref www.zeb.no). The goal is planned to be met using the following measures: • Minimize energy demand through the energy efficiency of the buildings. Development of an individual energy system based on solar cells and local thermal energy hub. • Stepwise development of the area in combination with a gradually rise of ambitions with regard to building standards (from ZEB-O÷EQ at an early stage to ZEB-COM, see www.zeb.no). • Development of a transport infrastructure based on a broad network of walking and bicycle pathways, charging stations for electrical bikes, a car pool for electric cars and an electric bus that connects the neighbourhood to the nearby train station. • Creation of an attractive public space which encourages an emission-friendly lifestyle: e.g. shared space, community gardens, a market place in a central position within the neighbourhood and playgrounds.
Indicators/expected impact	ZEN KPIs (https://fmezen.no/wp-content/uploads/2018/11/ZEN-Report-no-7-Bilingual.pdf)
Overall strategies of city/municipality	n/s

connected with the project	
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ Refurbishment ☐ Sustainable production ☐ Sustainable consumption ☐ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	The main stakeholder in the ZVB project is the private project owner ByBo, a Bergen based developer that focuses on the development of low-energy and environmental-friendly buildings and neighbourhoods.
Typology of energy supply	The key elements are photovoltaic generation with excess power used for EV and public facilities a local thermal hub based on renewable energy. The energy demand for all purposes will be covered to the greatest possible extent by renewable energy sources.

Success factors	Challenges/barriers
Planning phase.	Based on a mapping of pilot projects within the ZEN center [16] and PI-SEC project[17], six major **challenges and risks** have been identified in the planning process so far: 1. Limited knowledge and understanding about ZEN ambitions, and embedded requirements are a low priority on the executing level (construction side). 2. Time pressure: Ongoing construction around the area, such as the regional road Hjellestadvegen, requires a decision about the connection of the ZVB development area to the technical infrastructure. A later connection to the infrastructure network will result in higher project costs. 3. Uncertainty and risk: High uncertainty about the acceptance of the project by the authorities, the time pressure, and the assumed cost increases, heighten the risk for hindering project implementation. The risk is mainly carried by one private developer, and the risk of project cancellation is therefore medium. 4. Conflict of goals (Risk): The ZVB project refers differently to goals for emission reduction and densification than the public actors, and thereby offers room for disagreement among the involved partners. 5. Political commitment (Risk): Disagreement between the local and regional authorities on the evaluation of the project with regard to planning regulations could jeopardize the implementation of the project. The associated time lag arises will cause more costs and uncertainty for the private developer. 6. Costs to develop alternative solutions (Risk): The development of alternative solutions (e.g. wood as construction material for the parking garage) is cost-intensive and the approval of funding proposals is perceived as low. Due to the described uncertainty and risk, the ability of the private developer to bear the costs is limited.

[16] https://fmezen.no/wp-content/uploads/2019/01/ZEN-Report-no-10.pdf
[17] https://www.ntnu.edu/smartcities/pi-sec

23 Espoo, Finland - SPARCs

General information	
City	**Espoo, Finland**
Project name	**SPARCs**
Project status	**planned** ☒ under construction ☐ realized ☐ in operation
Project start – end	Potential: 01/2020 - 12/2025
Contact	Elina Wanne, City of Espoo Francesco Reda, Project international coordinator
Project website	https://www.sparcs.info/ (partly under construction)
Size of project area	about 52 ha
Building structure	**Newly built** ☒ **Existing neighbourhood** ☒ **Mixed** ☒
Land use	- Residential: 21% - Office: 6% - Industry: - - Services/cultural/civil: 73% 
Financing	The PEDs demonstration are included within the city activities for the carbon free transformation by 2030, which mobilizes a huge capital from different financial resources: - Municipal funds: 172.3 M€ - Private funds: 507.3 M€ - Research EC funds: 6 M€ (pending approval) - National research funds: 6Aika collaboration platform with a total budget of 100M€ and covering the 6 largest cities in Finland, including Espoo

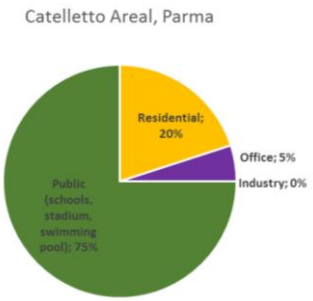
Overview description of the project
Sustainable energy Positive & zero cARbon CommunitieS demonstrates and validates technically and socio-economically viable and replicable, innovative solutions for rolling out smart, integrated positive energy systems for the transition to a citizen centred zero carbon & resource efficient economy. The project will facilitate the participation of buildings to the energy market enabling new services and a virtual power plant concept, creating VirtualPositiveEnergy communities as energy democratic playground (positive energy districts can exchange energy with energy entities located outside the district). Espoo, PEDs demonstration activities focus on mixed-use building blocks, consisting of both existing building stock and new-built, within fast growing districts along the multimodal public transport network.

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ **Social aspects/affordability** ☒
Indicators/expected impact	Environmental, Societal, Social, Economic, technical, Spatial, Regulatory

	PEDs demonstrations will enable, inform and support the efficient urban transformation of cities into carbon free societies, including especially smart networks, low carbon transport solutions, a sustainable energy transition, and improved air quality. In numbers, the project targets a 64% carbon emission reduction, 65% increase in share of RES, and 53% of energy savings
Overall strategies of city/municipality connected with the project	Espoo is the fastest growing city in Finland, and an integral part of the Helsinki capital metropolitan area. Espoo expects to reach 300,000 inhabitants by 2022 and continue growth to 400,000 residents and 180,000 jobs by 2050. The overarching sustainability objective of Espoo is to reach **carbon neutrality by 2030**, including fossil-free district heating, and reduce its emissions per capita by 60 % by 2030, compared to 1990. Espoo has set in the city strategy a **cross-administrative development programme "Sustainable Espoo"** for the council term 2017-2021 to implement actions towards the carbon-neutrality 2030 objective. These actions are implemented in collaboration with companies, RDI institutions, NGOs and local residents. The focus of the programme period is the implementation of fast-acting methods in the promotion of carbon neutrality. The planned PEDs are actions towards these objectives. The programme has five key utility goals: - Espoo is built and developed using smart solutions, - Citizen mobility is made easier and multi-modal transport is fostered, - Emission-free energy production and smart energy solutions, - Espoo citizens act responsibly. - Environmental benefits and recreational opportunities of the nearby surroundings grow.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	Citizens, Industry, Investor/real estate, Business, Research, Energy utilities, Regulators, educational institutes. Alliance models for smart city development, citizen engagement strategies.
Typology of energy supply	Solar thermal energy, Geothermal energy, District heating/local heating, Heat pump system, waste heat, seasonal storages, batteries, PV, Biomass CHP, Bi-directional eV charging; 2nd life battery; Peer to Peer energy transaction, Virtual Power Plant

Success factors	**Challenges/barriers**
The city is a frontrunner in intelligent and sustainable, smart city development: Espoo is the most sustainable city in Europe, and won the international Intelligent Community Award 2018. Espoo has been nominated pioneer and one of 25 the cities participating UN's SDGCity leadership programme of the UN Agenda 2030 Sustainable Development Goals. The city joined the Covenant of Mayors 2020 commitment in 2010. In February 2018, Espoo has also signed the Covenant of Mayors 2030 commitment to reduce the city's greenhouse gas emissions by 40% by 2030. The City of Espoo was also the first municipality in Finland to join the national Commitment 2050 - the Society´s Commitment to Sustainable Development. Espoo has also been recognized as being among the first movers in the Nordics in working with the 2030 Agenda. The goal is to be a top performer of sustainable city development in Europe.	Changes in the business environment challenge the city development, requiring the city to take the initiative for active, new and innovative co-creation models for stakeholder collaboration. Rapid growth of the city as well as demographic changes, cause increased demands on resources and e.g infrastructure, to be concurrently developed towards sustainable and carbon neutral solutions. Hence emissions can be decreased per inhabitant, whereas the total use of e.g. energy tends to increase. Main Challenges during the PEDs planning: - Wide network of different stakeholders involved, do we understand each other's position and goals thoroughly? - The change in theme of energy is currently very rapid, how can we take this into account when planning this kind of long ambitious project? - There are challenges due to the climate and northern location regarding heating and energy demand. These are different from Central Europe. How can these be brought forward.

24 Parma, Italy - Castelletto

General information	
City	**Parma**
Project name	**Castelletto**
Project status	**planned** ☒ under construction ☐ realized ☐ in operation ☐
Project start – end	2020 – 2025
Contact	**Enzo Bertolotti**
Project website	n/a
Size of project area	n/a
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use	- Residential: 20% - Office: 5% - Industry: 0% - Other: 75% (schools, swimming pool, stadium) 
Financing	- Public-Private - Research funding

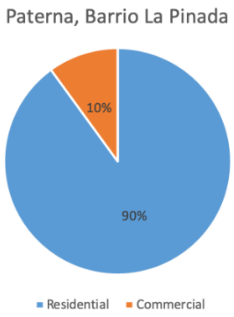
Overview description of the project
The City of Parma wants to redevelop a part of the city, located in the south-eastern part, into the first PED – Positive Energy District. The area is just outside the city centre and it is mainly residential, with several sport, commercial and health facilities and a good accessibility by public transport and bicycles. The buildings involved in the PED will be: - a stadium - a school (with an auditorium and a gym) - a swimming pool - 7 residential buildings in a former industrial area.

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐
Indicators/expected impact	The project will have environmental, social, economic, regulatory impacts
Overall strategies of city/municipality	• Parma Smart City 2030 (2019) • SEAP (2014)

connected with the project	• SECAP (2019) • PUG 2020 (Urban General Plan)
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	The project will develop innovative involvement strategies for citizens, investor/real estate, business and research.
Typology of energy supply	- Solar thermal energy - Geothermal energy - District heating/local heating - Heat pump system - Photovoltaic

Success factors	Challenges/barriers
- Quadruple helix model applied to PED	- The main challenge is to make local authorities drivers of the Plus Energy strategy. - The main barrier is the effective and innovative management of smart grids

25 Paterna (Valencia), Spain - Barrio La Pinada

General information	
City	**Paterna (Valencia), Spain**
Project name	**Barrio La Pinada**
Project status	planned ☐ **implementation Stage** ☒ realized ☐ in operation
Project start – end	2016 - 2027
Contact	Oscar David Sánchez
Project website	https://www.barriolapinada.es/en/
Size of project area	about 25 ha
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use	- Residential: 90% - Commercial: 10% 
Financing	- Private - Research Funding - Green Financing

Overview description of the project
Barrio La Pinada is the first Eco-district in Spain to be co-designed by its future residents and conceived around a school. The project is located in Paterna, Valencia (Spain), at 10 minutes from Valencia city centre and typically enjoys sun 300 days of the year. It integrates the principles of sustainable urban development while aiming to create social and environmental value and a positive impact and an attractive environment where residents will be able to live, work and enjoy nature. It will offer 25 hectares of pine trees, where approximately 1.000 families will be settled progressively throughout the growth phases of the project.

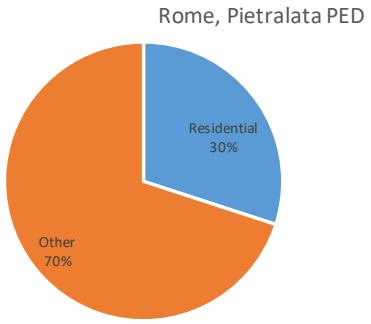


Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒
Indicators/expected impact	- Environmental - Societal - Social - Economic
Overall strategies of city/municipality connected with the project	- Smart City Strategies - Growing City

Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ Refurbishment ☐ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	- Citizens - Industry - Investor/real estate - Research
Typology of energy supply	- Geothermal energy - District heating/local heating - Photovoltaic

Success factors	**Challenges/barriers**
- Involvement of citizens and local authorities in the development of a new district - Open innovation lab (La Pinada Lab, http://lapinadalab.com) focused on urban sustainability where we do collaborate with companies, startups, universities, research and technological institutes and citizens in order to tackle challenges in cities; Barrio La Pinada serves as a real-world testbed of new, innovative urban solutions.	- Gain international recognition so our solutions and learning can be scaled up and we can achieve a greater impact. - Establish an international network of collaborators in order to learn from other positive energy districts, projects and initiatives. - Mobilizing finance for sustainable urban developments.

26 Rome, Italy – Pietralata PED

General information	
City	Rome, Italy
Project name	**Pietralata PED**
Project status	**planned** ☒ under construction ☐ realized ☐ in operation
Project start – end	n/a
Contact	**Stefano Pizzuti**
Project website	n/a
Size of project area	70,000 m^2
Building structure	Newly built ☐ **Existing neighbourhood** ☒ **Mixed** ☐
Land use	Residential: 6 Buildings (30%) Other: School, Swimming Pool (70%) 
Financing	- Public-Private - Research funding

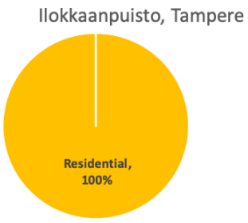
Overview description of the project
The project consists of a large and solid public and private partnership made of research and technology academic and science institutions, industry & SMEs, non-profit and consultant agencies. The ambition is to contribute to energy transition through smart integrated infrastructure by the realization of Positive Energy Blocks (PEB), working on a Positive Energy District (PED) perspective, suited and tailored for Mediterranean Cities. An ambition also based on the contribution of the energy flexible communities, a pillar to achieve such paramount results. The project is based on 4 main pillars: Vision Climate, Cultural, Socio-economics Specific Approach for Urban Energy efficiency in the Mediterranean Context respecting the European Policies and targets and enforcing the public debate, knowledge exchanges and international networking to build Bold City Visions. Replication Plans will look forward to regulatory framework evolution and to the next innovations in the energy market. Model Expansion to scale up PEBs EE, e-mobility and Sharing solutions to Smart Energy Districts – SED - that can evolve into PEDs. Engagement, Policies and incentives supporting Smart Energy Districts transition toward PED and Positive Energy City models, within a multi-scale and integrated energy management. Flexible Capacity & Energy Sharing Models

Demand Side (Response) Model for Communities enabling flexible Capacity and increasing Energy Efficiency; Integrating Energy System through RES growth, Deep Retrofitting and both thermal and electric Smart Grid expansion. Energy Communities Citizens Energy Communities -CEC- based on public participation and stakeholders' engagement. Urban Center, Living Labs and Open Innovation Environment for PPPP co-design of Deep Retrofitting and Smart Solutions. School centered PEB Model as best practice and awareness core to boost energy transition. Integrated innovative solutions for PEBs/Districts will be developed, implemented, tested and their performance monitored where PEB Living Labs will be the core of replication and expansion to the District scale.

Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ Sustainable neighbourhood ☐ **Social aspects/affordability** ☒
Indicators/expected impact	- Environmental - Societal - Social - Economic - Spatial - Regulatory
Overall strategies of city/municipality connected with the project	- Smart City Strategy - Energy Masterplanning - Other: Citizen Energy Communities
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ **Sustainable production** ☒ **Sustainable consumption** ☒ (Local) Governance ☐ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	- Citizen - Investor/real estate - Business - Research
Typology of energy supply	- Solar thermal energy - Geothermal - District heating/local heating - Heat pump system - Solar Bicycle Pathway

Success factors	**Challenges/barriers**
Total net energy need [kWh/y]: 3,201,512 Total local RES [kWh/y]: 4,114,827 % of total net energy need covered by local RES: 128.5%	ESCOs have a major role in the financing scheme, it should be better balanced with public fundings Regulatory framework to be updated

27 Tampere, Finland - Ilokkaanpuisto

General information	
City	**Tampere, Finland**
Project name	**Ilokkaanpuisto**
Project status	**planned** ☒ under construction ☐ realized ☐ in operation
Project start – end	planning completed; construction starts June 2019
Contact	Maarit Vehvilainen
Project website	**www.stardustproject.eu**
Size of project area (hectare)	Floor area for residential buildings and parking 16,600 m^2 (1,7 hectares)
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use	Residential: 100% 
Financing	Private, research funding 30 milj € euro is construction cost of Ilokkaanpuisto and PV plant.

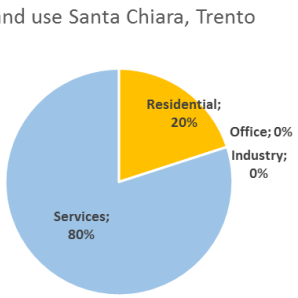
Overview description of the project
New residential area at urban environment. Apartment buildings connected either DH or has own GSHP. Own PV farm outside the urban area. H2020 Lighthouse project Stardust demonstration. Show case in Finland. Number of stakeholders from private and public sectors involved to the project.

Strategies	
Goals/ambition	**Positive Energy** ☒ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ Sustainable neighbourhood ☐ Social aspects/affordability ☐
Indicators/expected impact	Environmental, Economic, Regulatory
Overall strategies of city/municipality connected with the project	Smart City Strategy, Grow smart Together https://smarttampere.fi/en/home/ The City of Tampere is building into a smart city by treating city development projects as platforms for innovative solutions and new business models. The city enables this by opening data, building ecosystems and enhancing the culture of cross-industry co-operation. The City of Tampere is creating platforms that enable co-creation, business ecosystems, new business models, smart city solutions, and as a result, better quality of life. In the field of real estate and buildings the main

	aspects of development in Tampere are sustainability, energy efficiency, wide range of services from house maintenance to health and security services and the whole 'living as a service'.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ Mobility ☐ **Buildings** ☒ **Materials** ☒ Refurbishment ☐ Sustainable production ☐ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	Industry, Real estate, Business, Politicians, Research
Typology of energy supply	Geothermal energy, District heating, Heat pump system

Success factors	**Challenges/barriers**
City level: The Grow Together strategy (see previous field). Regional and national Level: Ministry of Environment, The Ministry of Economic Affairs and Employment and Housing and The Housing Finance and Development Centre of Finland have positive attitude towards the project. European level: H2020 funds towards the demonstration of smart energy solutions (Stardust SCC1)	Project is the first energy community project in Finland. It is therefore a test case from legal point of view, business concept, energy transfer. Ilokkaanpuisto has needed a lot of legal and business consulting, because project it the first one and this is why ministries are following it. Solutions have been for example: - PV farm is a Ltd Real Estate owned by Ltd housing companies - Refinements to RS documents (RS is system, how housing projects are secured) - Deal with utility company

28 Trento, Italy - Santa Chiara Urban District

General information	
City	**Trento (Italy)**; Case Study: Santa Chiara Urban District
Project name	**Santa Chiara Open Lab**
Project status	**planned** ☒
Project start – end	December 2017 – December 2023
Contact	Giuliano Franzoi, Sara Verones, Luigi Crema
Project website	http://www.comune.trento.it/Comunicazione/Il-Comune-informa/Ufficio-stampa/Comunicati-stampa/S.-Chiara-Open-Lab-approvazione-dei-progetti
Size of project area	3.5 hectare
Building structure	Newly built ☐ Existing neighbourhood ☐ Mixed ☒
Land use (%)	- Residential: 20% - Services: 80% 
Financing	- Public-Private - Research funding About 41 million euros of total investments in the Santa Chiara Open Lab project.

Overview description of the project

In the north of Italy, Trento has a population of about 117,000 inhabitants and a surface area of 158 km². Every year, the city classifies among the first five in Italy for quality of life and has been selected in 2014 to enter the IEEE Smart Cities initiative. Trento's energy saving action plan includes: a global energy saving (mostly by retrofitting of public buildings) of 760,000 MWh, a renewable energy share of 10,200 MWh and a CO2 reduction of 210,500 tons.

In 2016 the Municipality of Trento has drawn the "Programme for refunctionalization and sustainable reuse of the area Santa Chiara". The total amount of the project is approximately 41 M€ and has been recently funded by the Italian Government for 18 M€ in the call "extraordinary intervention program for urban regeneration and the safety of the suburbs".

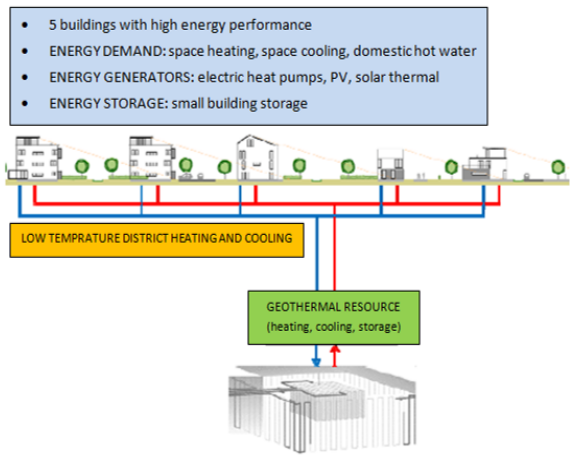
Starting from 2019, in the Santa Chiara Urban District will be refurbished four public building complexes (volume: 25,995 m^3, floor area: 9,076 m^2) and will be built another new private building complex (Habitat complex, volume: 3,1047 m^3, floor area: 1,1088 m^2). These buildings are designed to: public offices, public meeting areas, social and health needs, cultural, shops, housing.

The 5 involved buildings will be supplied with an innovative "geosolar" heat and cool supply concept. The system consists of the following main components:

- A central geothermal resource providing heating and cooling through borehole heat exchangers and acting as a seasonal storage for the residual heat from building cooling and for the excess solar heat production;

- A low temperature DHC network (T < 50°C) that connects the geothermal resource with buildings;
- Electric heat pumps at building level providing the necessary heat and cool to the buildings (space heating, space cooling and domestic hot water);
- Distributed PV feeding electric heat pumps;
- Distributed solar thermal collectors for domestic hot water and space heating;
- Distributed small building storage for domestic hot water and space heating/space cooling inertia.

With only one thermal machine, the heat pump, it will be possible to provide space heating, space cooling and domestic hot water. The high expected efficiency of the heat pump (SPF>5) will be guaranteed thanks to the high energy performance of the buildings (for space heating user side temperature < 50°C), the use of the geothermal source, rather than the air, and the integration of the solar source for domestic hot water and space heating. For the low temperature district heating and/or cooling network heat transport losses < 3% are expected. The outcomes of the project will include detailed dimensioning of all components, including the innovative ones, and their adjustment to each other for best performance of the overall system, development of operation strategies, evaluation of possible tariff models, identification and proof of sensitive parameters (e.g. geothermal characteristics of the ground, solar production profiles, individual building thermal demand profiles). A detailed dynamic simulation model of the whole heating and cooling supply system will be established.



Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ **Energy neutral** ☒ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ Sustainable neighbourhood ☐ Social aspects/affordability ☐
Indicators/expected impact	• Reduction of heat demand in the public building complexes: 1.3 GWh/year • Local RES production: PV = 291 MWh/year; geothermal = 734 MWh/year heat + 1100 MWh/year cold • Environmental: reduction of CO2 emissions = 351 tCO2/year • Economic: reduction of energy cost = 94,000 euro/year
Overall strategies of city/municipality connected with the project	- Smart City Strategies - Urban Renewal Strategies - Energy Masterplanning
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	- Citizens: Municipality of Trento, Province of Trento - Investor/real estate: Habitat - Research: FBK
Typology of energy supply	- PV: 230 kW, 291 MWh/year - Heat pump system: 1080 kW, 917 MWh/year heat + 917 MWh/year cold - Geothermal energy: 23750 m of BHEs - District heating/local heating - Solar thermal - Waste heat

Success factors	Challenges/barriers
- Involvement of main public and private stakeholders as project partners - High reduction of heat demand in existing buildings (-77%) - Refurbishment of existing buildings and shift from 0 to 100% in the use of renewable sources - Construction of new highly efficient buildings 100% powered by renewable sources - High production of renewable electrical (291 MWh/year) and thermal energy (734 MWh/year heat + 1100 MWh/year cold) - Use of seasonal underground thermal energy storage (seasonal UTES) - Optimal integration of multiple renewable sources and waste heat (power to heat; low temperature DHC) - Inclusion of the study area in the Province of Trento characterized by renewable electricity production (mainly hydroelectric) greater than consumption (in an annual balance) - Introduction of advanced monitoring and control systems at building and at DHC level	- Involvement of all citizens living in the Santa Chiara Urban District - The Santa Chiara Urban District is a mixed-property area (Public-Private): share technical solutions, subdivision of costs and incentives - High financial commitment - Intervention on existing buildings - Optimal integration of multiple renewable sources and waste heat - Introduction of advanced monitoring and control systems at building and at DHC level

29 Vienna, Austria - Zukunftsquartier

General information	
City	**Vienna, Austria**
Project name	**Zukunftsquartier** (Future Quarter)
Project status	**planned** ☒ under construction ☐ realized ☐ in operation
Project start – end	07/2018 – 06/2019 (start of construction: Q3/2021; Finalisation Q3/2024)
Contact	Petra Schöfmann, UIV Urban Innovation Vienna
Project website	http://www.urbaninnovation.at/de/Projects/Zukunftsquartier
Size of project area	n/a
Building structure	**Newly built** ☒ **Existing neighbourhood** ☒ Mixed ☐
Land use	The (planned) usage mix includes about 50% living and 50% office/trade/small industry and other businesses in each examined quarter.
Financing	This exploratory study is funded by "City of tomorrow". „City of tomorrow" is a research and technology program of the Federal Ministry for Transport, Innovation and Technology (BMVIT). It is handled on behalf of the BMVIT via the Austrian Research Promotion Agency (FFG) together with the Austrian Economy Service Corporation (aws) and the Austrian Society for Environment and Technology (ÖGUT).

Overview description of the project

One of the many challenges on the path to decarbonisation is the development of sustainable, safe and affordable energy supply strategies for (new construction) quarters. As support and to set an example, the municipal government of Vienna undertook the realization of an innovative role-model city district in its governmental agreement (2015) in the chapter "energy".

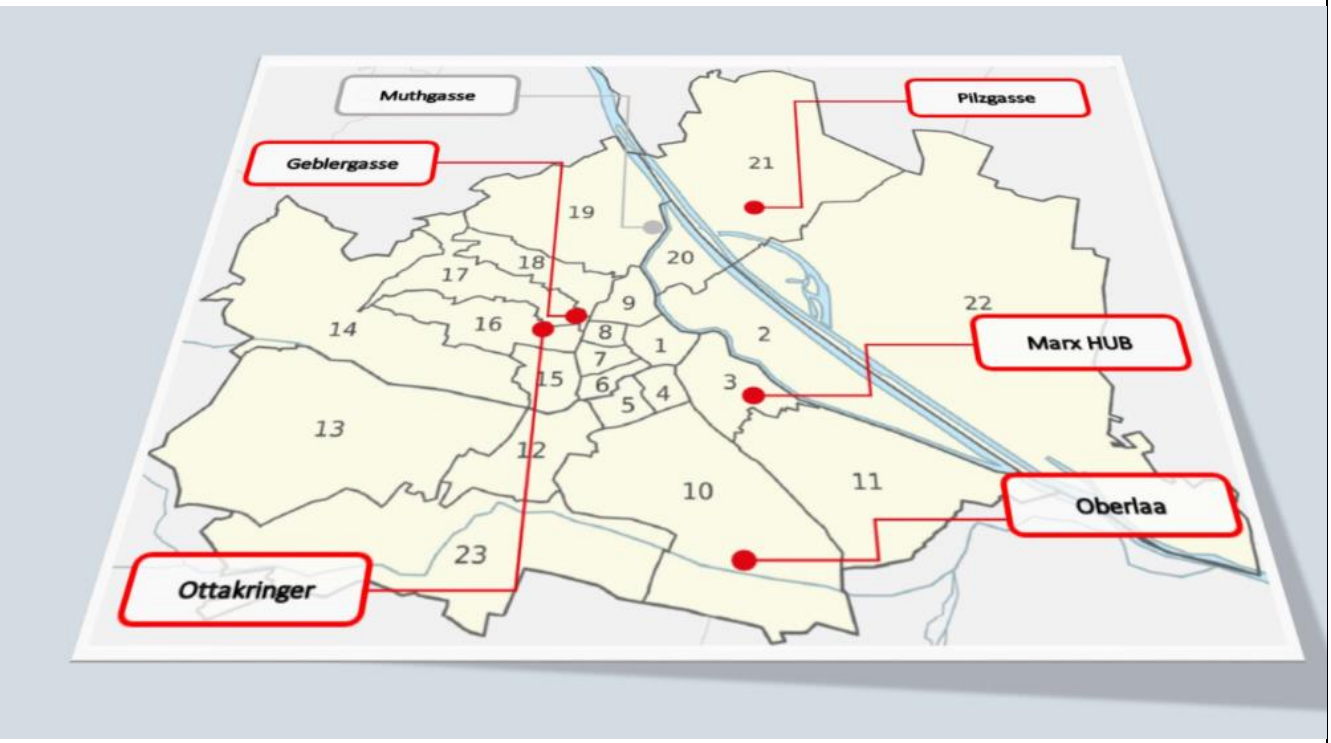
In the course of the funded exploratory study "Future Quarter" ("Zukunftsquartier") transferable concepts for plus-energy quarters are developed. Based on and subsequent to this scoping study, an energy showcase quarter in Vienna shall be realised. Plus-energy quarters are city districts which produce more energy (electricity and heat) over the year than the users consume by utilising local energy sources, synergies concerning mixed usages and flexibilities. In the course of the project, possibilities and definitions to transfer this concept to the very dense city are being investigated.

The undertaking strives for the development of a quarter-energy-system that enables the distribution of the recovered energy between the local consumers and thereby optimizes all energy services comprehensively. The areas of focus lie on the technical and economic feasibility as well as user comfort. On the basis of the exploratory study, an energy showcase quarter in Vienna shall be realised.

Under the direction of the UIV Energy Center and together with the project partners University of Applied Sciences Technikum Vienna (FH Technikum Wien) and the Institute of Building Research and Innovation (IBR&I), profound technical and economic analysis and rough energy concepts as well as variants for a number of concrete areas with mixed usage in Vienna in the 3rd, 10th, 16th, 17th and 21st district are currently being developed. These are predominantly new construction quarters, but also existing quarters of different size, that show varying on-site energy potentials which shall be used with innovative concepts. For the one or two quarters with the highest probability of realisation and on the basis of the local energy situation as well as stakeholder requirements, detailed energy concepts on the level of preliminary drafts are being developed. Thereby, the technical and economic feasibility as well as the legal framework are analysed and examined.

Property developers and planners of the respective quarters are involved in the project as well as important municipal actors. This creates the best possible conditions for a subsequent realisation. Through collective analysis of a greater number of quarters and the development of recommendations for action, the project shall give new insights for the

broader application of the concept “plus-energy quarter” and function as an important initiator and precursor for the realisation of future innovative energy showcase quarters in Vienna and other cities.



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Strategies	
Goals/ambition	**Positive Energy** ☒ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ Sustainable neighbourhood ☐ Social aspects/affordability ☐ Other: • Economic feasibility • High quality of living and comfort • Early and constant user integration for reaching the positive energy goal.
Indicators/expected impact	The methodological approach is based on a primary energy balance of the quarter. In the course of the project, certain indicators and system boundaries have been developed. In order to differentiate the possibility to harvest on-site renewable energy in densely populated urban areas in comparison to less densely built regions (apartment buildings vs. single-family houses), an “energy balance” based on the floor area ration has been developed. Additionally, an “energy credit”, coming from central renewable power plants after all industry and public transport is supplied, is calculated for each Austrian inhabitant - which can then be taken into account for primary energy balancing of the quarter. To visualize economic feasibility, additional costs in comparison to a conventional energy supply (gas heating) and lower building standards are calculated.
Overall strategies of city/municipality connected with the project	The project supports the goals of the Smart City Wien Framework Strategy concerning saving resources and decarbonisation. The project helps to reach the goals stated in the Energy Framework Strategy and the Climate Protection Program, as well as the Urban Development Plan 2025. Additionally, the municipal government of Vienna decided on realizing innovative energy showcase quarters in its governmental agreement of 2015.

Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ Sustainable production ☐ Sustainable consumption ☐ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒ Other: - Needs and experiences of property owners/ developers - Integration plan for future users
Innovative stakeholder involvement strategies	A concept for the integration of future users (renters, owners, employees) will be developed. The aim is to optimize the user behaviour respectively to minimize the potential negative effects on the energy system. In order to support a realization in the best possible way, both the developers as well as the relevant administration of the city of Vienna have been involved right from the start.
Typology of energy supply	Different energy concepts and variants for concrete quarters are developed in order to achieve plus-energy over the year, while focusing on economic feasibility. Energy (both electricity and heat) can be exchanged with the (public) networks, although the on-site renewable energy supply has to be greater than the consumption over the year. Each energy system of the different quarters includes photovoltaic systems as well as geothermal (field of boreholes and/ or groundwater) heat pumps. Depending on the local availability and demand district heating and direct or indirect surplus heat are also used. The gentle cooling of the buildings during summer (via component activation) is one measure for climate adaptation and supports the economic feasibility by enabling the long term attractiveness for renters and buyers of the building. The extracted heat is stored underground and used for heating in winter. The planning of the local energy system includes flexibilities which facilitate the usage of renewable energy from Peak-Shaving through demand side management measures.

Success factors	**Challenges/barriers**
The developed system boundaries for positive energy quarters in densely populated areas have already received considerable national recognition. The early and comprehensive involvement of all implementation-relevant actors, including the city administration, was an important step in supporting a later realisation. Initial cost-effectiveness analyzes show that the plus-energy concept in combination with a suitable business model is economically viable (in some cases even without subsidies) in the long term.	On the one hand, it is very important to consider the topic of energy early in the planning process, on the other hand, it complicates the conception, as the future non-residential users are not yet known and their energetic behaviour (demand, synergy effects etc.) is therefore difficult to plan. Success factors in future realization projects will be the willingness of the quarter developers to accept longer payback times for their investment and put additional effort into the planning and innovation process. Last but not least the engagement of the future users concerning energy consumption and technology usage as well as a long term monitoring process are key to reach the planned efficiency in reality.

TOWARDS POSITIVE ENERGY DISTRICTS

In this Section, 32 projects that did not declared a PED ambition but presents interesting features for the PED program are described. They are grouped in 3 categories depending on their development phase: Projects Implemented/In Operation (11), Projects in Implementation Stage (15) and Projects in Planning Stage (6).

Figure 6 shows geographic distribution of projects without a PED ambition (Towards PED) in Europe while table 2 summarizes selected features of towards PED projects based on information provided by the projects and/or available on their websites.

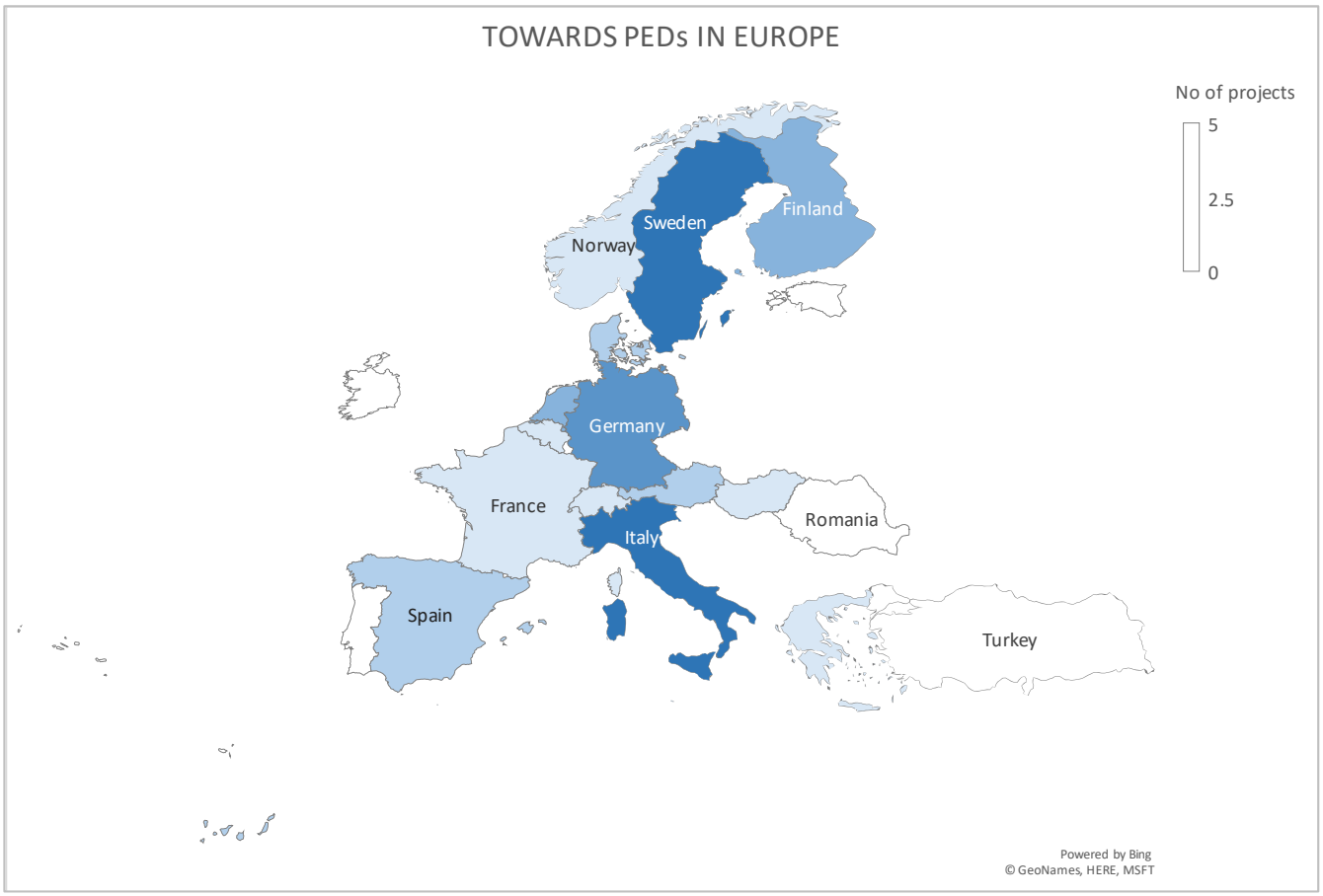


Figure 5 Europe distribution of projects of this booklet with not declared PED ambition

PROJECT No	CITY	STATE		ENERGY EFFICIENCY			ENERGY PRODUCTION	ENERGY FLEXIBILITY	ENVIRONMENTAL SUSTAINABILITY		SOCIAL SUSTAINABILITY		ECONOMIC SUSTAINABILITY	
			PED AMBITION	BUILDING/ INFRASTRUCTURE	MOBILITY	SUSTAINABLE CONSUMPTION	LOCAL/REGION RENWABLE ENERGY PRODUCTION	REGIONAL ENERGY SYSTEM	ENVIRONMENTAL IMPACT	ZERO EMMISION/ CARBON FREE/ CLIMATE NEUTRAL	SOCIAL/SOCIETAL IMPACT	CITIZEN/OWNER INVOLVEMENT	ECONOMIC IMPACT	BUSINESS MODELS
30	Drammen	NO	-	✓			✓	✓	✓	✓	✓		✓	✓
31	Espoo	FI	-		✓		✓	✓	✓	✓		✓		✓
32	Grenoble	FR	-	✓			✓	✓	✓	✓	✓	✓	✓	✓
33	Győr	HU	-	✓			✓	✓	✓	✓	✓	✓	✓	✓
34	Lund (Linero)	SE	-	✓		✓	✓		✓	✓	✓	✓	✓	✓
35	Mieres	ES	-	✓		✓	✓	✓	✓	✓	✓		✓	✓
36	Milano	IT	-	✓	✓	✓	✓		✓		✓	✓	✓	
37	Mostoles (Madrid)	ES	-	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
38	Stockholm	SE	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
39	Vienna	AT	-			✓					✓	✓	✓	
40	Zurich	CH	-	✓	✓	✓	✓	✓	✓	✓	✓	✓		
41	Bolzano	IT	-	✓	✓	✓	✓	✓	✓		✓		✓	✓
42	Firenze	IT	-	✓	✓	✓	✓		✓		✓	✓		✓
43	Graz	AT	–	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
44	Florina	GR	-	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
45	Helsinki	FI	-	✓	✓	✓	✓		✓	✓	✓	✓		✓
46	Henningsdorf	DE	-	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
47	Hoje-Taastrup (Østerby)	DK	-	✓			✓	✓	✓	✓	✓	✓	✓	✓
48	Hoogeveen	NL	-		✓	✓	✓	✓	✓	✓		✓	✓	✓
49	Kaiserslautern	DE	-		✓		✓	✓	✓	✓	✓	✓		✓
50	Brunnshög/Lund	SE	-	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
51	Lund	SE	-	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
52	Malmö	SE	-		✓	✓	✓	✓	✓	✓	✓			
53	Munich	DE	-	✓	✓			✓	✓	✓	✓	✓	✓	✓
54	Odense	DK	-				✓	✓	✓	✓	✓	✓	✓	✓
55	The Netherlands	NL	-				✓	✓	✓	✓	✓	✓		✓
56	Arnhem	NL	-			✓			✓		✓	✓	✓	
57	Brussels	BE	-	✓	✓	✓	✓		✓	✓	✓	✓	✓	
58	Freiburg im Breisgau	DE	-	✓	✓	✓	✓	✓		✓		✓		✓
59	Lecce	IT	-	✓	✓		✓		✓	✓			✓	✓
60	Trento	IT	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
61	Turku	FI	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 2. Summary of selected features of projects without a PED ambition

30 Drammen, Norway - Jacobs Borchs Gate

General information	
City	**Drammen, Norway**
Project name	**Jacobs Borchs Gate** Case provided by RHC/DHC+: https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf
Project status	planned ☐ under construction ☐ **realized** ☒ **in operation** ☒
Project start – end	2009-2012
Contact	Jon Vincent Haugen
Project website	www.df.no
Size of project area	1000 m^2 (energy centre)
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	Mixed use (city centre)
Financing	The facility is owned by an Energy Services Company. Profits are re-invested. Business model: Make heat cleanly and cheaply and sell fairly, reinvesting in growing the network and continuing to improve the quality of the facility.

Overview description of the project
Drammen wished to upgrade their existing district heating which was a mixture of electric, biomass and gas/oil. They recognised the need to move from fossil and combustion fuels and so decided to utilize seawater as a heat source for an industrial heat pump. Also recognizing the danger of HydroFluoroCarbons (HFCs) and other synthetic working fluids they began to explore the use of ammonia. The facility is 50% owned by the city financial leaders and 50% owned by private investors. The price of heat is regulated and transparent. The quality or cleanliness of heat is also regulated with respect to carbon and combustion particulate hence the shift from biomass.

Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐ A drive for both non fossil fuel and non-greenhouse gas working fluids plus maximum efficiency led to deploying ammonia fjord source heat pumps.
Indicators/expected impact	**Economic:** Burning gas loses the client money. Specific financial information isn't available on sales price of heat but gas costs €70/MWh, biomass €50/MWh and heatpumps €10/MWh (electricity is €30/MWh). **Environmental:**

	Heat delivered from the heat pump is 67GWh/year, which avoid 78Gwh of gas, whilst consuming 23GWh/yr of electricity which is practically zero carbon. In the UK the same consumption would equate to 5,000 T of CO2 per annum. Gas would be 16,000 T of CO_2 per annum. The working fluid being ammonia contributes practically zero CO_2. Had they used HFC R134a this would have been an equivalent of 800,000 km of driving equivalent if the plant leaked 70 kg per year. **Societal:** Hard to say as Norway is so accustomed to district heating and doesn't have a gas network. However, were the buildings to use electricity their cost would be far higher.
Overall strategies of city/municipality connected with the project	Keep expanding. They also plan to utilize the waste cooling (10MW – enough for 10 soccer fields worth of data centres).
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ Sustainable consumption ☐ (Local) Governance ☐ **Legal framework** ☒ **Business models** ☒ They began deploying a district heating system many years ago and continue to offer heat at a competitive price. The key to expansion is the operation of a concession whereby buildings must connect if on the DH but don't need to buy but must be offered reasonably priced heat. So everyone wins and the network is as large as possible and still growing.
Innovative stakeholder involvement strategies	n/a
Typology of energy supply	District heating/local heating, Heat pump system

Success factors	Challenges/barriers
- Cleanliness and price control. - Biggest ammonia heatpump operating at 90C in the world.	- Keep growing, broaden supply options to include cooling.

31 Espoo, Finland - Smart Otaniemi

General information	
City	**Espoo, Finland**
Project name	**Smart Otaniemi**
Project status	planned ☐ under construction ☐ realized ☐ **in operation X**
Project start – end	2018 - 2024
Contact	Ismo Heimonen; smartotaniemi@vtt.fi
Project website	**https://smartotaniemi.fi/**
Size of project area	n/a
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use	n/a
Financing	Total budget of 6.6 Mill. € Research institutes 2.7 Mill. €, companies 3.9 Mill. € Partly (50 – 60%) financed by Business Finland

Overview description of the project
The target of Smart Otaniemi is to plan and implement a new type of smart energy piloting area and ecosystem in a large and dynamic district. Smart Otaniemi is an ecosystem of 34 partners, working on 6 concrete pilots, developing new ideas and creating new energy business. An essential objective is to realise a showroom for new smart energy solutions and especially for Finnish competence. At the same, pilots from different domains (smart energy, buildings, transport, and communication) will be combined in Otaniemi which enables finding synergies and maximising benefits from cross- cutting value chains. Smart Otaniemi pilot platform serves both experimental research activities as well as close-to- market proofing of concepts and products. Thus it enables both testing and piloting of solutions in development phase and proof of feasibility for commercial and exportable solutions. Smart Otaniemi aims to be a living lab with real customers involved. Focus will be especially on utilizing all types of data (energy, weather, traffic etc.) for new applications and services and on making Otaniemi more real-time monitorable and controllable area. The Smart Otaniemi innovation ecosystem is open to all and will be lasting and developing over time following the progress on its relevance areas.

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ Carbon-free ☐ **Climate neutral** ☒ Sustainable neighbourhood ☐ **Social aspects/affordability** ☒ Other: Smart Otaniemi seeks to establish a piloting platform that contributes to four common objectives: societal development, innovation capabilities, export businesses and new investing possibilities.

	Smart Otaniemi clearly targets the objectives set by Business Finland Smart Energy program. In terms of high level objectives, Smart Otaniemi contributes to developing smart energy ecosystems and platforms. Further Smart Otaniemi addresses utilization of digitalization and IoT in energy sector, as well as develops new business models for energy efficiency, renewable energy, smart grids, system flexibility and customer interface. At the same, Smart Otaniemi supports export industry be means of providing an international level showroom and reference cases for new solutions. There is also a strong need of coordinating and evaluating of different Smart Energy pilots in Finland. Smart Otaniemi can act as a hub for these pilots and produce combined information in order to get even more benefits of Smart Energy innovation ecosystems in Finland for business and decision-making purposes.
Indicators/expected impact	n/a
Overall strategies of city/municipality connected with the project	Smart Otaniemi will offer Espoo one potential channel to realise parts of their vision to become emission free by 2030. Aalto Campus has the target of being carbon free by 2030. Smart Otaniemi provides one roadmap how to get to this target. The key issues are intelligent management of local renewable energy resources, harnessing of the flexibility of the local loads, energy storages management, Electric Vehicles smart charging systems and intelligent integration of the mentioned resources into the energy markets. The Helsinki Metropolitan Smart & Clean Foundation is a five-year (2016-2021) step change project. The foundation's task is to drive the change in the Helsinki capital region and the City of Lahti for the area to be the world's best test bed for smart and clean solutions. The close cooperation with the Smart & Clean Foundation will ensure that possible cross insemination of data, ideas, and pilots lead to cross sectoral innovation. The learnings from Smart Otaniemi Pilot can be distributed to other areas and cities as well as used for creating open data platforms for other sectors.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ **Sustainable production** ☒ Sustainable consumption ☐ (Local) Governance ☐ **Legal framework** ☒ Business models ☒
Innovative stakeholder involvement strategies	VTT (Research) Aalto University (Research) ABB (Industry) ACRE (real estate owner) e2m (Industry) Empower IM (Industry) Eneron (Industry) ESF (Industry) Fourdeg (Industry) Ensto (Industry) GEF (Industry) Granlund (Industry) Merus (Industry) Nokia (Industry)

	Nuuka Solutions (Industry) Parking Energy (Industry) Savon Voima (Industry) Seneqo (Industry)
Typology of energy supply	District heating (open district heating), Deep Geothermal energy

Success factors	Challenges/barriers
Strong support from the Finnish national innovation agency, Bussiness Finland. The Ecosystem has increased and there are now 70 partners. The pilots are ongoing and feasibility studies have been done. More pilots are planned and in the pipeline for a 2nd and 3rd phase. Regulatory sandbox under evaluation.	Regulatory barriers for test bed/piloting experimentation.

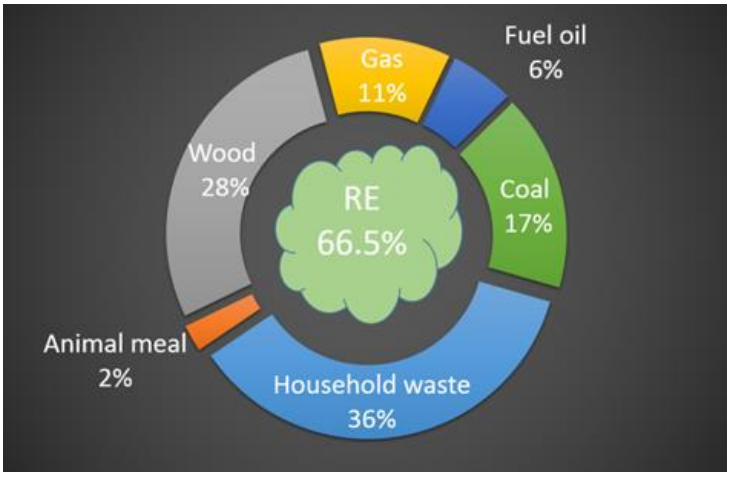
32 Grenoble, France - City Wide Project

General information	
City	**Grenoble, France**
Project name	City-wide project Case provided by RHC/DHC+: https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf
Project status	**planned** ☒ **under construction** ☒ **realized** ☒ **in operation** ☒
Project start – end	1970 – ongoing
Contact	CCIAG – Nicolas Giraud
Project website	https://www.cciag.fr/
Size of project area	(City)
Building structure	**Newly built** ☒ **Existing neighbourhood** ☒ **Mixed** ☒
Land use	n/a (mixed use/city-wide)
Financing	Investment by Grenoble-Alpes Metropolis and the private company CCIAG The district heating is operated through a public delegation service: the private company CCIAG invest and operate the district heating for the next 15 years

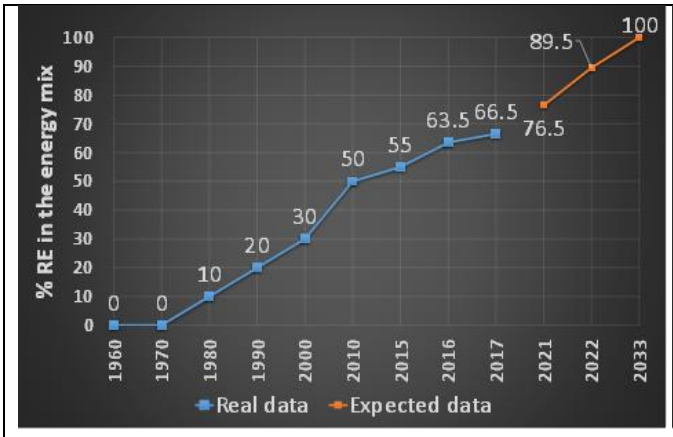
Overview description of the project

The GRENOBLE-ALPES-METROPOLIS (METRO) district heating, with its 170 km of liquid pressurized water distribution pipes, is the second largest District Heating System in France (900 GWh). The district heating is a strong part of the energy strategy of the city. For 30 years, the city is engaged in a process to integrate renewable energy and decarbonize the network. Then CO2 emissions have drastically dropped (-60%) since 1990 to reach a minimum level (115 g/kWh) in 2017 while the RE penetration is currently about 66.5%.

The integration of renewable and recovery energy accelerates and solutions are deployed to achieve a 100% RE District Heating in 2033. State of the art solutions (biomass, waste heat from incineration plant,…) are combined with innovative solution (storage, CO2 capture, smart control,…) that are under study and development with CEA research center.



Share of each fuel mode (2017); source: GAM-DHS



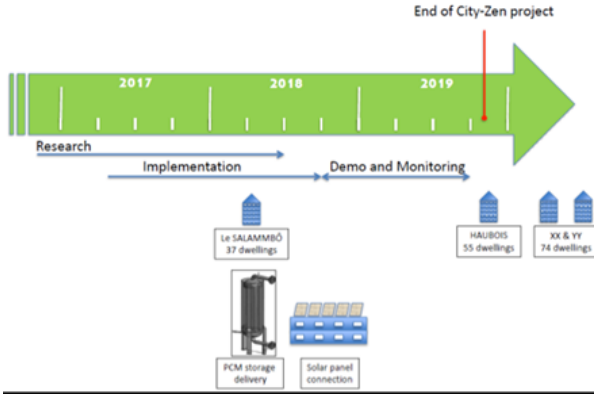
% RE in the energy mix; source: GAM-DHS

CO2 emissions (g/kWh); source: GAM-DHS

For the CITY-ZEN European project (2016-2019), the Flaubert district demonstrator is an expansion of the network via a low temperature (70 °C) and low pressure sub-station.

A new renewable (thermal solar energy) at lower temperature source is connected to limit heat losses during transportation. This new RE is coupled to a phase change material (PCM) heat storage.

With a smart management control system the environmental footprint is optimized and balanced using the solar energy, the storage and the buildings' thermal inertia.



FLAUBERT Demonstrator timeline

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ **Social aspects/affordability** ☒ - 75 % RE in 2020 - 85 % RE in 2022 - 100% RE in 2033
Indicators/expected impact	**Economic:** Competitive price of the DH compared to other energy **Environmental:** 100% RE in 2033 **Societal:** Maximise local energy and satisfaction of user
Overall strategies of city/municipality connected with the project	The development of the DH and its decarbonisation is part of the directory scheme of energy of city that include all energy (gas, electricity and heat). The strategy is based on : - Integration of recovery and renewable energy : replacement of fossil fuel boiler - Densification and extension : increase or stabilize the energy delivered of the DH - Innovation : development of advanced control system and innovative components (storage,…)

Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ Sustainable consumption ☐ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	Citizens were involved in the directory scheme of energy of the city
Typology of energy supply	District heating/local heating

Success factors	**Challenges/barriers**
Supportive regulations: - specific VAT on energy delivered by DH that include at least 50% of renewable and recovery energy - classification of green and efficient district heating: obligation of new building in the area to connect to the DH - bonification in the building regulation for new buildings connected to low carbon district heating Strong investment of the municipality and the district heating operator to develop a green District Heating	n/s

33 Győr, Hungary - Győr Geothermal District Heating Project

General information	
City	**Győr, Hungary**
Project name	**Győr Geothermal District Heating Project** Case provided by RHC/DHC+: https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf
Project status	planned ☐ under construction ☐ **realized** ☒ **in operation** ☒
Project start – end	2013 – 2015
Contact	pannergy@pannergy.com
Project website	http://pannergy.com/en/projects/#gyor
Size of project area	5 ha
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use	n/a
Financing	• EU based national financial supports were important. Implementation costs were decreased by EU based national financial supports. Supports helped to make the Project profitable. • Heating price covers the operating costs and ensures the profitability

Overview description of the project
Pannergy Plc. with Győr Municipality and also with Audi Hungaria Motor Ltd. implemented a large Hungarian geothermal district heating project. The technical goal of the investment was to feed geothermal energy to the heating system of Győr district situated the nearest to the facilities in order to supply heat to the prefabricated buildings of the local housing estates. The technology provide heat to the industrial district of Győr as well. Three producing wells provide the thermal water. The heat output of the thermal wells are transmitted to the heat consumers via pipelines and heat exchangers, while after cooling down the fluid is reinjected by three reinjection wells. The technology ensures the operations of a large geothermal heating plant and also the industrial district of Győr.

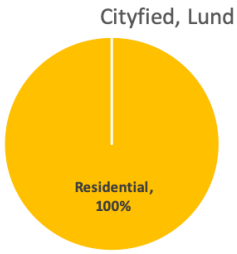
Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐ Municipality of Győr City, Audi Hungaria Motor Ltd. and daughter companies of PannErgy Plc. decided to decrease the natural gas consumption and hazardous material emission of the city's central heating plant with renewable energy, which would ultimately ensure a cleaner and more liveable city for the inhabitants of Győr.
Indicators/expected impact	**Economic**: PannErgy Group received non-repayable grants in a combined amount of more than HUF 2 billion from the European Union based Environmental ans Energy Efficiency Operative Programme

	Environmental: - Redeemed natural gas – 52 MW heat capacity - Reduction of CO2 emission – 800–900 TJ/year **Societal:** A new renewable energy operating company with dozens of employees : Arrabona Geothermal Ltd.
Overall strategies of city/municipality connected with the project	- The city and industrial consumers are supplied with natural gas by the national gas system. Formerly natural gas was the key energy resource for the district heating systems. - Municipality started to implement a "greening" process. - The main energy resources in the city are geothermal energy and solar energy. - Geothermal energy is appropriate to substitute the largest possible part of the natural gas in the district heating systems. The Municipality and PannErgy jointly decided to found a project company, Arrabona Geothermal Ltd. with the intention to supply a large proportion of heat to Győr town and also to industrial consumers from renewable resources.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ Refurbishment ☐ **Sustainable production** ☒ Sustainable consumption ☐ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	As the municipality was involved in the Project, the citizens were continuously informed by all possible information resources in the town and also in the region.
Typology of energy supply	District heating/local heating, geothermal, solar energy

Success factors	Challenges/barriers

- receiving permission is easier according to the latest changes of national regulations
- heating capacity
- provided annual heat energy
- heating factor
	- maximized heating price
	- The operating system has numerous opportunities:
	  - There is opportunity for enlargement of the system
	  - In upper temperature range (>90oC) electricity generation is to be examined as well
	  - Hybrid energy supplying solutions (with solar and biomass energy resources) are to be analyzed
	  - Underground heat storage opportunity is also to be analyzed
	  - The barrier is the heat capacity of the reservoir and the thermal water temperature on the head of the wells.

34 Lund, Sweden - Cityfied

General information	
City	**Lund, Sweden**
Project name	**Cityfied (demo Linero)**
Project status	planned ☐ under construction ☐ **realized** ☒ **in operation** ☒
Project start – end	2014– 2019
Contact	Markus Paulsson
Project website	www.cityfied.eu
Size of project area	80 000 m2
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	- Residential: 100 % - Office: 0 % - Industry: 0% - Other: 0 % 
Financing	Public Research funding

Overview description of the project
CITyFiED is a pioneering smart city project based on a mix of demonstration, technologies and sound business models. It has developed a replicable, systemic and integrated strategy for sustainably renovating residential districts. The benefits include reduced thermal energy consumption, lower greenhouse gas emissions and greater use of renewable energy.


Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ Sustainable neighbourhood ☐ **Social aspects/affordability** ☒ Notes: The goal was to establish a near zero energy district

Indicators/expected impact	- Environmental - Social - Economic
Overall strategies of city/municipality connected with the project	n/a
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ Sustainable production ☐ Sustainable consumption ☐ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	- Industry - Investor/real estate - Business - Research
Typology of energy supply	- District heating/local heating - Heat pump system - Photovoltaic

Success factors	**Challenges/barriers**
Energy efficiency has been considered in both the buildings and in the energy system as one system to prevent sub-optimization. District heating based on 100% renewable energy has been combined with solar power (PV) and heat pumps.	More collaboration than usual is needed between the housing and the energy company. The municipality can be a good middle man.
The retrofitting has been performed in stages. After the first planning period the measures was implemented in a pilot house. The measures were evaluated and some design changes were made before the retrofitting of the remaining buildings started.	It takes longer time to do it in stages.
To gain involvement and acceptance it's important to engage tenants upfront. Linero's strategy, besides the formal meetings, was to organise informal meetings in the residential area. The purpose was to gain trust, but also to allow tenants to know the project team directly. By creating different activities for all generations, we encouraged tenants to get involved and have their say. Such activities give tenants a sense of belonging in the project, increasing its overall success.	• Challenging to give proper feedback. • Some tenants are more resistant to change. • Not all tenants are reached
Kraftringen, a local energy company, created Energikollen, a fun and interactive smartphone app to help tenants keep tabs on their energy consumption. As Kraftringen has a utility franchise over the electricity grid in the area, the company can use the collected data for the app. Moreover, all data gathered before the installation of the app is also available. To raise the tenants' awareness about energy, two home visualisation apps were developed. The apps allow tenants to evaluate their electricity use based on real time and historical data.	• Complicated login system. • Only works within the franchise areas. • Does not generate any income.

35 Mieres (Asturias), Spain - District Heating Pozo Barredo

General information	
City	**Mieres (Asturias), Spain**
Project name	**District Heating Pozo Barredo**
Project status	planned ☐ under construction ☐ **realized** ☒ **in operation** ☒
Project start – end	12/2017 – 04/2019
Contact	Juan Enrique Álvarez Areces
Project website	http://www.aulahunosa.es/red-de-calor-mieres/
Size of project area	1km²
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	n/a
Financing	- Investment of 1,421,541€ (Subsidy of 503,000€) - Annual turnover of 120.000€ Business model: It consists of a supply contract establishing guaranteed saving respect to the expense used to cover the same demand of conventional fuel (gas) that is covered with geothermal energy.

Overview description of the project

Taking advantage of the experience accumulated in recent years by the Hunosa Group in the installation and maintenance of geothermal facilities based on the use of mine water, it was proposed to carry out a project to create an urban heat network in the municipality of Mieres.

This network starts from Pozo Barredo and serves the Polytechnic School of Mieres (EPM), the secondary school Bernaldo de Quirós (IBQ) and a group of buildings, located in the Vasco-Mayacina area, which has a total of 248 dwellings.

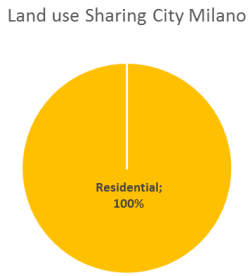
District Heating network in Mieres, Asturias

(Orange: DH Pozo Barredo project; Purple: Previous projects)

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐ This project involves a total of 4 buildings with a heating volume of 170,065.30 m3 for a nominal power of the equipment replaced by 5,437.80 kW and a reduction in emissions of 636.85 tCO_2/year.
Indicators/expected impact	**Economic**: An annual turnover of €120,000 is assumed. **Environmental:** Reduction of 636.85 tCO_2/year **Societal:** The project means a clear improvement in the environmental quality, access to an efficient technology that provides savings to the end customer, which in the case of Public Protective Housing (PPV) means minimizing the risk of energy poverty.
Overall strategies of city/municipality connected with the project	The Council of Mieres has requested financing from the Mining Funds for the expansion of the DH to access Mieres'public buildings for an amount of 2.5 M€.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	In this case, as the action is almost entirely restricted to publicly-owned buildings, no awareness-raising campaign has been necessary; the only private building has been incorporated through the approval of the owners' meeting of the offer presented.
Typology of energy supply	District heating/local heating, geothermal

Success factors	Challenges/barriers
- All those who favour the energy transition towards renewable energies help this type of action. - It is essential that public institutions have an exemplary role in this type of actions, first facilitating contracts' negotiation and then giving confidence to private institutions to join the network.	- Granting of resource exploitation permits, municipal licenses, approvals from the various agencies, make the time for the completion of the project much longer. - The main challenge is technological: The transport of the thermal energy to great distances is difficult since the centres of consumption are distant from the centres of production and only in very particular cases the mining wells are in an urban environment. Another thing is that urban operations (technology centres, industrial estates, etc.) can be carried out around wells to minimise the Consumption/distance ratio, which is key in this type of action.

36 Milano, Italy - Sharing Cities

General information	
City	**Milano, Italy**
Project name	**Sharing Cities**
Project status	planned ☐ under construction ☐ **realized** ☒ in operation ☐
Project start – end	2016 – 2020
Contact	Piero Pelizzaro, Clara Maddalena Callegaris
Project website	www.sharingcities.eu and www.milano.sharingcities.it
Size of project area	2.8 (28.000 m²)
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐ 
Land use	Residential: 100%
Financing	For private residential buildings more than 70% of the costs have been covered by residents (with the help of different financial mechanisms: tax credit, transfer of tax credit, loans, etc.) and the rest of the costs have been funded by the programme through unit-cost mechanism (i.e. the partner in charge for the measure implementation receives a reimbursement on the base of the achieved results). For San Bernardo 29A, the Municipality covered with its own resources 90% of the costs, while Sharing Cities EU funds covered the rest 10%.

Overview description of the project

Sharing Cities is a H2020-SCC1 project. Sharing Cities is proving ground for a better, common approach to making smart cities a reality; by fostering international collaboration between industry and cities, the project seeks to develop affordable smart city solutions. In each of the three lighthouse cities (London, Lisbon, Milan), a district has been identified for the implementations, that are

- Charging points: 60 charging points (40 normal and 20 fast) for boosting private and shared electric mobility, located in 10 Mobility Areas
- Bike sharing: 150 new e-bikes for bike sharing with child seats and 7 new project bike sharing stations (plus 7 financed by City of Milan)
- Community car sharing: 2 e-vehicles and dedicated recharging points.
- e-logistics: 11 e-vehicles (2 cargo bikes) for goods delivery in the area.
- Smart parking: 175 parking places with sensors (for logistics, disabled people, no-parking areas, Mobility Areas)
- Smart lampposts as the enabling infrastructure for several new services: Wi-Fi antennas, environmental noise and transport monitoring. The telecommunication infrastructure uses LoRaWAN protocol.
- Among the other implementations conceived for creating a Smart District, the one closely related to PED theme is the Residential building retrofit. Within Sharing Cities has been refurbished:
  - 24,000 m² of private residential buildings integrated with sensors for monitoring and managing energy consumption. Owners co-designed interventions with a dedicated process with project's experts. Estimated

energy consumption saving 50-70%. Buildings located in Via Tito Livio 7 (ca. 2,000), Via Verro 78 BC (ca. 3,800), Viale Fiamma 15-1 (ca. 3,300), Via Passeroni 6 (ca. 6,500) and Via Benaco (8,800). 5,000 m^2 of public residential building with PV, heat pump and comfort monitoring system. Estimated energy consumption savings around 60%. Building in Via San Bernardo 29A.

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒
Indicators/expected impact	A wide monitoring tool has been implemented in order to assess the effectiveness of the measures in terms of: • Energy and emissions saving (environmental) • Comfort and liveability (social) • Economic affordability (economic)
Overall strategies of city/municipality connected with the project	Urban Renewal Strategy: Sharing Cities interventions represent a best practice for the wider initiative of the Municipality of Milan of tackling building retrofit challenge. In particular, for private ones a 23 million of € call has been launched for financing interventions on obsolete heating systems and for energy efficiency measures. For the public ones the technical requirements identified and designed within Sharing Cities will be applied for future interventions on public residential properties that are in planning phase.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ **Refurbishment** ☒ Sustainable production ☐ **Sustainable consumption** ☒ **(Local) Governance** ☒ Legal framework ☐ Business models ☐
Innovative stakeholder involvement strategies	The main challenge of multi property private residential is to make the majority of residents agree about the need of building retrofit intervention and about which kind of energy efficiency interventions have to be implemented. The methodology developed and applied in Sharing Cities tries to address this issue choosing and co-designing the interventions involving the residents from the very beginning of the process. The methodology will be spread through easy and user-friendly materials able to depict the entire process, highlighting barriers, opportunities and constraints. These materials will be one of the main output of the project in terms of knowledge enhancement about how to address the building retrofit issue.
Typology of energy supply	- Solar thermal energy - Geothermal energy - Heat pump system

Success factors	**Challenges/barriers**
- Wide public-private partnership - Innovative methodology (codesign) - Cross-cutting work within different departments of the Municipality - Measures included in a wide strategy of the Municipality	- New GDPR affects most of the activies - Public Administrative procedure not aligned with Innovation project timing

37 Móstoles (Madrid), Spain - Móstoles Ecoenergías

General information	
City	**Móstoles/Madrid, Spain**
Project name	**Móstoles Ecoenergías** Case provided by RHC/DHC+: https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf
Project status	planned ☐ under construction ☐ **realized** ☒ **in operation** ☒
Project start – end	04/2015 – undefined
Contact	Raúl González Alcorlo
Project website	n/a
Size of project area	n/a
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	n/a
Financing	There are mainly three distinct costs: - Investment –The initial cost is high and it has an amortisation period of around 20 years. Reducing investment costs is essential in many cases to ensure the viability of the project, so it is recommended to adjust the initial investment to the initial demand of the project. - O&M - This is the recurring cost of the installation, once the heating network is up and running. It contains all the necessary costs to carry out the correct maintenance of the installation. - Fuel supply and electricity consumption - These are two costs directly related to the energy demand of the plant. Their cost is directly related to the performance of the installation, which makes it essential to have the installation in perfect operating conditions. Business model: Móstoles ecoenergías tries to give solutions to several existing problems in Móstoles. It offers a heating and DHW system with renewable energy without investment costs for the neighbours. It allows them to have a modern and efficient heating system without added costs for the communities. This also permits many communities with obsolete boiler rooms, high maintenance costs for having exceeded their useful life, and low efficiency, to change into an efficient system, without maintenance costs and with a stable price throughout the contract.

Overview description of the project
Heating Network for the supply of heating and DHW to 7,200 homes with biomass: The Móstoles Ecoenergía District Heating is a project developed to promote a heat network in the city of Móstoles, located in the southwest of Madrid and with a population of more than 200,000 inhabitants. Móstoles District Heating is Spain's largest and most ambitious biomass-based district heating plant project, which in its first phase serves 3,000 homes, and is being expanded to 7,000 homes.

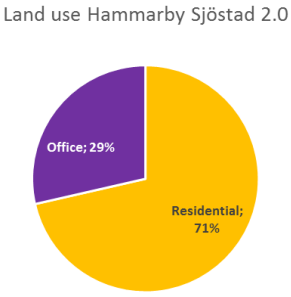
Current distribution of Móstoles Ecoenergías DH

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐ Replace the current coal, diesel and natural gas boiler rooms of 7,200 homes with a heating system with renewable energies, and avoid the emission of 18,000Tn of CO2 per year. There are currently 2,664 homes connected to which 18 GWh/year of energy is supplied, with a reduction in emissions of nearly 9,000 tCO2/year
Indicators/expected impact	**Economic** - Investment - 4.8 M€ - Current annual turnover - 2 M€ - Current supplied biomass - 9,000 tons/year **Environmental:** - Current CO2 emission reduction - 9.000 tCO2/year (2,664 homes) - Expected reduction with 7.200 homes - 18.000 tCO2/year

	Societal: The installation of a heating network with biomass represents a change of concept with respect to the traditional systems that we use to heat our homes. It is a clear sample that alternative, economic and sustainable methods exist, without penalizing our comfort or well-being.
Overall strategies of city/municipality connected with the project	Concession (75 years) of a plot of land owned by the Municipality of Móstoles for the construction and operation of a thermal power station and urban heat network with solar thermal energy and biomass support (District Heating). For this kind of project, it is essential to have the support of the City Council to facilitate the administrative procedures to make this type of project a reality. In addition, town councils benefit directly from the benefits of using clean, sustainable and green technologies in the municipalities themselves, reducing environmental pollution in cities and improving air quality.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	Citizens are an essential component for the development of district heating projects. There are many zones and areas where individualised heating systems (individual boiler) are considered to be the most suitable systems to ensure comfort at a contained cost. It requires a major effort on the part of public administrations and private companies to promote the use of heat networks as efficient heat supply systems. It is so important for citizens that the support or not of this type of technology is the difference between whether carrying out projects of these characteristics or not.
Typology of energy supply	District heating/local heating

Success factors	**Challenges/barriers**
- The rebate of highly energy-efficient homes with tax reductions provides an appropriate legal framework to encourage the use of new technologies that have an impact on the good of all. - The main factor is the support of this type of project on the part of citizenship. It is necessary to provide real projects that offer alternative solutions within the current tariffs of the systems it seeks to replace and, make a commitment to education and awareness of the importance of changing our habits of energy consumption by other different models.	- It is necessary to carry out rigorous inspections of deficient heating systems. Central heating systems with low performance, without maintenance and with high levels of pollution shouldn't be allowed.

38 Stockholm, Sweden - Hammarby Sjöstad 2.0

General information	
City	**Hammarby Sjöstad (City district in Stockholm), Sweden**
Project name	**Hammarby Sjöstad 2.0**
Project status	planned ☐ under construction ☐ **realized** ☒ **in operation** ☒
Project start – end	2014-2030
Contact	Jorgen Loof
Project website	http://hammarbysjostad20.se//
Size of project area	2 km²
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use	- Residential:25,000m² - Office: 10,000m² - Industry: n/a 
Financing	Public-private Research funding

Overview description of the project
The **ElectriCITY's** mission is to transfer the city district of Hammarby Sjöstad into the Paris climate deal 2050 already 2030. We also have a mission to be global leaders in sustainable developments and to inspire other. We will do this through research, innovation and business. As it is a citzen-driven initiative the key is to develop solutions that is adapted quickly by the citizens. Hammarby Sjöstad, means the lake city of Hammarby. It is situated approximately 5 km south from the city center of Stockholm. The district is still under construction today with 25' inhabitants (to be 30') and 15,000 employees. Hammarby Sjöstad has a good international renommé and we have been on the news all around the globe, e.g. the Economist stated us to be "One of the World's highest profile examples of Sustainable City Development". More than 3,000 visitors come to Hammarby Sjöstad every year, interested in cooperation, and every week one Chinese delegation visits Hammarby sjöstad. "It will be twice as efficient as any other urban development this decade!" was the goal of the political leaders before planning HS. Even though we had at the time high standards of sustainability; It was to be a modern suburb built using the latest technology. Residential and commercial energy consumption should be low, people would choose public transport rather than cars, garbage would be used to produce district heating and food waste would be turned into biogas for cooking and fuel for vehicles. The planning is based on the "The Hammarby Model is a natural cycle approach to urban living".

However, in the end the district didn't perform enough. Most of the buildings in the district consume more energy than was originally envisaged and many suffer from a lack of maintenance, specifically in the technology that they use. Cities, like companies, if you do not constantly innovative, you will not be successful. The feeling of not being "good enough" was the start for the project Hammarby sjöstad 2.0. And the organization to run this in ElectriCITY. We have now a scientific based strategy to deliver on the Paris Climate deal 2050 already in 2030. We will do this through activities in the area of energy, buildings, mobility, digitalization, communication, circular-and sharing economy. Some of the projects are described in the attached document.

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ **Social aspects/affordability** ☒
Indicators/expected impact	- Environmental - Societal - Social - Economic
Overall strategies of city/municipality connected with the project	Only commercial and citizen driven
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ Sustainable production ☐ Sustainable consumption ☐ **(Local) Governance** ☒ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	- Citizens - Business - Utility - Housing association
Typology of energy supply	- Solar thermal energy - Geothermal energy - District heating/local heating - Heat pump system - Industrial waste heat

Success factors	**Challenges/barriers**
Success factor is that it is citizen and commercial driven	n/s

39 Vienna, Austria - SCITHOS

General information	
City	**Vienna, Austria**
Project name	**SCITHOS**
Project status	planned ☐ under construction ☐ realized ☐ **in operation** ☒
Project start – end	May 2016 – September 2019
Contact	Ko Koens
Project website	www.scithos.eu
Size of project area	n/a
Building structure	n/a
Land use	- Residential - Services (urban destinations)
Financing	Research funding

Overview description of the project

This project introduces Smart City Hospitality as a concept that consists of guidelines and tools to help cities find solutions to make the transition towards environmentally and socially responsible tourism that simultaneously contributes to long-term prosperity. SCITHOS actively involves the public in doing so, for example by means of the 'SCITHOS challenge', which brings together policymakers, residents and other local stakeholders to discuss the future of tourism in their destination in a playful setting.

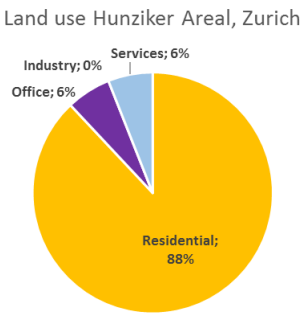
© scithos.eu

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐ The project aims to support stakeholders in making decisions related to tourism while aiming for sustainable neighbourhoods and overall the city.
Indicators/expected impact	SCITHOS project focuses on the values of equitability, liveability, economic wealth, experience quality, natural viability and smart hospitality. In doing so, the expected impacts are expected to work on a spatial distribution of an urban destination, but also at the regulatory level, where new policies and regulations can be implemented.

Overall strategies of city/municipality connected with the project	The project predominantly focuses on the smart city strategies for managing tourism in an urban space embracing the growth of tourist arrivals.
Which factors have been included in implementation strategies?	Local (renewable) resources ☐ Regional energy system ☐ Mobility ☐ Buildings ☐ Materials ☐ Refurbishment ☐ Sustainable production ☐ **Sustainable consumption** ☒ **(Local) Governance** ☒ Legal framework ☐ Business models ☐
Innovative stakeholder involvement strategies	- Citizens - Industry - Business Through the SCITHOS-challenge, a serious gameplay, all stakeholders in a destination are invited to plan the destination and collaborate. Through the gameplay, stakeholders get a better understanding how the implementation of policies to manage the city impacts the stakeholders but also the sustainable values representing the quality of life and in the city and visitability of tourists.
Typology of energy supply	n/a

Success factors	Challenges/barriers
- 6 pilot cities across Europe - Serious gaming prototype - Variety of engaged/involved stakeholders - Raised awareness among participants	- Collaboration between partners - Cultural differences of partnering cities - Willingness to participate among specific stakeholders

40 Zurich, Switzerland - Hunziker Areal

General information	
City	**Zürich, Switzerland**
Project name	**Hunziker Areal**
Project status	planned ☐ under construction ☐ **realized** ☒ **in operation** ☒
Project start – end	2007 – 2017
Contact	Project contact «mehr als wohnen» Example presented for PED Programme Cities Workshop (3 April, Vienna): Swiss Federal Office of Energy Ricardo Bandli Federal Department of the Environment, Transport, Energy and Communications (DETEC)
Project website	https://www.mehralswohnen.ch/
Size of project area	4.1 ha
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use	- Residential: 88 % - Office: 6 % - Industry: / - Other: Business & restaurant 6 % 
Financing	Private cooperative „mehr als wohnen“

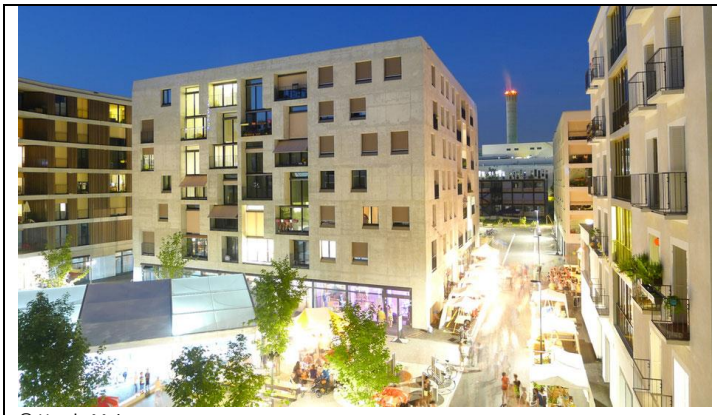
Overview description of the project

Several dozen smaller cooperatives in the city of Zurich founded in 2007 the cooperative “mehr als wohnen” (more than living) with the idea to develop new forms of living and structural innovations. In 2010, the cooperative was able to buy the 41,000 m^2 large site of the former “Hunziker concrete factory” from the City of Zurich.

Since the beginning of 2015, the Hunziker site in the north of Zurich provides living space for 1,200 people and about 150 jobs. 370 residential units offer various typologies for different needs and budgets. The broad range from studios to cluster apartments with spacious communal areas enables a high mixing. The apartments are subject to occupancy regulations and residents should refrain from using private cars. The Participation of the residents is central to active coexistence instead of an anonymous neighbourhood. This is made possible by numerous public ground floor uses and open spaces on the Hunziker site. There they can celebrate parties together, having workshops or plant vegetables.

With incentives to combine living and working, attractive business, participatory processes and a variety of living realities, a socially sustainable and lively quarter is priority.

The Hunziker site is operated according to the principles of the 2000-watt society. The buildings meet the Minergie-P standard (energy efficiency and sustainable materials) and are heated with waste heat from the neighbouring municipal computer centre. The photovoltaic systems on the roofs cover 20 percent of the electricity consumption.

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Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒ Other: According to the **goals of 2000-Watt-Society** *(includes CO_2 emissions max. 1 tonne per person per year)* https://www.2000watt.swiss/english.html
Indicators/expected impact	- Environmental - Social - Spatial
Overall strategies of city/municipality connected with the project	Smart City Strategies https://www.stadt-zuerich.ch/portal/de/index/politik_u_recht/stadtrat/weitere-politikfelder/smartcity/strategie/publikationstrategie.html Urban Renewal Strategies & Energy Masterplanning https://www.stadt-zuerich.ch/gud/de/index/umwelt_energie/2000-watt-gesellschaft/publikationen/roadmap.html (English)
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ Refurbishment ☐ Sustainable production ☐ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ Business models ☐
Innovative stakeholder involvement strategies	- Citizens - Research Pilot, demonstration and flagship projects programme of the Federal office of energy https://www.bfe.admin.ch/bfe/en/home/research-and-cleantech/research-and-development/pilot--demonstration-and-flagship-projects-programme.html
Typology of energy supply	Heating and hot water: District heating plant with server waste heat of the urban Data centre The regulation of the heating of the thirteen houses is based on a system solution which works predictively and self-optimizing. For this purpose, the temperature and relative humidity of all use units are measured on the site and transmitted online to a server. The temperature and humidity data can then be visualized per house. A big advantage is the measurement of room

	temperatures in the apartments. This information helped to more systematically address and address the problems of regulatory intervention Electricity consumption and production The electricity consumption of the residents and users is crucial for optimizing the total energy consumption of the area. The local businesses account for one third of the total land use. Efficient kitchen appliances, central freezers and laundry rooms, as well as sufficient residents contribute to the economical use of electricity on the site. In addition to Stromverrauch also the production data were evaluated. A quarter of the power consumption can be produced directly on site. The self-consumption share of the entire area is 92%. Say only 8% of the electricity produced is reflected in the annual balance in the network

Success factors	Challenges/barriers
n/s	n/s

IN IMPLEMENTATION STAGE

41 Bolzano, Italy - Sinfonia

General Information	
City	**Bolzano, Italy**
Project name	Sinfonia
Project status	planned ☐ **under construction** ☒ realized ☐ in operation
Project start – end	2014-2020
Contact	Daniele Vettorato
Project website	http://www.sinfonia-smartcities.eu/en/project
Size of project area	For Bolzano: 785 hectares (exdended district – Bolzano south)
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	mixed use area - Residential: 100% Social Housing - Office: n/a - Industry: n/a
Financing	20% Research funding 40% Public 40% Green financing

Overview description of the project

The **SINFONIA project** is a five-year initiative to deploy large-scale, integrated and scalable energy solutions in mid-sized European cities. At the heart of the initiative is a unique cooperation between the cities of Bolzano and Innsbruck, working hand in hand to achieve 40 to 50% primary energy savings and increase the share of renewables by 20% in two pioneer districts. This will be done through an integrated set of measures combining the retrofitting of more than 100,000 m² of living surface, optimisation of the electricity grid, and solutions for district heating and cooling.

Since 2005, Bolzano (Italy, 100,000 inhabitants) has developed an ambitious investment plan for large scale urban refurbishment in collaboration with both public and private stakeholders. The work undertaken in SINFONIA is part of this plan, and aims to achieve 40% to 50% primary energy savings in the demo sites and to increase the share of renewables in the district of Bolzano SW (South West) by 20%.

BUILDING REFURBISHMENT

37,000m² of social housing from the 50s-70s will be retrofitted to achieve high energy performance and improve interior comfort while ensuring cost effectiveness and minimal impact on tenants. Measures include:

- Building envelope insulation;
- Integration of renewable energy sources for electricity, heating and domestic hot water, Solar PV panels;
- Additional storeys using innovative timber construction technologies.

DISTRICT HEATING & COOLING

The district heating & cooling network will be extended and optimised to reduce both the CO_2 and the nitrogen equivalent emissions. Measures include:

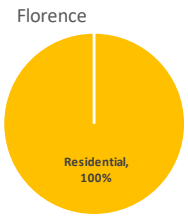
- Real time monitoring and forecasting of peak loads and energy demand;
- Hybrid hydrogen/methane backup system;
- Study on recovery of wasted energy from local industrial park.

ELECTRICITY GRID Bolzano will implement an Urban Service-Oriented Sensible Grid (USOS-grid) system in the South West district for improved energy distribution control. Measures include: - Recharge points for vehicles and bicycles; - Meteorological stations for local climate condition monitoring; - Smart retrofitting of the public lighting system.

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒
Indicators/expected impact	**Environmental:** - Final energy consumption reduced by factor 10 - Reduced energy bills by factor 1 in social housing (tackle energy poverty) - CO_2 emissions reduced by factor 8 **Social:** - 33,000 m^2 of social housing refurbished **Behaviour change**: http://www.sinfonia-smartcities.eu/en/blog/post/behaviour-change-how-to-increase-the-impact-of-energy-efficient-renovation-projects
Overall strategies of city/municipality connected with the project	Energy Masterplanning: the project is connected to the SEAP
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	- Industry: partner of the project. Local energy provider + startups incubator - Research: partner of the project Good practices for effective stakeholder engagement: explore our database of solutions http://www.sinfonia-smartcities.eu/en/blog/post/good-practices-for-effective-stakeholder-engagement-explore-our-database-of-solutions
Typology of energy supply	- Solar thermal collectors integrated in the facedes for domestic hot water production - NSGE - District heating - Heat pumps - Industrial waste heat recovery feasibility study.

Success factors	**Challenges/barriers**
- Empowerment of project partners - High visibility of results - Growing interest on the Smart City transition in the city	- Slow procurement procedures. - Technology integration is not BAU in the market: difficulties to find market players able to provide/bring technologies from TRL7 (minimum requirement for innovation) to 9 (requested by public tender rules). - Public funds not always lockable for 5 years time horizon (changes of local governments)

42 Florence, Italy - REPLICATE

General information	
City	**Florence, Italy**
Project name	REPLICATE (pilot action in the Novoli-Cascine district on „le Piagge“ buildings)
Project status	planned ☐ **under construction** ☒ realized ☐ in operation
Project start – end	2017-2021
Contact	Alessandra Barbieri
Project website	www.replicate-project.eu
Size of project area	2,500 ha the district, 20,200 m^2 of buildings involved
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	- Residential: 100% 
Financing	Financed by the municipality with the support of the EU project for the 20% and of the national programs (Bando periferie, Conto termico...) for about 25%.

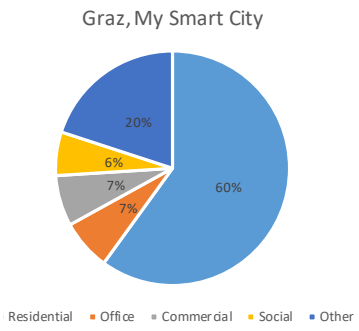
Overview description of the project
The intervention consists in the retrofitting of two residential social housing buildings in Florence and the creation of a dedicated District Heating network exploiting solar heating through an underground seasonal thermal storage. The total surface selected is about 20,000 m^2 with an actual consumption of about 3 GWht and 500 MWhe. The building blocks structure is made of reinforced concrete and bricks. The main objective of the intervention is the disposal of old existing individual heating systems, with a high-performance micro DHS producing energy with high efficiency and RES exploitation through an innovative solar thermal seasonal storage. The network reaches the flats where the single boilers have been replaced with small heat exchangers without disruption for the tenants who will benefit from the change in terms of maintenance and energy costs. In parallel, the buildings are being insulated and the tenants are asked to adopt measures (exploiting national financial subsidies) and change their habits to decrease sensibly the energy demand. The main challenge consists in increasing the efficiency of residential buildings realizing such an innovative plant in a difficult urban environment (regulatory constrictions in such an urban area as Florence, low income users, single boilers replacement...) to demonstrate its replicability in more favourable boundary conditions. Energy consumptions will be monitored in order to improve the system management and the users' awareness: a smart info system (e-distribuzione) and a municipal gaming APP have been made available to the tenants to monitor energy demand and habits (water consumption, mobility...). A smart grid implementation has been tested in the area with innovative automation devices to enable new services and increase the grid resilience and its performances. One of the services enabled regards the e-mobility: the public charging infrastructure has been updated and optimised in the district in connection with the creation of a dedicated fast infrastructure for taxi fleets. Also, the public lighting system has been innovated with smart solutions including energy efficiency, video surveillance, WIFI and sensors to gather environmental data. IoT solutions have been tested in the district (smart bench, smart waste, smart irrigation and Tim Citylink).

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ Sustainable neighbourhood ☐ **Social aspects/affordability** ☒ Other: The technological choice about RES exploitation, has been made also taking into account the local air quality issue in the urban centre (no biomass, no CHP)
Indicators/expected impact	- 300 families involved in the buildings action (-10% on energy bills) - 600 families provided with smart info devices to monitor consumptions - 100 e-taxi and 6 fast recharge dedicated stations - 40 public charging stations in the district connected to the municipal network - Innovative mobility services for vulnerable people - Regulatory innovations: dedicated public infrastructure for fleets, data management in the Smart City Control Room compliant with GDPR, underground energy storage in urban context with natural and historical boundaries - Environmental impacts: o Piagge buildings: -70% fossil fuel consumption, 750 MWh of RES production, 450 tCO_2/y savings o Taxi fleet: -200 tCO_2/y o Recharging network: - 40 t/y o Smart public lighting: - 149 t/y
Overall strategies of city/municipality connected with the project	The pilot action is linked to the following city strategies: • "zero volumes" structural plan (2015) • Covenant of Mayors Sustainable Energy Action Plan (2011) • Smart City Plan (2015) Its results are influencing the latest planning tools like the Sustainable mobility plan (Metropolitan area, 2019), the upcoming buildings regulation updates and the Sustainable Energy and Climate Action Plan (foreseen for spring 2020).
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒ Other: sustainable energy distribution (smart grid), energy poverty (social housing)
Innovative stakeholder involvement strategies	This project is the practical pilot test of the Smart City Plan which has been co-created together with citizens and stakeholders following the "system thinking" methodology (FP7 Steep http://www.spesconsulting.com/node/34) for complex problems solving. Participated modelling sessions as well as public debates (Maratone dell'ascolto http://maratoneascolto.comune.fi.it) have been carried out with interested stakeholders and citizens.
Typology of energy supply	The district heating system is connected to a seasonal Thermal Energy Storage feeded by a thermal solar field of about 1,000 m^2 on the buildings roofs. The storage volume is about 4,000 m^3 built totally underground. A heat pump system is foreseen to exploit the storage also during lower temperature periods.

Success factors	Challenges/barriers
- The success factor is the involvement of the stakeholders at different levels in the city management: in the planning activity with the participatory approach as well as in the most innovative implementations related to the ICT (Smart City Control Room) through the digital manifesto signed by all the companies involved in services management. - The continuous monitoring, supported by EU standard approaches and qualified technical support like the European Energy Award, is another key.	The lessons from Florence experience are related to the following three barriers: - Legal framework with long and binding procedures: the schedule of such projects has to comply with public procurement timing and that should be taken into account also in the definition of the incentives' income supporting the realisation - Investments availability, especially for implementations with indirect impacts ("externalities"): separating complex (and expensive) projects could spread investments and cash flows while highlighting indirect impacts and externalities in business models is becoming more and more important in such transversal projects (including energy efficiency, environmental impact, resilience, innovation, social inclusion & wellbeing ...) - Boundary conditions (historical, landscape, natural boundaries): another lesson is that some works have different costs in each nation/location and have to be tailored to the specific context, especially if boundary conditions include historical heritage or natural resources. Hereafter some specific hints for the single actions: - In case of the innovative Thermal Energy Seasonal Storage (TES) a site with less boundaries could be a cheaper option allowing the construction of new volumes (not underground or at least not totally) both for the storage and the technical rooms. Capacity building is needed for designers and plant managers as there are no national examples already in place. - The cost of the Smart Grid is the main barrier for the implementation, but if the action is included in a planning tool as enabler (for RES, e-mobility, users awareness, active demand management, ...) it could be easily deployed. The technology is quickly evolving and improving and this aspect must be taken into specific account while designing the extensions - For the fast recharging stations installation, the collection of all the competent bodies opinions has taken more time than expected, because of the bindings of Florence's cultural heritage and also of the new national rules on public tendering. The electric vehicles technology and the recharging procedure need training before the daily use. Some exchanging protocols between the fast recharging station and the different car models have to be tuned to work properly. There is a need of surveillance for the recharging infrastructure in some areas due to vandalism problems and to avoid unwanted parking. The energy tariffs for e-mobility are very different in the market and should be analysed in detail to find the best option for the different users. - Regarding IoT and Capillary Networks maintenance is a crucial issue. The Sensors deployed have to be maintained providing remote maintenance as much as possible. Each Sensor depending in the complexity shall be reachable both in VPN or directly using a public IP address. This will allow remote diagnosis and intervention. In case of very simple sensors it is mandatory to foresee a remote "OFF command" and "ON command" able to cut off power in such a way that the sensor can be shut down and restarted.

	- It should be highlighted that the Smart City Platform and the ICT related activities in REPLICATE are not achieving impacts by themselves, but they are the enablers for the other single actions in the different fields (energy management and smart metering in buildings and public lighting, e-mobility manager, traffic control, IoT, environmental monitoring, ...). For more details about city platform, please see REPLICATE Public Deliverable 4.6 "ICT Pilot Architecture". The Smart city control room should support city management and stakeholder engagement with its predictive capacity that sees in the passage from laboratory to reality its main challenge. - Cyber Security's activities assume complete investigations of the systems in object, for which vulnerabilities and weaknesses are highlighted. This process could be considered invasive for the investigated systems owners which can hinder cooperation. The hope is that thanks to Project on Smart City of future, like Replicate, the third millennium technological themes like Cyber Security can become better know so that society can be ready to face the IT security challenges of the coming years. - The city and its territory: the national legal framework and the local peculiar situation (cultural heritage) have deeply influenced the realisation schedule; these different boundary conditions ought to be taken into account in the replication plans - Technology development: innovation allows an easier access to services, a better use of the city and a higher quality of life and it has to be followed even if it evolves faster and faster. Technology implementation in a city should be aimed at providing useful services and not just for testing innovation – this is what "smart" means for Florence. The final aim of any innovative implementation should be always clear and monitored to obtain good performances impacting on citizens' quality of life. - Citizens participation, supported by the availability of enabling systems like the Apps or the smart benches and the communication panels, is a transversal basic condition for a city like Florence that considers the direct exchange and the interaction with its citizens the real answer beside any ICT supporting tool

43 Graz, Austria - My Smart City Graz - Smart City Project Graz Mitte

General information	
City	**Graz, Austria**
Project name	**My Smart City Graz - Smart City Project Graz Mitte**
Project status	planned ☐ **under construction** ☒ realized ☐ in operation ☐
Project start – end	01.07.2012 (innovation- and Research Project 30.06.2017 (innovation- and Research Project) Completion of the whole city district 2022
Contact	Kai-Uwe Hoffer, City of Graz
Project website	http://www.smartcitygraz.at; https://www.mysmartcitygraz.at/
Size of project area	Ha: 12,7
Building structure	**Newly built** ☒ Existing neighbourhood ☐ **Mixed** ☒
Land use	- Residential: 60%. student hostel, housing for all generations - Office: 7%. Offices for companies and research institutes - Commercial: 7%. Super Market, Shopes, etc. - Social: 6%. smart city school campus, nursery school etc. - Other: 20%. Parking spaces parking garages, basement spare rooms, etc. 
Financing	- Private: ca. 80%. Financing of residential buildings, partial financing of public space - Public: 18%. Financing of the Energy and Mobility Infrastructure, financing of public space (streets, squares, parks) Smart City School Campus - Research funding: 2%. Funding Smart City Pilot Project Smart City Project Graz Mitte

Overview description of the project

Smart City Project Graz Mitte is a project to demonstrate urban technologies for the use of renewable energy sources, but is also a spatially integrated, networked urban development project, which is located in the presently heterogeneous and multi-use urban district close to the main train station in the city of Graz. The goal is the innovative implementation of smart technologies to obtain a sustainable, livable and intelligent district with the lowest possible emissions (zero emissions as the target) and low resource consumption, which not only uses sustainable energy, but also aims for sustainable mobility and social mixing. The innovative Smart City district is currently under development following the quality standards agreed in urban development agreements. In total, about 1,400 residential units for approximately 3,900 people as well as office space for about 1,700 jobs will be provided by 2024 on the total development area of 12,7 ha. At present, design planning of the public space is being intensified, supported by enhanced citizen participation. The core part is the construction of a new district park covering the total area of approx. 11,500 m² as well as a public space north of the Science Tower. The park and the square are following a stepwise development process in line with the requirements of the public space competition, considering the ongoing and planned construction projects as well as the extension of the tram connection. After the opening of the Science Tower, the new student hall for 250 people, called "Cool City", is expected to be finished by the end of October 2017, whereby the "Cool City" residential complex will be handed over by the end

of 2017. Moreover, the City of Graz is building the new Smart City school campus for 600 students. This process is divided in two stages. Construction works of the primary school will take place between spring 2018 and autumn 2019 whereby the new secondary school will start its activities four years later in autumn 2023. The extension of the tram connection (line 6) is already in the submission phase; the construction decision is expected to be made in spring 2018 (commissioning by the end of 2020). The current construction projects account for total investment volume of around €330 million.

Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ **Energy neutral** ☒ **Energy efficient** ☒ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐
Indicators/expected impact	- Environmental - Societal - Social - Services - Economic - Spatial - Regulatory Notes: first smart city District in Graz and Austria
Overall strategies of city/municipality connected with the project	- Smart City Strategies - Urban Renewal Strategies - Energy Masterplanning
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ Refurbishment ☐ Sustainable production ☐ Sustainable consumption ☐ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	- Citizens, - Investors/real estate - Business - Research
Typology of energy supply	- Geothermal energy - District heating/local heating - Heat pump system - Photovoltaic

Success factors	**Challenges/barriers**
Construction of the Science Tower demonstrating technological innovations (Grätzel-Cell, geothermal buffer, energy grid, battery store, 24/7 PV-shading) as the lighthouse building for the future sustainable district Development of the District Energy concept 2.0 based on 100% renewable energies Development of Mobility measures Specification and securing of finance for further phases of construction - Development of new insights and models for integrated and holistic urban planning and development processes that can be transferred and applied to other districts and target areas in Graz	• Limited financial resources of the Cities • At the beginning of the project, limited knowledge for the initiation and development of smart city districts • Social and legal barriers • Complexity of a transdisciplinary urban development process • Long-term nature of an urban development process

44 Florina, Greece - DETEPA

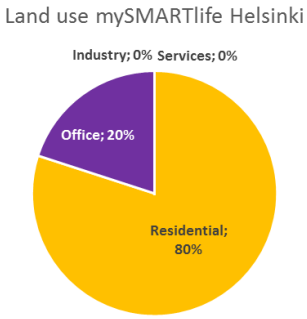
General information	
City	**Florina, Region of Western Macedonia, Greece**
Project name	**District Heating Municipal Company of Amyntaio (DETEPA), Greece – Building of a new biomass plant to cover thermal needs** Case provided by RHC/DHC+: https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf
Project status	planned ☐ **under construction** ☒ realized ☐ in operation ☐
Project start – end	10/2018 – 02/2020
Contact	Dr. N. Margaritis, Dr. P. Grammelis, E. Karampinis
Project website	https://www.district-energy.gr/en/energy-en/energy-technologies-en/district-heating-en/district-heating-of-aminteo/ http://detepa.gr/dhca/
Size of project area	Existing buildings of villages of Amyntaio, Levaia, Filotas - 1850 connected buildings and 2.500 dwellings
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	Total floor space: ~58.000 m^2
Financing	The project envisages the construction of two thermal power plants with biomass of a total installed capacity of 30 MWth (2x15MW). The project cost is projected to amount to € 14.57 million including VAT and is financed (55%) by European Cohesion Policy funds through the NSRF (National Strategic Reference Framework) 2014-2020". The Special Development Program of the Region of West Macedonia is also contributing to the financing of the project with a capital grant of € 1.5 million. The project fully complies with the provisions of Directive 2012/27 / EU on Energy Efficiency (L.4422 / 2015) as an efficient district heating system, since it uses more than 50% renewable energy sources (RES). - Amount of funding >> 6,3 million - Municipality of Amyntaio own contribution >> 1,9 million - Regional Authority of Florina >> 1,5 million - Loan from District heating company >> 2 million

Overview description of the project
The core of the investment program for the DH system of Amyntaio is the installation of a new biomass combustion plant to serve Amyndeon's existing district heating system as well as its future extensions. The thermal energy production unit, the implementation of which has been launched, is a combustion of biomass with a small amount of lignite. It has a total capacity of 30 MW (2x15MW) and will cover the thermal needs of the existing district heating network in the villages of Amyntaion, Filotas, and Levaia as well as future thermal needs. The contract for the implementation of the project was signed on 2/10/2018 with the contractor HELECTOR SA.

Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐ To cover the thermal needs of the existing district heating network in the villages of Amyntaion, Filotas, and Levaia as well as future thermal needs. The existing district heating network is now utilizing the waste heat from lignite thermal power station of Amyntaio (PPC) which is expected to close by 2021.
Indicators/expected impact	**Economic:** Citizens of above villages will continue to have access to cheap district heating (in relation to use of heating oil devices) **Environmental:** Buildings of above villages will continue not to pollute the environment through the use of separate heating devices (oil boilers, wood stoves, fireplaces etc) **Societal:** New jobs are expected in the organization of biomass supply chain in the area
Overall strategies of city/municipality connected with the project	To expand the network to nearby villages (Xino nero, Sotiras); Purchase new funding opportunities (EU and national)
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	Workshops organized in the area regarding district heating from biomass
Typology of energy supply	District heating/local heating

Success factors	Challenges/barriers
- Funding for using RES in district heating systems - Willingness of Municipality to keep heating cheaply its citizens	- Significant biomass quantities required on yearly basis. Cost effective sourcing of biomass required in order to keep district heating cost at low level. Efforts needed to develop local biomass supply chains from agricultural and forest residues. Estimated required quantity: 11.700 tones/year (industry pellet) or 12.800 tones/year (corn residues)

45 Helsinki, Finland - mySMARTlife

General information	
City	**Helsinki, Finland**
Project name	**mySMARTlife**
Project status	planned ☐ **under construction/implementation** ☒ realized ☐ in operation
Project start – end	11/2016-11/2021
Contact	Marja Vuorinen, Esa Nykanen
Project website	**https://www.mysmartlife.eu/cities/helsinki/**
Size of project area (hectare)	mySMARTLife Interventions in Helsinki (BELOW : LINKS w text and pictures) • Merihaka and Vilhonvuori - Retrofitting Projects • Kalasatama High-Performance Residential Buildings • Viikki Environment House • Energy Projects • Smart Public Lighting • Solar Power Plant • E-Mobility • Helsinki Urban Platform
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use	- Residential: 80 % - Office: 20 % 
Financing	City of Helsinki and H2020.

Overview description of the project
The Lighthouse project mySMARTLife aims at making the three Lighthouse Cities of Nantes, Hamburg and Helsinki more environmentally friendly by reducing the CO_2 emissions and increasing the share of renewable energy. Three Fellow Cities of Bydgoszcz (Poland), Rijeka (Croatia) and Palencia (Spain) are involved to collaborate in the project and build their sustainability agenda. The interventions include innovative technological solutions in connection with energy refurbishments of buildings, usage of renewable energies, clean transport and supporting ICT solutions. The project aims for transformation towards more sustainable and inclusive cities allowing improved quality of life. **Helsinki´s demonstration area** Vanhankaupunginlahti (old Town Bay) is representing the history, present and future of smart energy systems in Finland. While the oldest hydroelectric plant in Finland is still producing electricity on the site, the world´s most eco-efficient coal-based electricity and heat co-generation plants and further modern power plants are situated right next to it. A major step forward was the recent decision by the City of Helsinki to phase out the current coal

power plant by 2024. MySMARTLife is involved in promoting the transition towards decentralised production and increasing the share of renewable energy sources.

In this high performance area, four zones of intervention for the 47 mySMARTLife actions, in Helsinki, can be identified:

- **Zone 1 ("Merihaka & Vilhonvuori" retrofitting area)** is the residential retrofitting zone where large retrofitting actions are taking place, including smart metering and control for heat demand response. This service will also be connected to the urban platform through IoT allowing a performance evaluation and thermal imaging e.g. to pinpoint heat loss and management and optimisation of the district heating and cooling.
- Activities in **Zone 2 ("Kalasatama" new construction area)** are focusing on the construction of a high-performance residential zone with smart home solutions, smart meters in all flats, the integration of renewable energy sources for example to the e-mobility charging network and utilising waste heat from individual sources.
- **Zone 3 (Viikki environment house)** comprises a high performance office building where the contribution of renewable energy sources will be maximised through a better control and power management.
- **Zone 4 (old town bay area)** covers the entire district and even city level. Several interventions, mainly mobility actions, will be implemented

Example pic merihaka:

https://www.mysmartlife.eu/fileadmin/_processed_/8/2/csm_helsinki-merihaka1_3afe08d7cd.jpg

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ Carbon-free ☐ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐
Indicators/expected impact	Example: Work in preparation has included collection of the baseline energy consumption data and estimation of the energy savings potential. VTT Technical Research Centre of Finland has performed a comprehensive technical and cost-efficiency study on suggested renovation measures for particular type of apartment buildings– information table embedded as pop-up clickable feature onto the model

	Merihaka apartment buildings) and the City of Helsinki has collected extensive data on buildings' energy information for open source use in the Energy and Climate Atlas as an integral part of the 3D City Model. https://kartta.hel.fi/3d/atlas/#/
Overall strategies of city/municipality connected with the project	Helsinki strives to reduce greenhouse gas emissions by 30 percent by year 2020 and by 60 percent by year 2030. The City of Helsinki's climate work is detailed on the pages on the Helsinki Climate Site. The goals are defined in the Helsinki City Strategy 2017–2021. Significant progress has already been made with continuous climate work. In 2017, Helsinki's emissions were 24% smaller than those in 1990, even though the number of residents had in- creased by 150,000. Per resident, the emissions were calculated to be approximately 42% smaller. However, in order to make Helsinki carbon-neutral, the emissions have to be reduced even more and faster than before. A carbon-neutral Helsinki is being created in collaboration between the residents, the City, businesses and organisations.  - The Carbon-neutral Helsinki 2035 Action Plan (pdf) - Carbon-neutral Helsinki 2035, Summary (pdf)
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ Sustainable production ☐ Sustainable consumption ☐ **(Local) Governance** ☒ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	Example: Helsinki uses in kalasatama (Zone 2) agile prototyping to harvest ideas from citizens. One practical idea in development is an App "Carbon ego" to be used in the daily life of a citizen to follow own carbon footprint. There will be functions like "challenges" to create social activities around the app.
Typology of energy supply	- Geothermal energy - District heating/local heating - Heat pump system - Industrial waste heat - Solar energy (crowdsourcing in panels for normal citizen)

Success factors	Challenges/barriers
The project technical actions are carried out within the first 3 years with an additional monitoring period of two years, during which time the energy consumption data is collected and energy savings potential further evaluated until the end of November 2021. The results and lessons learnt will be taken to practice on district level in other areas of the city. Engaging private stakeholders will continue in order to expand the collaboration network and influence the decision-making regarding energy saving investments. The main objectives on energy efficiency is to reduce consumption by 10 per cent in initial piloting and expand the learnings to further energy efficiency improvements.	The heating of buildings causes more than half of Helsinki's emissions. The greatest emission reduction potential lies in energy renovations: for example, when a building is renovated, it can be made significantly more energy-efficient than before. Emissions from buildings can be reduced by **80%.** Because only a small percentage of all buildings located in Helsinki are owned by the City, it is important to encourage residents and organisations to take part in reducing emissions. The buildings owned by the City hold **11%** of the emission reduction potential of the entire building stock of Helsinki. The majority of the measures to reduce emissions are financially attractive to building owners in the long term. They often improve liveability as well. Helsinki's plan to go around barriers is: • Providing advisory services to support Helsinki residents' energy renovations and increased use of renewable energy • Steering district planning more towards carbon neutrality than before • Steering people towards energy-efficient solutions and renewable energy through Building Control Services • Improving energy efficiency and increasing the use of renewable energy in the City's service and residential buildings • Taking the entire carbon footprint of construction into account and promoting wooden construction • Replacing outdoor lights with more energy-efficient alternatives • Making provisions for emission-free thermal and wind energy

46 Henningsdorf, Germany - Heat Hub Henningsdorf

General information	
City	**Hennigsdorf, Germany**
Project name	**Heat Hub Hennigsdorf** Case provided by RHC/DHC+: https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf
Project status	planned ☐ **under construction** ☒ realized ☐ in operation ☐
Project start – end	2017 – 2022
Contact	Stadtwerke Hennigsdorf GmbH
Project website	https://www.swh-online.de/aktuell/forschungsprojekte
Size of project area	800 hectares (municipality)
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	Mixed use (municipality)
Financing	To be able to finance this big project, different subsidy schemes were combined in a suitable way: funding of innovative technologies and realisations by the German Federal Ministry for Economic Affairs and Energy with 3.8 mio. Euro and credits from the Reconstruction Loan Corporation. The utility aims at selling CO2-neutral heat with stable prices in future.

Overview description of the project
The municipal utility company of Hennigsdorf aims at a district heating with 100 % renewable and CO_2-neutral heat in 2025. Until the year 2022 the share of CO_2-neutral heat in the district heating with a yearly heat demand of 120 GWh/a will be increased from 50 to 80 % within a lighthouse project. To reach this target, waste heat from the local steelworks, large solar thermal collector fields as well as power-to-heat from renewable surplus electricity production of wind turbines are on the way to be integrated into the district heating net. Biomass driven combined heat and power plants are already used to about 50 % of the annual heat load. To be able to operate the district heating with fluctuating waste and solar thermal heat, the entire network has to be developed to a heat hub by integration of two heat storages of 1,000 and 22,000 m^3. In addition, the reduction of the flow and return temperatures in the district heating network is supported by efficiency measures on the consumer side of the existing buildings.

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐ CO_2 neutral district heating network for an entire city with 9,800 dwellings (share of about 80 %) and 100 buildings for commerce and industry with a heat demand of 120 GWh/year.

Indicators/expected impact	**Economic:** The entire project comprises investments of about 15 million Euro within 5 years. The project is funded by the German Federal Ministry for Economic Affairs and Energy due to its lighthouse character for multiple cities with comparable situations. **Environmental:** The heat demand of most of the entire city is going to be transformed from coal fired plants to a heat hub that integrates waste heat and different renewable energy sources with a reduction of CO2-emissions to zero. **Societal:** The customers of the district heating network comprise all social classes due to the fact that the district heating network is connected to most of the buildings in the city. All inhabitants of the city of Hennigsdorf benefit in the same way and to the same extend of the project: their heat demand will be delivered CO2-neutral in 2025 with a first step to reach a renewable part of over 80 % per year in 2022.
Overall strategies of city/municipality connected with the project	Since 2006 the overall strategy of the city of Hennigsdorf and the utility is to reinvest in CO_2-neutral heat production technologies. In 2015 a climate protection strategy was decided by the municipal council, which is geared to the climate protection plan 2050 of the German Federal Government aiming at a greenhouse gas neutrality of all sectors. To legally separate the district heating network and the heat generation, a new project company was founded and the utility began to sell its heating plants to this company. In a first step in 2009 and 2012, a woodchip CHP with ORC technology and a biogas CHP were realized by the project company. At the same time, the different parts of the district heating network were linked and combined to one network. About half of the overall heat demand is provided by these two plants with CO_2-neutral heat. Until 2022 the share of CO_2-neutral heat is to be increased to more than 80 % as an intermediate step. The completion of 100 % of CO_2-neutrality will be reached in 2025.
Which factors have been included in implementation strategies?	Local (renewable) resources ☐ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ Sustainable consumption ☐ (Local) Governance ☐ Legal framework ☐ **Business models** ☒ - Use of waste heat from the local steelworks (2019) - Increase of solar thermal heat production (central and decentral) - Use of power-to-heat from renewable surplus electricity - Optimisation of the efficiency of the district heating network and the consumer substations - Dismantling of all old heating plants still burning coal and oil - Realisation of a multifunctional heat storage with 22,000 m³ and a buffer tank with 1,000 m³ water volume - Development of a smart system control for the entire heat hub
Innovative stakeholder involvement strategies	The entire project is based on a climate protection strategy that was developed together with the citizens. The Heat Hub Hennigsdorf is based on decisions of the municipal council. All citizens participate at the project by the connection of their dwelling to the district heating net.
Typology of energy supply	District heating/local heating

Success factors	Challenges/barriers
- The project Heat Hub Hennigsdorf put in practise the formal decision of the municipal council of Hennigsdorf for an environmental friendly town. The project is attached to other ones that regard a CO_2-neutral electricity production by wind mills in the region around the city. - A well-rehearsed local project team of technical and project consultants is completed by a research institute that has comprehensive experience in consulting and realizing innovative systems like the Heat Hub Hennigsdorf. This team is supported by the management board of the utilities and the municipal council that are willing to make strong decisions for a long term system change.	- Although a bunch of innovations is in the Heat Hub Hennigsdorf, most regulatory barriers are raised by the state-of-the-art and existing laws like the cost for using surplus renewable electricity of wind mills, the tunneling of a railway, project coordination with a very lot of different companies etc. - Financing of this big project by a mid-sized utility is a challenge due to risk management of the banks. - To sign a contract for industry waste heat delivery over 10 years with the local steelworks. - The complexity of the task to develop a district heating system with 120 GWh/a to CO2-neutrality.

47 Hoje-Taastrup (Østerby), Copenhagen region, Denmark – COOL DH

General information	
City	**Hoje-Taastrup (Østerby) – Copenhagen region , Denmark**
Project name	**COOL DH –** Cool ways of using low grade Heat Sources from Cooling and Surplus Heat for heating of Energy Efficient Buildings with new Low Temperature District Heating (LTDH) Case provided by RHC/DHC+: https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf
Project status	planned ☐ **under construction** ☒ realized ☐ in operation ☐
Project start – end	October 2017 – September 2021
Contact	Reto Michael Hummelshoj / COWI Gabriele Pesce / Euroheat & Power
Project website	http://www.cooldh.eu/
Size of project area	The network will serve an area of terraced houses with 158 dwellings. The LTDH network will eventually be expanded in the neighbouring areas with 350 houses (36,000 m²),
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use	36,000 m² + In Høje-Taastrup, the results of COOL DH will be used for designing a new urban development of 250,000 m²
Financing	The project will contribute to reduce costs of heating supply, which means that collective DH supply can reach out further and compete with local supply based on natural gas and heat pumps, especially in areas where buildings are energy renovated or in areas where new energy efficient buildings are constructed. The cost savings derive from the low marginal cost of purchasing low-grade energy. By connecting to larger DH systems, it will further be possible to export excess energy during the summer to pre-heat the return of the larger DH system. To encourage the consumers to modify their installations for LTDH supply, the COOL DH project will offer a new tailored beneficial tariff structure. One task of the project is dedicated to the searching for the most suitable business model including terms for new LTDH tariff promoting energy efficiency, flexibility in supply options and ensure low return temperature, since this is vital for an efficient performance of the waste heat recovery. The business plan looks into new possible price models and contract boundaries, where the utility may own and operate substations including possible heat pump and main pipes in the building, and ensure regular inspections and heat supply at competitive cost.

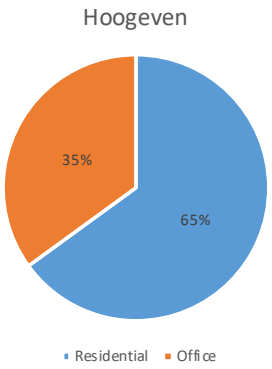
Overview description of the project
The COOL DH project will innovate, demonstrate, evaluate and disseminate technological solutions needed to exploit and utilise sources of very low-grade “waste” heat for heating of energy efficient buildings via Low Temperature District Heating (LTDH) and show how the District Heating (DH) systems can be more resource efficient and more energy efficient. The demonstration covers both new developments and stepwise transition of existing areas with district heating and energy retrofitting of buildings. The COOL DH consortium consists of the utilities and municipalities of the two cities Lund (SE) and Høje-Taastrup (DK) and leading DH energy specialists as well as leading industrial manufacturers.

Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐ The present project on utilising a larger share of low-grade surplus heat and increasing system efficiency is an important step of reducing emissions even further from the present level of 98 kg/MWh CO_2 emission (2015). The surplus heat will be harvested from various sources. The surplus heat derives from: - Cooling machines at the CITY2 Mall that will operate on power from more than 16,358 m² PV plant with an installed capacity of 2.07 MW (the so far largest roof mounted PV plant in the Nordic Countries of Europe). - Cooling machines and cooling of servers at the Danske Bank data centre, DSB and hotels having a high cooling demand year-round. At the moment in Høje-Taastrup the DH is based on 49 % fossil and the CO_2 emission factor is 98 kg/MWh (2015). Alongside a coalfired CHP-plant called Amagerværket, in the neighbouring city of Copenhagen, will undergo a transition to use biomass during the actual project period. The demonstration project in Høje-Taastrup is interlinked to the other COOL DH demo site in Lund which is totally fossil-free. The biomass waste heat freed in Sweden will supply the Danish side. This means that the COOL DH project will reduce the fossil fuel consumption in Høje-Taastrup and in Lund. The recovered waste heat of 10 GWh per year a consumer will liberate 5,000 tons of biomass yearly.
Indicators/expected impact	**Economic:** The new LTDH supply will be tariffed according to actual costs, but is based on experience expected to be 10-25% cheaper in variable cost depending on temperature level. The project will be calculated on basis of the present DH market price, from which CAP-EX and O&M-EX for the total at the consumers are subtracted. This will define the earned margin. **Environmental:** The yearly energy saving based on recovery of low grade waste heat is estimated at 10 GWh p.a; Each 1 MWh utilised low grade waste heat will save 1 MWh primary energy; Utilised low grade waste heat will marginally save 300 kg CO_2 /MWh; In Høje-Taastrup the share of renewables will be increased from 51% to 90% for the served area. **Societal:** The project will contribute to reduce costs of heating supply, which means that collective DH supply can reach out further and compete with local supply based on natural gas and heat pumps, especially in areas where buildings are energy renovated or in areas where new energy efficient buildings are constructed. COOL DH will demonstrate secondary effects of efficiency improvement in operation of cooling systems that supply the low-grade heat to the LTDH systems and other quality of life improvements on reduced emissions and tertiary use reducing costs of snow clearance and increasing green season of plants in the science village area.

Overall strategies of city/municipality connected with the project	Høje-Taastrup Municipality has worked with environmental and energy policies for many years and published an updated climate plan in 2015. The municipality has committed itself to the requirements set up by the Danish society for Nature Conservation, i.e. requiring a minimum of 2 % reduction of CO_2 emissions per year on a continuous basis. Over the last ten (10) years, the municipality (geographically) has reduced its CO_2 emissions by more the 3 % each year! The work with reducing the emissions derives partly from the former EU supported ECO-Life project under the Concerto initiative. This project led to a Danish project called Høje-Taastrup Going Green, supported by the Danish Energy Authority, and included investigations of the elements for this present project and the provision of legislative approvals. Høje-Taastrup is one of the most sustainable municipalities in Denmark and is the only municipality that has received support to demonstrate the implementation of an accelerated transition to a fossil free future in a cost effective way. The district heating supply in Høje-Taastrup is getting greener and greener every year. In 2015, the supply consisted of 51 % fossil free energy from biomasses, the renewable part of waste, solar, geothermal energy etc. In Høje-Taastrup, the results of COOL DH will be used for designing a new urban development of 250,000 m² with all facilities including homes for 3,000 new inhabitants. The name of this development is "Nærheden", and the LTDH system will fully serve the district. In addition, existing settlements of multifamily blocks are facing deep energy refurbishments and in connection with this, the heating systems will be converted to LTDH district by district. Furthermore, the new town hall, new residential buildings (social housing) and new and existing offices in Høje-Taastrup C (downtown) will also be connected to the LTDH system.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ Sustainable consumption ☐ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	The District Heating company "Høje Taastrup Fjernvarme" is in charge of the implementation of LTDH. The utility was founded in 1992 and is owned by the consumers as a cooperative. Generally, the public authorities pay a lot of attention to the citizens acknowledgement about the development of the project's works through a constant communication activity.
Typology of energy supply	District heating/local heating, Heat pump system

Success factors	Challenges/barriers
- The project proposal will be approved by the authorities based on calculation of societal benefits excluding taxes and fees but including value of environmental externalities - The project is one of the most innovative in the field of DH and the framework in which is being implemented is already demonstrated at large-scale. The whole project is a best practice in term of share of RES and rate of CO_2 neutrality.	- Proposed concepts do not show technical and economic viability - Variations in heat supply

48 Hoogeveen, The Netherlands - Hydrogen district Hoogeveen

General information	
City	Hoogeveen (The Netherlands)
Project name	**Hydrogen district Hoogeveen**
Project status	planned ☐ **Implementation stage** ☒ realized ☐ n/a ☐
Project start – end	2018-2020
Contact	**Jan-jaap Aué**
Project website	https://www.en-tran-ce.org/ ; https://www.hoogeveen.nl/waterstof(dutch)
Size of project area	Ha: 8
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use (%)	- Residential: 65%. 80 new homes will be developed in this new district, all running their heating on 100% hydrogen - Office: 35% A local industrial area adjacent to the newly developed district is being investigated as a potential renewable energy hub for local renewable production, conversion to green hydrogen and (limited) storage of green hydrogen. 
Financing	- Public-Private: 100%. The current project is a co-production of industry, municipality and research institutions working closely together.

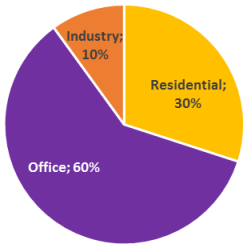
Overview description of the project
The Dutch municipality of Hoogeveen is developing a new location with 80 houses at the west side of the city of Hoogeveen; Nijstad-Oost. With this development, the municipality wants to contribute to the energy transition in the Netherlands, especially focused on building new houses which do not require naturals gas as its main resource for heating. With it arises a unique opportunity in which this project is an important link. The goal of this project is to deliver a (techno-economic) blueprint and corresponding technology concept for the heat supply of the 80 houses in Nijstad-Oost on 100% hydrogen (H2), based on operating with a hydrogen central heating boiler. Finally, this blueprint and technology must be transferable and scalable for existing residential areas in the Netherlands. Besides the nationwide reduction of natural gas use, market opportunities are being created for the involved parties. There are also other topics and aspects included in the blueprint besides the technological developments, such as the social business case, sourcing strategy and the support amongst the residents. This approach will be set off with other hydrogen related solutions (fuel cells, local heat network, etc.), in order to gain insight on the pro's and cons of the blueprint and accompanying solutions. This project does not stand on its own, Nijstad-Oost is a demonstration project which serves as a pilot and an accelerant for the application of hydrogen in the built environment. The reason the project does not immediately start with converting and retrofitting existing buildings, is because of the fact that it wants to begin from a green meadow in order to create an organized and controlled environment which is comparable with the already existing built environment (in terms of infrastructure and equipment). From this controlled environment we want to create a sense of security and acceptance which is the starting point to existing buildings, the adjacent district Erflanden, for which 2,000 houses are aimed to be heated through Hydrogen. The key challenge of the project is focused on creating new residential areas without having

the need for natural gas as the key energy carrier to supply heating and to make urban areas more sustainable. Experiences from this project are also used to work on retrofit hydrogen CV boiler solutions for the existing residential areas. Subsequently, step-by-step blending tests shall be executed with the final goal: 100% hydrogen

Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ Energy neutral ☐ Energy efficient ☐ **Carbon-free** ☒ Climate neutral ☐ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐ Notes: The goal of this project is to deliver a (techno-economic) blueprint and corresponding technology concept for the heat supply of the 80 houses in Nijstad-Oost on 100% hydrogen (H2), based on operating with a hydrogen central heating boiler. Finally, this blueprint and technology must be transferable and scalable for existing residential areas in the Netherlands. Besides the nationwide reduction of natural gas use, market opportunities are being created for the involved parties. There are also other topics and aspects included in the blueprint besides the technological developments, such as the social business case, sourcing strategy and the support amongst the residents.
Indicators/expected impact	- Environmental - Economic - Spatial Notes: The concept should contribute the decarbonizing the energy system and making city area's emission free. Economically a sound business case is pursued.
Overall strategies of city/municipality connected with the project	- n/a
Which factors have been included in implementation strategies?	- Local (renewable) resources - Regional energy system - Mobility - Buildings - Sustainable production - (Local) Governance - Legal framework - Business models Notes: the project aims at developing an "integral "blueprint, not only focussing at technology.
Innovative stakeholder involvement strategies	- Citizens - Industry - Business - Other: municipality Notes: the project is a public – private partnership where industry, municipality and research institutions work closely together. Citizens are involved via public stakeholder meetings aimed at potential inhabitants of the district.
Typology of energy supply	- Photovoltaic - Other: renewable energy from solar and wind converted to green hydrogen Notes: Renewable power sources are converted to green hydrogen. In the first stage off location, with transport to the district. Next step will be local production and conversion.

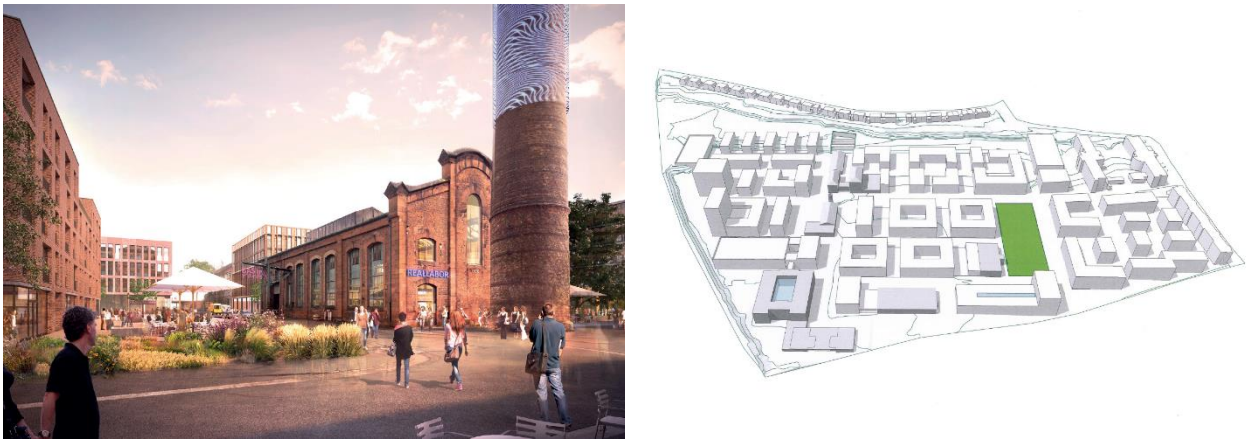
Success factors	Challenges/barriers
- The project embraced open innovation from the start o: open invitation to parties to join and share knowledge. Secondly close cooperation between industry, municipality and research institutions. Thirdly open information to citizens, being potential home owners	- The main bariere A hydrogen gas flow meter or monitoring system which is suitable for usage in residential environments taking into account retrofit possibilities Retrofit household appliances (like e.g. furnace, stove, boilers etc.) for which hydrogen can be used to operate/power them Cost-efficient hydrogen compression and storage solutions Cost-efficient electrolyser with smart power system Odour suitable to be mixed with hydrogen which is either divergent (or with equal smell) from the odour applied to/mixed with natural gas Regulatory and legal issues dealing with hydrogen in the built environment Safety and hazard issues related to hydrogen production, distribution and in particular utilisation within the houses

49 Kaiserslautern, Germany - EnStadt:Pfaff

General information	
City	**Kaiserslautern, Germany**
Project name	**Pfaff-Quartier** (district development) **EnStadt:Pfaff** (accompanying scientific project))
Project status	**planned** ☒ **under construction** ☒ realized ☐ in operation
Project start – end	10/2017 – 09/2022
Contact	Dr. Stefan Kremer, PEG (district development) Bettina Dech-Pschorn, City of Kaiserslautern (leader EnStadt:Pfaff) Gerhard Stryi-Hipp, Fraunhofer ISE (scientific leader EnStadt:Pfaff)
Project website	www.pfaff-reallabor.de / www.pfaff-quartier.de
Size of project area	18 ha
Building structure	**Newly built** ☒ Existing neighbourhood ☐ **Mixed** ☒
Land use	- Residential: ca 30% - Office, research, culture: ca 60% - Industry: ca 10% Land use EnStadt:Pfaff, Kaiserslautern 
Financing	The development of the district is pre-financed by the city (public), supported by the federal state of Rheinland-Pfalz and will be refunded by selling the construction ground. The accompanying research project EnStadt:Pfaff is jointly funded by the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Education and Research.

Overview description of the project
The City of Kaiserslautern plans a climate neutral district on the area of the former sewing machine factory Pfaff close to the city centre. The German federal ministry for economy affairs and energy together with the ministry of education and research funding the project EnStadt:Pfaff, which is a Reallabor (living lab), in which innovative technologies in the fields of energy, buildings, mobility and ICT are developed, demonstrated, evaluated and optimized in the first construction phase of the Pfaff-Quarter. In addition, socio-economic research is executed on aspects of acceptance and participation of the stakeholder in the quarter and a living lab centre (Reallabor-Zentrum) is implemented with an exhibition, a living lab workshop and an electric vehicle and battery lab to demonstrate, explain, and work together in the sense of co-creation and co-design with the stakeholder of the district as well as interested stakeholders from the city and from outside the city. The project consists of nine partners led by the city administration and includes companies (investors, developer, utility) and research institutes (Fraunhofer, university of applied sciences).

Plan of the Pfaff-Quarter with existing buildings, which will be refurbished (red) and planned new buildings (white)



Rendering of the Living lab centre (left) and 3D animation of the quarter (Plan and images: ASTOC Mess)

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ Carbon-free ☐ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐
Indicators/expected impact	Environmental: CO_2-neutrality Social: high quality of live, inclusive, barrier-free A mission statement (Leitbild) was developed by the project consortium.

Overall strategies of city/municipality connected with the project	Energy Masterplanning: A Master plan 100% climate protection to become CO2 neutral by 2050 was adopted by the city council in 2017. https://www.kaiserslautern.de/sozial_leben_wohnen/umwelt/klimaschutz/masterplan/index.html.de
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ **Materials** ☒ **Refurbishment** ☒ Sustainable production ☐ Sustainable consumption ☐ **(Local) Governance** ☒ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	Stakeholders are involved in the planning process by public measures (Beteiligungsverfahren zum Bebauungsplan) as well as by actions of the socio-economic researchers of the project, which e.g. did a survey to identify, how the Pfaff-Quarter must be designed to meet the specific needs of start-ups.
Typology of energy supply	Photovoltaic, industrial waste heat from a company close by the quarter at medium temperature, heat pumps

Success factors	Challenges/barriers
- Integrated planning (urban planning, planning of energy and mobility infrastructure) - Integrated technical solutions - Stakeholder participation supported by socio-economic research	- Long planning processes (input on an early planning phase necessary) - Development of a joint mission - Regulative framework - Limited local renewable energy resources

50 Lund, Sweden - Brunnshög

General information	
City	**Brunnshög/Lund, Sweden**
Project name	**COOL DH –** Cool ways of using low grade Heat Sources from Cooling and Surplus Heat for heating of Energy Efficient Buildings with new Low Temperature District Heating (LTDH)
Project status	planned ☐ **under construction** ☒ realized ☐ in operation ☐
Project start – end	October 2017 – September 2021
Contact	Reto Michael Hummelshoj / COWI Göran Strandberg / Kraftringen
Project website	http://www.cooldh.eu/
Size of project area	100 hectare (world's largest LTHD network)
Building structure	**Newly built** ☒ **Existing neighbourhood** ☒ **Mixed** ☒
Land use	n/a
Financing	Soft loans over 50 years are used for building works. The housing companies finance the RES supply for the selected demo blocks. The public utility including 3rd parties finances the part of costs not covered by EC grant. The project will contribute to reduce costs of heating supply, which means that collective DH supply can reach out further and compete with local supply based on natural gas and heat pumps, especially in areas where buildings are energy renovated or in areas where new energy efficient buildings are constructed. The cost savings derive from the low marginal cost of purchasing low-grade energy. One task of the project is dedicated to the searching for the most suitable business model including terms for new LTDH tariff promoting energy efficiency, flexibility in supply options and ensure low return temperature, since this is vital for an efficient performance of the waste heat recovery. The business plan looks into new possible price models and contract boundaries, where the utility may own and operate substations including possible heat pump and main pipes in the building, and ensure regular inspections and heat supply at competitive cost.

Overview description of the project
The COOL DH project will innovate, demonstrate, evaluate and disseminate technological solutions needed to exploit and utilise sources of very low-grade "waste" heat for heating of energy efficient buildings via Low Temperature District Heating (LTDH) and show how the District Heating (DH) systems can be more resource efficient and more energy efficient. The demonstration covers both new developments and stepwise transition of existing areas with district heating and energy retrofitting of buildings. The COOL DH consortium consists of the utilities and municipalities of the two cities Lund (SE) and Høje-Taastrup (DK) and leading DH energy specialists as well as leading industrial manufacturers.

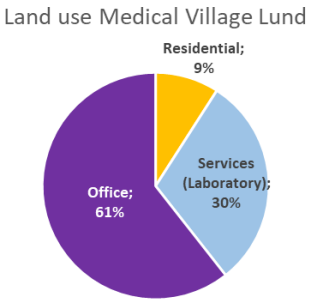
Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒

	Sustainable neighbourhood ☐ Social aspects/affordability ☐ Brunnshög district area will host the research facilities of MAX IV and European Spallation Source, ESS and Science Village Scandinavia. The main objective is to use the surplus heat from these research centers to increase the decarbonisation of the whole district heating network of Lund. In particular the project addresses use of low-grade heat sources by focusing on the huge amounts of low temperature surplus heat that is available from cooling of these facilities. Moreover, the buildings are powered by CO_2 neutral sources as it to a large extend is based on Wind power & Hydro power. The project addresses the use of these low-grade heat to heat buildings with high energy efficiency that can use the energy at very low temperatures i.e. <40oC mean temperature (5^{th} Generation DH) for space heating combined with decentral temperature topping to 45-50oC for the part used for preparation of DHW using renewable energy sources. The houses served are designed to have a primary energy consumption of 40-45 kWh/m² p.a. The project will also show how existing buildings in Lund after energy refurbishment can adopt to LTDH enabling a district by district to convert to LTDH.
Indicators/expected impact	**Economic:** The new LTDH supply will be tariffed according to actual costs, but is based on experience expected to be 10-25% cheaper in variable cost depending on temperature level. But CAPEX will be higher. The cost of the surplus heat is zero or even (as there is a saved cost of not having to operate a heat sink at the source). The project will be calculated on basis of the present DH market price, from which CAP-EX and O&M-EX for the total at the consumers are subtracted. This will define the earned margin. The earned margin will serve the DH users collectively leading to a competitive lower overall cost than for the present DH system, which represents best available solution existing today. **Environmental:** The yearly energy saving based on recovery of low grade waste heat is estimated at 10 GWh p.a; Each 1 MWh utilised low grade waste heat will save 1 MWh primary energy; Utilised low grade waste heat will marginally save 300 kg CO_2 /MWh; In Lund the share of renewables will be increased from 98% to 100%. **Societal:** The project will contribute to reduce costs of heating supply, which means that collective DH supply can reach out further and compete with local supply based on natural gas and heat pumps, especially in areas where buildings are energy renovated or in areas where new energy efficient buildings are constructed. COOL DH will demonstrate secondary effects of efficiency improvement in operation of cooling systems that supply the low-grade heat to the LTDH systems and other quality of life improvements on reduced emissions and tertiary use reducing costs of snow clearance and increasing green season of plants in the science village area.

Overall strategies of city/municipality connected with the project	The municipality has a political goal to reduce its environmental and climate impact substantially. Between the years of 1990 – 2020 Lund will decrease the total amount of GHG emissions by 50 %. In 2050 the GHG emissions should be nearly zero. The municipality has six overarching goal areas where one is to decrease its environmental and climate impact substantially. In this way, the expansion of the city can take place without increasing the GHG emissions and the biomass presently used in the district heating system will be released to replace fossil fuels where this is used today. As in many other Swedish cities, district heating started up in the 1950's and the district heating system now covers almost the entire city. The main heat production unit is a large scale biofuel based CHP facility. Other important production units are a large scale geothermal system, a heat pump for recovery of heat from sewage water, district cooling heat pumps and other renewable energy sources. Kraftringen has the ambition to be completely free from fossil fuels in all heat production, and the production in Lund is fossil-fuel-free already today. Expansion of the city will call for more non-fossil energy sources to be integrated and utilised in the system such as low-grade waste heat. The sustainability framework for the municipality of Lund is called Lundaeko. This framework is structured into eight different focus areas: Involvement, sustainable consumption, clean water and clean air, minimizing climate impact, decreasing chemical stress on the environment, sustainable city, climate change adaptation and biological diversity. The different focus areas are taken into account in the yearly planning process of the municipality. The yearly progress is described and evaluated in a sustainability report and is processed in an evaluation with top city managent and decisionmakers. Internal and external revues are performed on a regular basis.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ Sustainable consumption ☐ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	The development of the area is being implemented by the Lund-owned utility Kraftingen. Lund municipality is one of the main partner and sponsor of the project. Generally the public authorities pay a lot of attention to the citizens acknowledgement about the development of the project's works through a constant communication activity. Specific tasks of the project focus on the relation with the citizens.
Typology of energy supply	District heating/local heating, Heat pump system

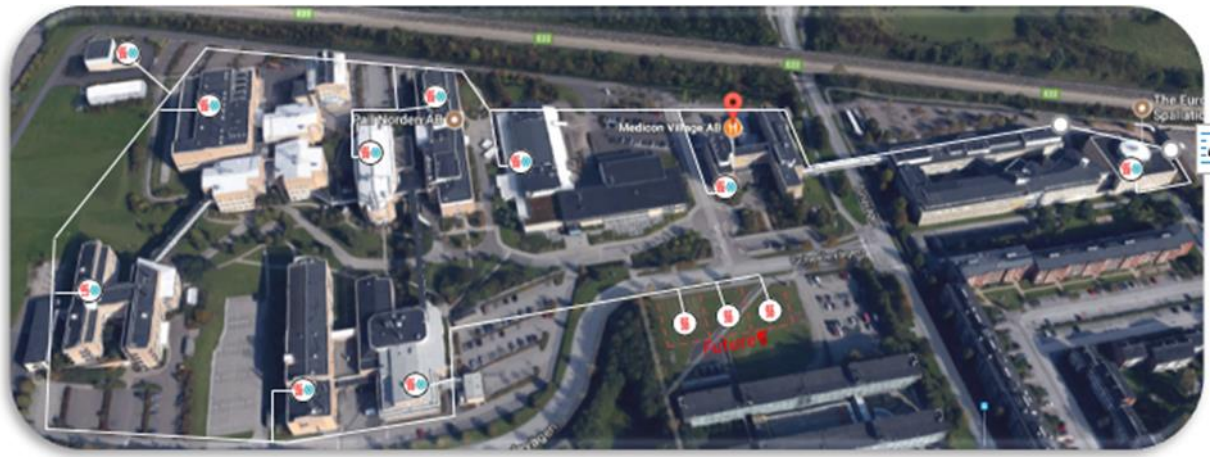
Success factors	Challenges/barriers
• The project proposal will be approved by the authorities based on calculation of societal benefits excluding taxes and fees but including value of environmental externalities • The unregulated sector results in a competitive market. The economic feasibility of this project therefore depends on cost awareness combined with a successful marketing/selling strategy.	• The Swedish heating sector, including district heating, is unregulated. • The unregulated market means sometimes heavy competition. Establishing district heating infrastructure in a new city development results in planning problems regarding the exact location of the piping network, since the roads haven't been planned in detail in all parts of the area.

51 Lund, Sweden - Medicon Village

General information	
City	**Lund, Sweden**
Project name	**COOL DH –** Cool ways of using low grade Heat Sources from Cooling and Surplus Heat for heating of Energy Efficient Buildings with new Low Temperature District Heating (LTDH)
Project status	planned ☐ **under construction** ☒ **realized** ☒ in operation ☐
Project start – end	2017 – 2020
Contact	Nilton Chan / Sonny Strömberg
Project website	http://ectogrid.com/use-cases/medicon-village/
Size of project area	~ 135.000m2 (floor space)
Building structure	**Newly built** ☒ **Existing neighbourhood** ☒ **Mixed** ☒
Land use	• Residential: 12.000m2 • Office: 80.000m2 • Industry: - • Services (Laboratory): 40.000m2 
Financing	Due to the high efficiency of the ectogrid™ system the main components of the new energy infrastructure is commercially viable and financed by the customer. As ectogrid™ for Medicon Village is a demonstration project, there are some additional financial risks and development of technical features that have been supported by the Swedish Energy Agency. 2 business models: 1) Good Neighbor™ Energy Partnership Agreement with Building owners (Customer X) - Customer X and E.ON enters in to a framework partnership agreement. - Customer X and E.ON agrees on a specific site, which will be an appendix to the framework agreement. - E.ON creates the PPP with the city and the energy customers. - EON invests, builds and operates the system. (Customer X may choose to co-invest but does not need to be active) - Customer X and E.ON shares the profits 50/50 after the investment is recovered. 2) Good Citizen™ Energy Delivery Agreement with Con/prosumers - Contract specifies terms and conditions for delivery of surplus energy - Energy price and local commercial specifications - Local site specific terms and conditions - Local technical specifications

Overview description of the project
Medicon Village in Lund was setup by the Mats Paulsson's foundation for Research, Innovation and Societal Development, to house more than 1600 persons in organizations dedicated to improve people´s health and lives. After the current expansion, it will consist of some 140.000m2 with ~15 GWh/year heat and 5 GWh/year chill demands. The ectogrid™ by EON at Medicon Village will connect 15 commercial and residential buildings with different heating and cooling needs.

This cutting-edge technology for tomorrow's sustainable cities connects customers with different thermal needs and utilizes waste heating and cooling between buildings, further increasing the efficiency of the energy system. The ectogrid™ has the potential to balance as much as 11 GWh of the current 10 GWh heating and 4 GWh cooling. This means the solution will use as little as 3 GWh of supplied energy, a reduction of 78.5% of the energy supply. The customer in Medicon Village will see their energy prices reduced by ca. 20%.



Steps:

- 2012: AstraZeneca hand over the keys to Medicon Village
- 2012 onwards: about 70 players have moved in comprising 570 people
- 2013: Lund University moves 200 researchers to Medicon Village
- 2015: Start of EON involvement in development and deployment of Ectogrid solution
- 2017: Agreement for ectogrid™ signed
- 2018: First buildings connected to ectogrid™
- 2020: ectogrid™ for Medicon Village is finalized, including for the new built buildings

Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐ Medicon Village expects major energy gains - it estimates it can reduce the amount of energy used per year to cover its heating and cooling needs from 16 GWh to 4-5 GWh by balancing energy flows within and between its properties. There are plans to complement these efforts with solar power on the large roof surfaces to make the area even more sustainable. The ability to circulate, reuse and share the energy within the buildings fits the mindset of Medicon Village's tenants who are committed to research and innovation in life sciences, and have strong desire to reduce the environmental footprint of the area as far as possible.
Indicators/expected impact	**Economic:** ~20 % reduction of energy costs **Environmental:** ~75% reduction on supplied energy compared to conventional heating and cooling systems With the ambition to have 100% local renewable electricity on site, it can be truly zero-emission energy system. **Societal:** The previously restricted pharmaceutical company facility is opened up for mixed use facilities where citizens, students, office workers share the space, allowing increased integration of different social groups

Overall strategies of city/municipality connected with the project	The sustainability agenda is highly important for the city in all development and daily operations. The city strategy is to increase the density of existing city areas in order to grow the city with minimal impact on valuable surrounding agriculture land. The city has also high ambitions for sustainable energy solutions where the ability of the ectogrid™ system to make use of low temperature surplus heat is of great value.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	The planning process is highly transparent and open for all citizens to follow and the citizens are also asked for input on city development projects.
Typology of energy supply	District heating/local heating, Heat pump system

Success factors	Challenges/barriers
• Motivate and support city scale sustainable energy solution on national and local levels. • The collaboration between E.ON and Medicon Village originated in Future by Lund, Lund Municipality's Vinnova-funded platform. The platform brings together over 60 participants from companies, municipalities and businesses to work with smart and sustainable cities. Within the group, different collaborations are being created to find new solutions and innovations that have not been possible for a single actor. • To the estate developers, ectogrid is superior to other solutions such as district heating because it balances energy needs sustainably with low investment costs. • To the city, save costs on heating and cooling, ectogrid is more advanced than classic district heating because it is more sustainable and lower in operating costs.	• The sharing of energy on commercial terms between different organizations is to some extent hindered by the current regulations. For Medicon Village it is handled by one party responsible for the overall commercial set up and the energy balance of the system, with no financial transactions between the organizations related to the exchange of heating/cooling. • Ongoing site development, the lead time for customer discussions to connections and the fluctuation of energy demands have impact to the design of Ectogrid and its energy management system for optimum energy saving and efficiency gains.

52 Malmö, Sweden - Klimatkontrakt Hyllie

General information	
Cities	**Malmö**
Project name	**Klimatkontrakt Hyllie**
Project status	planned ☐ **implementation stage** ☒ realized ☐ in operation ☐
Project start – end	2011 – 2020
Contact	**miljo@malmo.se**
Project website	http://www.hyllie.com/in-english.aspx
Size of project area (hectare)	Ha: 200
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use	n/a
Financing	n/a

Overview description of the project

The new development area Hyllie in Malmö, Sweden has the aim to be the most climate smart district in the region. The municipality works together with the private energy company and the public waste and water company to meet the environmental targets set up for 2020. When fully developed, Hyllie will host 12.000 dwellings and 15,000 people will work in the area

Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ Energy neutral ☐ Energy efficient ☐ **Carbon-free** ☒ Climate neutral ☐ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐
Indicators/expected impact	Areas of impact: - Environmental - Societal - Spatial
Overall strategies of city/municipality connected with the project	- Urban Renewal Strategies - Energy Masterplanning

Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ Sustainable production ☐ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ Business models ☐
Innovative stakeholder involvement strategies	- Investor/real estate
Typology of energy supply	**Solar thermal energy** ☒ **Geothermal energy** ☒ **District heating/local heating** ☒ **Heat pump system** ☒ **Industrial waste heat** ☒ **Photovoltaic** ☐ n/a ☐

Success factors	**Challenges/barriers**
- n/a	- n/a

53 Munich, Germany – Werksviertel München

General information	
City	**Munich, Germany**
Project name	**Werksviertel München** Case provided by RHC/DHC+: https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf
Project status	planned ☐ **under construction** ☒ **realized** ☒ in operation ☐
Project start – end	City: 2001 onwards EON: 2015 -2024 Construction mostly completed in 2020
Contact	Nilton Chan / Matthias Philipp
Project website	https://werksviertel.de/?page_id=410&lang=en
Size of project area	1000m2 (energy centre)
Building structure	**Newly built** ☒ **Existing neighbourhood** ☒ **Mixed** ☒
Land use	~390,290 m² development area, housing 3000 people within the ~90,000 m² energy supply area.
Financing	City: The current land price of all plots within Werksviertel is estimated exceeding €500 million, after development. EON: The investment needs for the development of the energy system will amount to some €6.4m by 2019. EON: Supply contract from 2016 to 2037 Business model: EON: be the common energy company in the center of partnership with our customer. E.ON is owner of all assets and can take assets out of customer's building. Contract type: Full service contracting (heat & cold for climate and processes & LV power) for 21 years The price structure, having a price adjustment factor, is tariffs based for heat and cold, with standing charges.

Overview description of the project
The City prospective: A new mixed-use development for living, working, leisure and culture is being created in Werksviertel that will make Werksviertel the district of the future for Munich. The Werksviertel district will enrich the quality of life of the city of Munich in many respects and offer people an urbane home. Here living space, offices, a concert hall, hotels and eateries and the carefully conceived social infrastructure and sports facilities form a symbiotic relationship with the environment and its users. A primary school, local shopping amenities and a wide range of retail outlets complete the offering. Life in the Werksviertel district is distinguished by the versatile architecture and use of buildings, sense of community, exceptional transport links, sophistication and green spaces. EON Prospective: EON installs an intelligent platform of heat, cooling & power networks with CHPs and heat pumps. This forms the basis of our climate-friendly energy solution for this large residential and commercial district.

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐
Indicators/expected impact	**Economic:** - 10% reduced energy cost - New jobs: approx. 7.000 **Environmental:** - 40% less CO_2 compared to conventional heating and cooling systems **Societal:** A hub of art, culture and communication for inhabitants and visitors to enjoy a diverse urban environment
Overall strategies of city/municipality connected with the project	City of Munich: the mission statement "compact, urban, green", all uses of everyday life are to be united in a small space: living, working, shopping, culture and leisure. The center of the new district will be a 1.3-hectare park, from which a network of green and open spaces will stretch across the area. Since the concept idea in 1999, on 20 September 2017 the City Council passed the statute for the project, hence the development plan is legally binding. In 2016, Bayernwerk Natur, an E.ON subsidiary based in the greater Munich area, is appointed as the energy supplier to Munich's new 'Werksviertel' district near the city's 'Ostbahnhof' railway station. With support from E.ON, the area around the former Pfanni factory site will become largely energy self-sufficient. Steps: - In 2001: the city of Munich announced an urban planning and landscape planning competition for the area. - In 2011: Establishment of the development plan with green regulations no. 2061 and local announcement. - From 2012: public consultation starts and submission of agreed structural and spatial plan - From 2013: the development concept was further developed - From 2016: further consultations, and approval and modification of the land use plan - In 2017: Statutory resolution of the development plan - In 2018: Implementation of the development plan
Which factors have been included in implementation strategies?	Local (renewable) resources ☐ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ Sustainable consumption ☐ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	- City: The land in Werksviertel is co-owned by nine organizations. The ownership structure of the district allows for extraordinary freedom of design with regard to the planning and realization of construction projects. These landowners have been working towards a common purpose, with development largely financed and undertaken by the respective parcel owners and overseen, coordinated, and connected to infrastructure by the city government. - EON: Intensive cooperation of all decision makers achieved establishment of project corporation within five months. Formed a joint venture was founded with OTEC, owner of werksviertel properties (name of JV: werkkraft GmbH). - Various public consultations including discussion meetings at different stage of the planning and decision process.
Typology of energy supply	District heating/local heating, Heat pump system

Success factors	Challenges/barriers
- City established local development plan with green regulations no. 2061 - Werksviertel is guided by a zoning plan, and the project has been enabled partly through development rights whereby the city of Munich - EON: A “common” energy company as key to success, which creates atmosphere of trust	- Main risks to EON: Lower than expected energy consumption of customer, higher than expected peak loads, late commissioning of new buildings. - Customer risks: gas / power price level increase (minor impact on heat / cold prices) - City: there are ever going land and housing constraints for the city to develop a sustainable, want to go and live, and future proof district.

54 Odense, Denmark - Coal phase out by 2025

General information	
City	**Odense, Denmark**
Project name	**Coal phase out by 2025** Case provided by RHC/DHC+: https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf
Project status	**planned** ☒ **under construction** ☒ realized ☐ in operation ☐ Multiple projects in planning and under construction
Project start – end	2018 – 2025
Contact	Head of Business Development, Kim Winther
Project website	www.fjernvarmefyn.dk
Size of project area	Odense municipality
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	Mixed use (municipality)
Financing	The entire coal phase out plan is expected to sum up to DKK 2 billion. In Denmark the price for district heating is regulated by the District Heating Act stating that the heat price should be equal to the costs over time ie. heat is not produced with profit. We select the best / lowest cost projects to supply the future heat. Any potential power production cost and income has a separate budget.

Overview description of the project
Fjernvarme Fyn has decided to phase out the remaining 30% coal consumption in the heat production by 2025. Already coal consumption has been reduced from ~900,000 t/y in 2010 years ago to 2-300,000 t/y today but the goal is to substitute this completely. The tools are electric heat pumps to a large extent, large heat storages, biomass boilers and electric boilers. The challenge is to carry this out without price increases for the consumers especially the greenhouse industry where heat price is an important competition faction.

Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ Energy neutral ☐ Energy efficient ☐ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐ "0 coal in 2025"
Indicators/expected impact	**Economic:** Minimal price increase ~5-10% **Environmental:** ½-1 mio. T CO2/year **Societal:** Danish job creation (construction, technology, technology export)
Overall strategies of city/municipality connected with the project	UN sustainability targets, green city, maintain jobs in greenhouse industry, make district heating even more attractive Our overall vision is to be the preferred supplier of future heating solutions. The vision underlines that we aim to use technologies that are sustainable in the future. The targets are to phase out

	coal by 2025 and at the same time keep our position among the top 3 lowest district heating prices in Denmark. We believe district heating can/will be the preferred solution in Denmark as the collective solutions give synergies, gives a more efficient energy transformation (fx utilization of waste heat and surplus power production from wind energy) and makes the entire energy system more robust than with multiply individual solutions. Our strategy is to invest in a number of smaller units and not to substitute the existing coal plant 1-1. The smaller units can be multiple 10-20 MW heat pumps, a 30-50 MW biomass boiler, +50 MW electric boilers etc. The exact figures are still pending as we are developing our scenario calculations up to summer 2019. Steps: - 2018: Strategy was formulated - 2018: Scenario analysis 1.0 and 2.0 was made - 2019 Q2: Analysis of new plants is being reported - 2019 Q2: Scenario analysis 3.0. (several iterations) describing the optimal roadmap towards 2025 - 2019 Q3: Decide on first new plants to commence planning phase
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ Materials ☐ **Refurbishment** ☒ **Sustainable production** ☒ Sustainable consumption ☐ (Local) Governance ☐ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	Our 200,000 costumers are represented by our owners /board who are approving all major decision. On a daily basis the business is run by the Fjernvarme Fyn CEO and top management
Typology of energy supply	District heating/local heating

Success factors	Challenges/barriers
- Renewable flues are not taxed on district heating and requires not carbon allowances. Hence there is an inventive to substitute the taxed coal (and gas) with renewables, where the saved taxed is an indirect substitute that can finance new investment and prices can be kept steady (to some state). - Process heat costumers pays no tax so they lack incentives. Fjernvarme Fyn has secured a small subsidy from a subsidy schemes to process heat but are under a time pressure to realize this subsidy by 2021 as the scheme has been shut down. - High share of electrification (heat pumps) - High utilization of local heat sources	- Tax on surplus heat - No new subsidies for process heat - Production of heat without power production (ie no CHP production) is the most viable solution in the future but requires an dispensation in Denmark as CHP has been preferred until now - Heat pumps are not proven in large scale - Biomass is no longer a politically accepted fuel - Costumers are allowed to "cut the connection" to district heating and find an individual solution, so we need to be competitive and informative of our advantages

55 The Netherlands - Program Natural-Gas Free Neighbourhoods

General information	
City	Amsterdam, Noordoostpolder, Appingedam, Wageningen, Pekela, Tilburg, Loppersum, Zoetermeer, Brunssum, Middelburg, Tytsjerksteradiel, Delfzijl, Katwijk, Den Haag, Purmerend, Hengelo, Utrecht, Sittard-Geleen, Groningen, Assen, Sliedrecht, Rotterdam, Oldambt, Drimmelen, Eindhoven, Nijmegen, Vlieland, Rotterdam (The Netherlands)
Project name	**Program Natural-Gas Free Neighbourhoods**
Project status	planned ☐ **Implementation stage** ☒ realized ☐ n/a ☐
Project start – end	2018-2030
Contact	**Joram Snijders Aline Fissette**
Project website	www.aardgasvrijewijken.nl
Size of project area	Ha: n/a
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use (%)	- Residential: The majority of the buildings have a residential function - Office: An integrated approach, including commercial and public buildings is encouraged. - Commercial - Social
Financing	- Public: The financing is mostly public (ca. 4 million euro per project is funded by the national government. The other finances come from local governments and in some cases European funding). - Public-Private: Funding also comes in large part from social housing associations if they hold a large percentage of assets in the specific neighbourhood. In some cases, stakeholders like energy cooperatives also invest in the project.

Overview description of the project
The Dutch national aim is to have a natural-gas free built environment by 2050 (as stated in the National Climate Agreement). This national intergovernmental program is developed to learn how the transition from natural-gas to sustainable alternatives can take place in existing neighbourhoods. The program selects and supports municipalities that run pilots in neighbourhoods (ca. 500 buildings). Each project receives around 4 million euros for the coverage of the unprofitable gap for investment. Bottlenecks detected on a local level that can be resolved by changing national rules and legislation are addressed by the Ministries participating in the program. In 2018, 27 projects have started. In 2020 another 25 projects will be selected to receive national funding and support. The goal is to have 100 projects by 2028. Learning by doing is central to this program. In selecting the projects, we look for a wide variety in technique, financial constructions, types of project organization and ways of organizing civic participation. In the second round in 2020 we will also look to select projects that focus on the connection with the renovation of large utility buildings, with climate adaptation and with circular renovation. Parallel to the pilots, a knowledge development program has also been created. All 355 Dutch municipalities are welcome to participate in this learning program.

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ Carbon-free ☐ Climate neutral ☐

	Sustainable neighbourhood ☐ **Social aspects/affordability** ☒ Other: natural-gas free replaced with sustainable sources
Indicators/expected impact	- Environmental - Societal - Social - Spatial - Regulatory
Overall strategies of city/municipality connected with the project	- Other: The Program is connected to national goals: The Netherlands is striving for a natural-gas free built environment by 2050. This means that all fossil fuelled energy systems will have to be replaced by a sustainable alternative.
Which factors have been included in implementation strategies?	- Local (renewable) resources - Regional energy system - Buildings - Refurbishment - (Local) Governance - Legal framework - Business models
Innovative stakeholder involvement strategies	- Citizens - Investor/real estate
Typology of energy supply	- Solar Thermal Energy - Heat pump system - District heating/local heating - Industrial waste heat - Other: the 27 running projects each have made their own choices for energy supply, ranging from local heating distributing systems to waste incineration plants. The focus is on heating, not so much on electricity generation, but it can be included. New techniques (in addition to the ones checked above) might be added in the 2020-call for projects.

Success factors	Challenges/barriers
- A large success factor is having a national goal and substantial funding. – Funding for both project execution and for learning and monitoring goals - Intergovernmental cooperation is of added value, each level can add its own authorizations to the program and projects (e.g. Ministries can address bottlenecks in national rules and legislations) – leaving room for local initiatives (bottom-up), projects are formed to local needs and opportunities – having a support and a learning network for municipalities is of great value - Funding for projects are freely disposable for the municipalities, the program works with local accountabilities	- Affordability and social support are of big concern. The program focuses on these themes, next to the development of national policy (e.g. national funding systems). By the end of 2019 the first results will be evaluated, more success factors and challenges can be communicated by then.

56 Arnhem, The Netherlands – Community focused Energy Transition

General information	
City	**Arnhem, The Netherlands**
Project name	**Community-focused Energy Transition (part of the research program Sustainable Energy and Environment of HAN-University of Applied Sciences)**
Project status	planned ☐ implementation stage ☐ realized ☐ **n/a** ☒ Notes: This is a practice-based program entailing part research, part development and part implementation
Project start – end	2019 - Tbd, in principle a long-term project with yearly extension
Contact	**Erik Jansen, Frits Schultheiss and Masi Mohammadi (project leaders)**
Project website	https://www.han.nl/onderzoek/zwaartepunten/see/
Size of project area	n/a Municipality of Arnhem is our key partner, and the program scope encompasses the municipality. However, special focus is given to pilot neighborhoods such as Spijkerkwartier, Kronenburg and Presikhaaf.
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐ n/a ☐
Land use	- n/a . We have currently no specific information on these data
Financing	- Public-Private. Financing is based on University funds as well as funding from private and public partners based on specific projects in the program - Research funding. University funding and grants.

Overview description of the project
In the project "Community-focused Energy Transition" we work towards answering four research questions: 1) How do we gain grip on the determinants for the energy transition in local communities?; 2) How do we develop smart solutions in which energy transition, sustainable life-long housing, enhancing comfort and financeability converge?; 3) How can individual and collective behaviour change be established in local communities?; 4) How can we transfer local insights in the approach on the energy transition to other communities? These four questions are focused on developing interdisciplinary insights and strategies for the (training of) professions relevant to the energy transition and practice partners currently working in the field. To this purpose, practice, public and research partners collaborate in various combinations in the sub-projects of which the results feed the overall research questions. Place of operation is the neighbourhoods and communities of our preferred partner, the Municipality of Arnhem

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒ Notes: Our ambition is to contribute sustainable and ethical solutions and strategies to the societal issue of the energy transition by gathering local partners from various disciplines such as technical expertise, social sciences and economics. This also involves the interconnectedness of issues such as sustainability and social inequality.
Indicators/expected impact	- Environmental - Societal - Social - Services - Economic - Spatial
Overall strategies of city/municipality connected with the project	Smart City Strategy. The project aligns with the sustainability policy of the Municipality of Arnhem that focuses on a balance between sustainability and equity.
Which factors have been included in implementation strategies?	Local (renewable) resources ☐ Regional energy system ☐ Mobility ☐ **Buildings** ☒ **Materials** ☒ Refurbishment ☐ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ Legal framework ☐ Business models ☐ n/a ☐
Innovative stakeholder involvement strategies	- Citizens - Business - Research - Other: Housing corporations
Typology of energy supply	- Heat pump system - Other: One of the subprojects focuses on heat pumps, but the project overall as yet does not entail different energy supplies. However, another project in the broader research program focuses on hydrogen-applications.

Success factors	Challenges/barriers
Interdisciplinary approach leads to innovation and learning; combining expertise areas (building and engineering professionals and social professionals normally learn to collaborate); direct feedforward to education of future professionals; as University we can have a neutral position in the networks; Mass and focus due to large numbers of partners involved.	- Governance: Collaboration takes time and effort; everything is interconnected (rhizomatic structure of issues); many expertise areas necessary, which makes it hard to gain overview; many partners involves balancing many interests and expectations

57 Brussels, Belgium - Positive4North

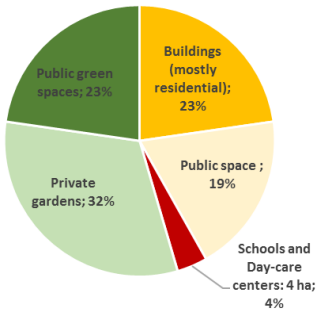
General information	
City	**Brussels, Belgium**
Project name	**Positive4North**
Project status	**planned** ☒ under construction ☐ realized ☐ n/a ☐ Notes: project is not totally planned yet: informal meetings have been organised, first data gathering with regards to the target area is needed
Project start – end	2020 – Not determined yet
Contact	**Laurent du Bus (Laurent.dubus@brucity.be) 0032 2279 4715**
Project website	n/a
Size of project area	Ha: project area not entirely defined yet (approximately: Brussels North Quarter ==> zone between Canal, the inner ring, railways, Chemin de Fer and Heliport Avenue) = 730 HA
Building structure	Newly built ☐ **Existing neighbourhood** ☒ **Mixed** ☒
Land use	- Residential: Residential apartments avenue Heliport and surrounding streets - Office: Several office towers in the target neighbourhood: Engie, Public Services, Belfius, Proximus - Commercial: Mixed blocks (residential + commercial floors) - Social: Social housing towers - Park: Maximilien Parc + Maximilien urban farm - Cultural: Shed with cultural function (museum KANAL) - Education: Various schools are located in the area
Financing	- Private: Association Up4North (association of companies and property developers of Northern Neighbourhood: Befimmo, AG Real Estate, Belfius Insurance, Tractebel,..) - Public: Brussels Capital Region (Perspective.brussels), Municipalities (City of Brussels, Schaerbeek, Saint-Josse-ten-Noode), Innoviris - Research funding: Tractebel (research entity of Engie) + Innoviris (Research administration of the Region)

Overview description of the project
The northern district is characterized by office towers and social housing. The renovation and revitalization of this neighbourhood will go hand in hand with the ambition to neutralize the carbon footprint while drastically reducing the energy bill for precarious tenants and increasing renewable energy production in situ. The project also aims to promote social cohesion and citizen involvement around projects focusing on "energetic" issues through an inclusive and participative approach. A significant effort will be done to involve social tenants. In a first phase, the project aims to explore the most efficient "energy" solutions that are economically and ecologically advantageous for neighbourhood users. These areas of technical action include the integration of smart grids, solar panels, biomethanisation solutions, integration with mobility (eg the provision of shared electric vehicles), energy storage, etc. These areas of technical action will be reviewed and expanded according to the changing needs of the project. In addition, the project aims to create energy communities to fight energy poverty. Therefore, there will be an exploration phase in which the potential for social cohesion from energy innovations and resource pooling solutions will be analysed. Furthermore, developing a pedagogical approach to empower citizens on energy issues is another important objective of the project. The physical area of the project is also subject to a “Urban Renewal Contract”, so synergies between this dynamic and the needs of the projects will be developed. The Stakeholders identified for this project include social tenants, social housing corporation, the City of Brussels, Up4north (organisation representing real estate developers in the neighbourhood), regional entities (Brussels Perspective, Brussels Environment, Sibelga, Brugel), Energy Cities Network, Citymined & Apere (La Pile project), workers of the area, Siamu, Schools of the area, merchants, inhabitants, KANAL museum

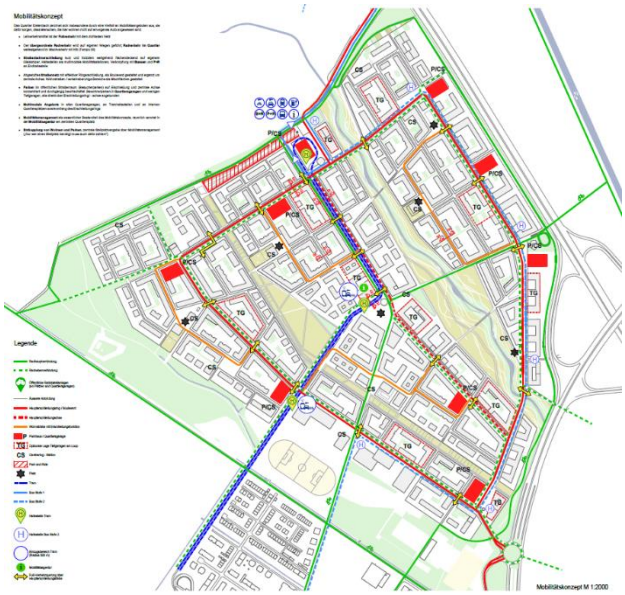
Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ **Energy neutral** ☒ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☒
Indicators/expected impact	- Environmental - Social
Overall strategies of city/municipality connected with the project	- Smart City Strategy - Urban Renewal Strategies - Energy Masterplanning
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ **Sustainable production** ☒ **Sustainable consumption** ☒ **(Local) Governance** ☒ **Legal framework** ☒ Business models ☐ Notes: not yet in implementation phase, still in "preparation" phase
Innovative stakeholder involvement strategies	- Citizens - Industry - Investor/real estate - Business - Other: social tenants
Typology of energy supply	- Geothermal energy - District heating/local heating - Photovoltaic - Other: biomethanisation

Success factors	Challenges/barriers
Political priority to work on this district, and enthousiasm of the local stakeholders about such project	Multiple and variety of stakeholders and authorities on the districts

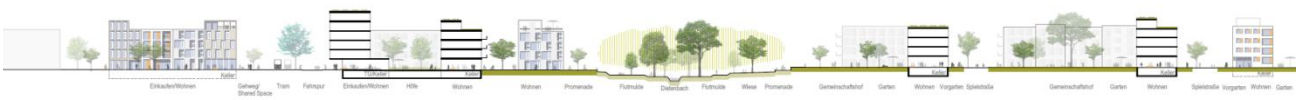
58 Freiburg im Breisgau, Germany - Dietenbach

General information	
City	**Freiburg im Breisgau, Germany**
Project name	**Dietenbach**
Project status	**planned** ☒ under construction ☐ realized ☐ in operation
Project start – end	Planning is on the way, start of the development (construction): 2022
Contact	Ruediger Engel, City of Freiburg, Project manager Dietenbach development, Klaus von Zahn, City of Freiburg, Head of environment department, Gerhard Stryi-Hipp, Fraunhofer ISE
Project website	https://www.freiburg.de/pb/,Lde/495838.html
Size of project area	110 ha
Building structure	**Newly built** ☒ Existing neighbourhood ☐ Mixed ☐
Land use	- Construction area for buildings: 25 ha (predominantly residential: 6,500 flats, approx. 15.000 inhabitants) - Public space (places and streets): 21 ha - Schools and Day-care centers: 4 ha - Private gardens: 35 ha - Public green spaces: 25 ha Land use Dietenbach Areal, Freiburg 
Financing	The district will be developed by the City of Freiburg, which owns the construction area. The infrastructure, schools and other public buildings will be financed by selling the construction ground to the building construction companies.

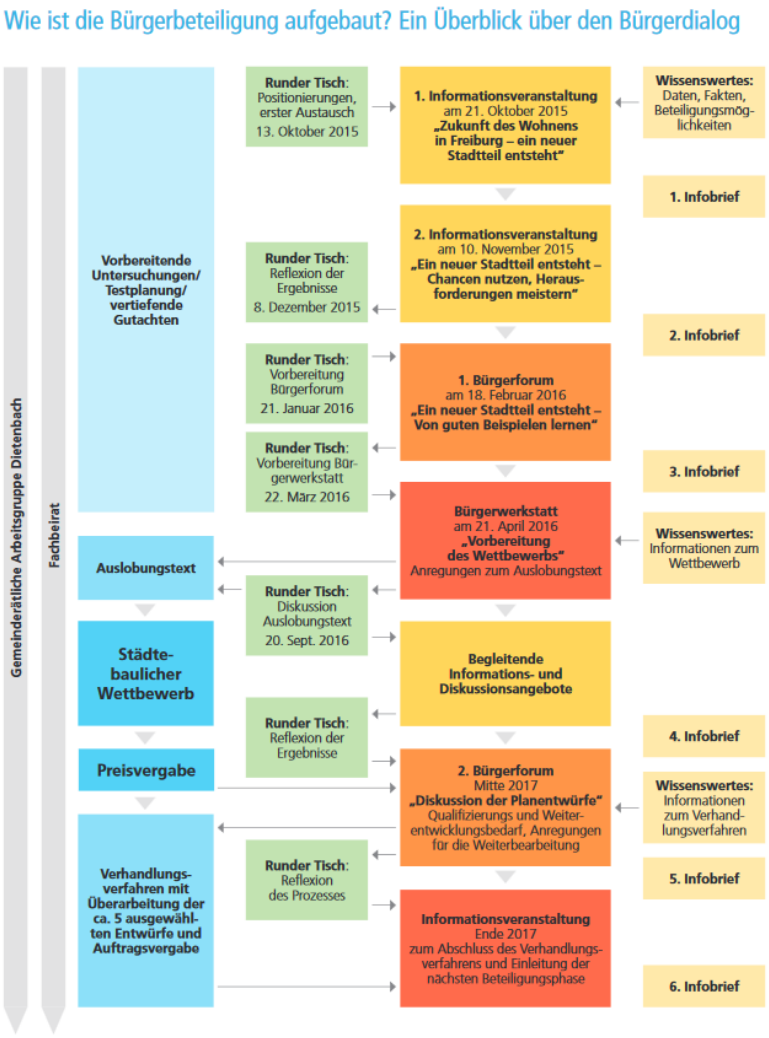
Overview description of the project
Development of a climate neutral city quarter with about 6,500 apartments for 15,000 inhabitants. To react on the strong increase of rental prices, affordable housing is an important goal. The district shall become mixed and agile with short distances and communicative areas, places, schools, sport facilities, day-care centers for children and shopping facilities. The district will become inclusive and barrier-free. An energy concept for the climate neutral / energy positive supply of the district was already part of the urban development competition. Based on the basic concept of the winning urban planning team, now the energy concept will be developed more in detail.




Markttag am zentralen Platz


Schnitt Dietenbach schmal M 1:500

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ Energy efficient ☐ Carbon-free ☐ **Climate neutral** ☒ **Sustainable neighbourhood** ☒ **Social aspects/affordability** ☐

Indicators/expected impact	(TBD)
Overall strategies of city/municipality connected with the project	- Energy masterplanning - Growing city - Regional planning
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ **Sustainable production** ☒ **Sustainable consumption** ☐ (Local) Governance ☐ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	Basis of the development is an intensive process of searching and selecting the construction ground for the new district. Finally, the city council decided to build it on the Dietenbach area. An extensive participation process during the selection phase and afterwards in the definition of targets and framework conditions of the district was established. However, a group of people didn't want to accept the decision of the city council and collected enough signatures for a plebiscite (popular vote). In the preparation of this popular vote many information events were organized and intensive discussions happened. Finally, 60% of the citizens decided on 24 February 2019, that the Dietenbach district shall be build. 

Typology of energy supply	The buildings are high efficient with a heating temperature of 30 °C. The energy will be supplied by Photovoltaic-Thermal-Collectors on the roofs and PV-modules on the facades and the noise protection wall. In addition, waste heat will be detracted from a main sewer canal closed by. Thermal energy will be supplied by a cold district heating network with uninsulated Polyethylene pipes and heated up by heat pumps within the buildings. Several Ice-storages will be installed.

Success factors	**Challenges/barriers**
- Extensive participation of all stakeholders. - Integrated planning from the beginning on (urban planning, mobility, energy, environment,…)	- Public opposition – intense discussion on: must the city of Freiburg further grow, can the consumption of farm land be acceptable and sustainable,…

59 Lecce, Italy - SmartEnCity,

General information	
City	**Lecce, Italy**
Project name	**SmartEnCity**
Project status	planned ☐ **implementation stage** ☒ realized ☐ n/a ☐
Project start – end	2016– 2021
Contact	**Serena Pagliula, Giovanni Puce, Roberta Cappello, Michele De Santis**
Project website	https://smartencity.eu/
Size of project area	n/a ☒
Building structure	Newly built ☐ Existing neighbourhood ☐ Mixed ☐ n/a ☒ Notes: Lecce is follower city involved within the development of the Integrated Energy Urban Plan
Land use	- n/a ☒
Financing	- Public - Research funding

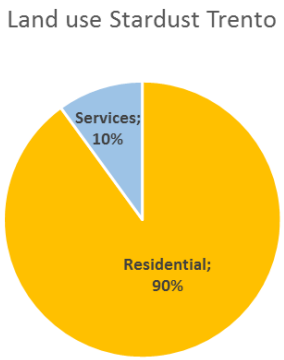
Overview description of the project
SmartEnCity's main objective is to develop a highly adaptable and replicable systemic approach towards urban transition into sustainable, smart and resource-efficient cities in Europe. This will be achieved through the integrated planning and implementation of measures aimed at improving energy efficiency in main consuming sectors in cities, while increasing their supply of renewable energy and demonstrating the benefits. Lecce has the role of "follower city" and is involved within the implementation of an Integrated Energy Urban Plan and Roadmaps, following the SmartEnCity methodology.

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ Climate neutral ☐ Sustainable neighbourhood ☐ Social aspects/affordability ☐
Indicators/expected impact	- Environmental - Economic
Overall strategies of city/municipality connected with the project	- Smart City Strategy
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ Regional energy system ☐ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ Sustainable production ☐ Sustainable consumption ☐ **(Local) Governance** ☒ **Legal framework** ☒ **Business models** ☒
Innovative stakeholder involvement strategies	- Industry - Research

Typology of energy supply	Solar thermal energy - District heating/local heating - Photovoltaic

Success factors	Challenges/barriers
- Involvement of local stakeholders for supporting the private-public partnerships	- Collection of data and interconnections among different departments of the Municipality and data sharing

60 Trento, Italy - STARDUST

General information	
City	**Trento, Italy**; Case Study: Madonna Bianca Urban District
Project name	**STARDUST**
Project status	**planned** ☒
Project start – end	October 2017 – September 2022
Contact	Paola Penasa, Ivano Gobbi, Daniele Vettorato, Luigi Crema
Project website	**https://stardustproject.eu/**
Size of project area	30 ha
Building structure	Newly built ☐ **Existing neighbourhood** ☒ Mixed ☐
Land use	- Residential: 90% - Office: - - Industry: - - Services: 10% 
Financing	- Public-Private 40% - Research funding 30% - Green financing 30% About 12 million euros of total investments in the STARDUST project.

Overview description of the project
STARDUST is a project funded under the European Union's Horizon 2020 smart cities and communities lighthouse programme. The STARDUST consortium is composed of 30 organizations from 9 different countries: 7 cities, 4 research institutions, 6 SMEs and 13 industrial partners. They represent all the different stakeholders targeted by STARDUST. These include research experts, public authorities, industrial partners, SMEs, dissemination and exploitation experts, and investors. In STARDUST, intelligent solutions for energy, mobility and ICT will be integrated in cities together with innovative business models, which will serve as blueprints for replication across Europe and abroad. These synergy of actions will transform cities into living labs, platforms where citizens and community engagement will become the driving elements to improve not only their way of life but also their local economies. For the first phase of the STARDUST project, a set of technical and non-technical interventions will be carried out in cities labelled as "lighthouse cities" (Pamplona, Tampere, Trento). They will serve as a basis prior to developing the replication strategy suitable for other cities termed as "follower cities" (Cluj-Napoca, Derry, Kozani, Litomerice). Technical interventions will be carried out in selected demonstration sites in all the three cities. The transformation will be carried out in district housing and mobility with the help of Information and Communication Technology (ICT). In the lighthouse city of Trento, the main area of intervention is the Madonna Bianca Urban District including a social housing residential complex composed by 14 towers, with a population of 1,800 inhabitants, lying in a common green area

of approximately 300,000 m^2. The social housing Madonna Bianca is a mixed-property complex having as major stakeholder and manager the project partner ITEA. The complex was built in the Seventies. Each tower has 13 floors for a total area of roughly 5,700 m^2/tower. About 70% of apartments are ITEA's property- the rest being privately owned. STARDUST aims at renovating 3 of the 14 towers within a nZEB vision through the following actions:

- refurbishment of the building envelope (integrating a modular, semi prefabricated BIPV facade with lean installation approach);
- creation of a thermal chimney for free ventilative cooling; creation of a low temperature smart district heating system replacing gas heating with ground source heat pumps (GSHPs);
- connection of the local supermarket to the smart grid;
- retrievement of the supermarket's heat waste; installation of smart meters and monitoring systems in each unit to encourage energy-saving habits;
- creation of a communication interface with inhabitants to stimulate an energy-aware culture.

The remaining 11 towers will be the focus of a local replication plan.

Strategies	
Goals/ambition	Positive Energy ☐ Zero-emission ☐ **Energy neutral** ☒ **Energy efficient** ☒ Carbon-free ☐ Climate neutral ☐ **Sustainable neighbourhood** ☒ Social aspects/affordability ☐
Indicators/expected impact	• Reduction of thermal demand: 1.3 GWh/year • Local RES production: PV = 140 MWh/year; geothermal = 786 MWh/year heat • Environmental: reduction of CO2 emissions = 484 tCO2/year • Economic: reduction of energy cost = 117000 euro/year
Overall strategies of city/municipality connected with the project	- Smart City Strategies - Urban Renewal Strategies - Energy Masterplanning
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ Mobility ☐ **Buildings** ☒ **Materials** ☒ **Refurbishment** ☒ **Sustainable production** ☒ **Sustainable consumption** ☒ (Local) Governance ☐ Legal framework ☐ **Business models** ☒
Innovative stakeholder involvement strategies	- Citizens: 164 dwellings - Industry: DOLOMITI ENERGIA, DEDAGROUP, HABITECH - Investor/real estate: ITEA - Business: OFFICINAE VERDI - Research: FBK, EURAC
Typology of energy supply	- PV: 180 kW, 140 MWh/year - Heat pump system: 450 kW, 1.1 GWh/year heat - Geothermal energy: 11600 m of BHEs - District heating/local heating - Waste heat

Success factors	**Challenges/barriers**
- Involvement of main public and private stakeholders as STARDUST project partners - Involvement of all citizens living in the 164 apartments of the 3 towers of Madonna Bianca - High reduction of heat demand (-54%)	- The social housing Madonna Bianca is a mixed-property complex (Public-Private): share technical solutions, subdivision of costs and incentives - High financial commitment

- Refurbishment of existing buildings and shift from 0 to 50-100% in the use of renewable sources - Construction of new highly efficient buildings 100% powered by renewable sources - High production of renewable electrical (140 MWh/year) and thermal energy (786 MWh/year heat) - Optimal integration of multiple renewable sources and waste heat (power to heat; low temperature DH) - Inclusion of the study area in the Province of Trento characterized by renewable electricity production (mainly hydroelectric) greater than consumption (in an annual balance) - Introduction of advanced monitoring and control systems, integrated in a single BMS (Building Management System) with data visualization differentiated for the Tower managers and the inhabitants	- Intervention on existing buildings (for example: use of radiators instead of underfloor heating) - Optimal integration of multiple renewable sources and waste heat - Introduction of advanced monitoring and control systems, integrated in a single BMS (Building Management System) with data visualization differentiated for the Towers Managers and the inhabitants.

61 Turku, Finland

General information	
City	**Turku**
Project name	n/a (under planning)
Project status	**planned** ☒ under construction ☐ realized ☐ in operation
Project start – end	n/a
Contact	**Miia Paananen**
Project website	n/a
Size of project area	n/a
Building structure	Newly built ☐ Existing neighbourhood ☐ **Mixed** ☒
Land use	n/a
Financing	n/a

Overview description of the project
In this questionnaire we introduce a few examples of ongoing energy pilot projects in the city of Turku. Turku aims to be carbon neutral by the year 2029. Some examples of our energy projects: - Energy solutions in the Student Village of Turku (managed by the Turku Student Village foundation TYS) - The new sustainable residential district of Skanssi - Several other, separate energy projects in the city

Strategies	
Goals/ambition	Positive Energy ☐ **Zero-emission** ☒ Energy neutral ☐ **Energy efficient** ☒ **Carbon-free** ☒ **Climate neutral** ☒ Sustainable neighbourhood ☐ Social aspects/affordability ☐ Other: **Stakeholder and citizen participation**
Indicators/expected impact	n/a
Overall strategies of city/municipality connected with the project	Turku, with its surrounding municipalities, is an energetic centre of growth in the Baltic Sea area. The city strategy is strongly supported by a strategic programme of Competitiveness and sustainable growth. There are over 190,000 residents in Turku. Turku has an estimated population growth of almost 20,000 new inhabitants by 2040, and the Turku subregion is estimated to have a population growth by 30,000 inhabitants by 2040. The city has two universities and four higher education institutions with over 35,000 students altogether. Turku is the sixth largest city and the third largest urban area in Finland. The city of Turku aims to be carbon-neutral by 2029 and has established milestones to reach this goal. We will extend the energy-efficient and resource-wise way of operating across all operations. We will increase the share of renewable energy sources and develop our energy system to make it

	smarter. We will engage companies, institutions of higher education and citizens in developing carbon-neutral innovations and implementing solutions. In order to reach the target of carbon neutrality by 2029, Turku City Council unanimously approved a Sustainable Energy and Climate Action Plan in June 2018. Furthermore, the plan includes a target of becoming a climate positive area with negative net emissions from 2029 onwards. Turku is a global forerunner in climate policy, and the city wants to be part of an international network of cities that will solve climate change issues. Environmental protection and natural diversity is important to Turku, and the city works actively to protect the Baltic Sea and the Archipelago Sea in particular. We will implement the principles of zero emissions, zero waste, sustainable use of natural resources and efficient use of resources by 2040.
Which factors have been included in implementation strategies?	**Local (renewable) resources** ☒ **Regional energy system** ☒ **Mobility** ☒ **Buildings** ☒ Materials ☐ Refurbishment ☐ Sustainable production ☐ Sustainable consumption ☐ (Local) Governance ☐ Legal framework ☐ Business models ☐
Innovative stakeholder involvement strategies	The sustainable district of Skanssi is a combination of smart solutions, sustainability and sense of community. The district of Skanssi is a platform for piloting and using low-carbon energy solutions, sustainable mobility and smart built environment. For creating motivation and solutions together, we have involved the developers, service-providers and inhabitants of the Skanssi area. Series of workshops have been organized and different means of consultation and co-creation put to use. Turku also takes part in the Energy Wise Cities-project together with the six largest cities in Finland. The project creates concepts of intelligent and energy-wise buildings and promotes new business opportunities and energy efficiency partnership models. The project has successfully organized e.g. market mapping events with themes such as building life-cycle and energy wise service buildings. In the Spring of 2019 a project called Carbon Neutral and Resource Wise Industrial Areas will start (ERDF). The project concretizes what carbon neutrality means for business parks and industrial areas and develops new means through stakeholder involvement and co-creation. Turku's pilot area for this project is Blue Industry Park, a production and innovation cluster of the maritime and manufacturing industries. The city of Turku also works in close so-operation with the Finnish Innovation Fund Sitra regarding climate goals and circular economy. Co-operation in the next months will involve for example co-operation in conceptualizing what a climate positive city means and how for example city districts can become climate positive.
Typology of energy supply	Some recent and upcoming examples: The student village in Turku has several ongoing building projects that promote the use of renewable energy sources. The Turku student village foundation has recently finished building a new residential building "Aitiopaikka" that utilizes solar electricity and has the potential of producing more energy than it consumes especially during Summer with its 515 solar panels. The building has 255 apartments. Electricity can be shared in the student village area. - The Turku student village foundation is currently planning its next climate friendly building project "Tyyssija". Tyyssija will use ground heat as its energy source and will furthermore have a waste water heat recovery, that collects waste water heat from approx.. 30 other buildings beside Tyyssija. Solar panels are also planned to be installed on the roof of Tyyssija. - The Skanssi district's energy vision includes new solutions to produce heat e.g. with solar collectors and to store the heat in the ground. Two-directional heat trade and a low-temperature district heating network are piloted in the Skanssi district. The first parts of the area have been built and the heat storage systems have been installed. An enabling factor for this experiment is the lower temperature solution for the heat grid in the area. By lowering the temperature in the grid down to sixty-seventy degrees Celsius we enable profitable heat production by solar collectors and other local means.

	- The Energy Wise Cities -project simulates and plans the realization of zero-energy district/blocks and examines the development of regional energy systems. - Different ways of storing energy (e.g. with energy poles) is also piloted in the Lämpöä-project run by Turku University of Applied Sciences. In the district of Kupittaa in Turku the Turku Energy company has built a solar park with 450 solar panels (approx.. 1 MW). Turku Energy company rents out the solar panels to customers, and the produced energy can then be credited in the customer's electricity bill.

Success factors	Challenges/barriers
n/a	n/a

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