IRIS

Integrated and Replicable Solutions for Co-Creation in Sustainable Cities

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User, Business and Technical requirements of Transition Track #1 Solutions

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Version History

Version	Date	Modifications made by
0.1	13/10/2017	First draft created by CERTH for internal review
0.2	20/11/2017	Updated template shared with LH/FC representative partners
0.3	07/01/2018	Initial contribution by LH (pre-pilot)
0.4	15/02/2018	Consolidated version and feedback by CERTH
0.5	02/04/2018	Contribution by LH (demonstration)
0.6	02/05/2018	Final contribution by LH (all chapters)
0.7	04/05/2018	Consolidated version and feedback by CERTH
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1.0	20/06/2018	First complete version by CERTH for internal review
1.1	29/06/2018	Final version by CERTH

Disclaimer

Executive Summary

The present document is the Deliverable D1.2 entitled as "User, Business and Technical Requirements of Transition Track #1 Solutions" of the IRIS project. The document presents the work undertaken in relation to Task 1.1 entitled as "Integration synergy on Transition Track (TT) #1: Smart renewables and closed-loop energy positive districts" of WP1, towards the definition of requirements and specification of the corresponding solutions (for example technical, operational, legislative, underpinning regulatory framework, business). The main scope of TT#1 is to integrate and implement solutions that comprise energy producing technologies in buildings for cooling and heating along with electricity purposes and to replicate already tested solutions for waste heat utilization. As a further step, these solutions can be integrated into one smart micro-grid, so as to test the compatibility, the efficiency and the benefits of solutions at district level. D1.2 summarizes the current know-how in LH cities about existing solutions relevant to increase of RES harvesting and utilization of waste heat streams among partners and their integration with smart components.

Moreover, the aspect of lessons learnt is included, aiming primarily at helping IRIS Lighthouse (LH) and Follower cities (FC) to familiarize among themselves of what is the previous experience related to the IRIS solutions expected to be investigated in detail, in the course of the project. The depicted in this Deliverable information can act as the baseline for know-how and experience exchange both among the IRIS participating entities and as well on a second level, on an EU level.

The 3 LH cities (Utrecht, Nice and Gothenburg) are going to deliver various demonstration use cases, taking into account the local needs of their different environments (for example building energy inadequacy, needs for reducing the energy consumption and the household bills, noise and atmospheric pollution,). The demonstrations are based on pre-pilots of previous projects that will move a step further, trying to integrate the proposed solutions to a wider extent of area, following a scalable, but at the same time replicable pathway. All LH cities and FCs (Vaasa, Alexandroupolis, Tenerife and Focsani) will replicate the solutions using the experience by the demonstration activities, after being fitted to their local needs, overcoming their individual barriers and fostering their drivers towards transforming their cities into smarter, more energy efficient, less environmentally polluted, but most of all citizen needs centred.

The present deliverable, along with deliverables D1.3, D1.4, D1.5 and D1.6, is purposed to provide information concerning the demonstrations that are going to be undertaken in the Lighthouse cities during the IRIS project, using as a basis the pre-pilot areas of them. The LH cities have already a mature-enough previous experience and considerable know-how of the specialties of most of these IRIS Solutions, since these have already been demonstrated (in a lower scale though), in their territory. This deliverable gives the Lighthouse and Follower cities, the opportunity to exchange know-how and opinions on how each of the IRIS solutions can be in the best way integrated in their site as a first point, and through the replication process in their city level. During the deliverable preparation phase, the IRIS partners established a strong collaboration both, at a local level (among the energy experienced partners of each LH and FC ecosystem), as well as, at the IRIS level (among key partners from LH and FCs). This collaboration and knowledge exchange resulted in the collection of a big amount of information about (a) pre-pilots, (b) demonstrations and (c) replications.

D1.2 takes into account the individual characteristics of each city and provides a detailed description of the pre-pilots along with a top-level description of the expected demonstration and replication activities, to be conducted within the next four (4) years of IRIS project evolution. The Deliverable covers a variety of topics that will be further analysed and elaborated in much more detail, in the context of WP3, WP5, WP6, WP7 and WP8. These work packages include activities that will present in detail the information provided by D1.2. The established collaboration along with the collected information about the integrated solutions of TT1 make it feasible for IRIS to have a quick start in order to successfully demonstrate and replicate the best practices the partners already have.

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List of Acronyms and Abbreviations

Abbreviation	Definition
FC	Follower City
LH	Lighthouse
RES	Renewable Energy Sources
TRL	Technology Readiness Level
TT	Transition Track
IS	IRIS Solution
KPI	Key Performance Indicator
LV	Low Voltage
PV	Photovoltaic
HVAC	Heating, Ventilation and Air-Conditioning
HEMS	Home Energy Management System
DHN	District Heating Network
WWTP	Wastewater Treatment Plant
WWTF	Wastewater Treatment Facilities
OPEX	Operating Expense
SME	Small-Medium Enterprise
ICT	Information and Communication Technology
DSM	Demand Side Management
DSO	Distributed System Operator
FED	Fossil-Free Energy Districts
DHW	District Heating Water
GHG	Greenhouse Gas
LTE	Lwa on Energy Transition
BIPV	Building Integrated Photovolaic

1. Introduction

1.1 Scope and objectives of the deliverable

The purpose of this document is to update and gather more detailed information for each of the Individual IRIS Solutions, based on the information included in the proposal document in section 1.3.8, providing more detailed and accurate information, which will be the main point of reference for the both LH cities and the FCs. The document will act as a point of reference for the work in WP5-6-7-8, where the actual demonstration activities will take place, and the replication activities will be planned.

The main objective of Transition Track #1 (TT#1) is the integration and demonstration of different Renewable Energy Sources (RES) based technologies and energy saving measures at building and at district scale including the symbiotic networks alongside with smart energy management systems (SEMS), in order to:

a. increase the share of locally produced and consumed renewable energy (self-consumption) for electricity, but also for heating and cooling purposes;
b. maximize the energy savings at building and district level reducing the citizen's energy bill and
c. define and evaluate the value-adding role of humans and of renewable energy-based solutions at the ecological system contributing to the reduction of air pollution, while at the same time the citizens benefit by increasing their comfort level and the quality of life.

The technical solutions intended to be demonstrated briefly include the following:

- application of various technologies in buildings, such as energy efficient building envelopes, ventilation systems and local production based on PV and on geothermal energy (Plus-energy blocks – producing excess of energy). Gothenburg will transfer its expertise in this technology to Utrecht and Nice considering that these technologies are interconnected with the LT district heating solutions which are explained thoroughly in TT#1;
- electrical storage (for example Li-Ion batteries) for electricity, short time thermal storage (geothermal boreholes) and other innovative ones such as buffer tanks and the thermal inertia of the building frame;
- smart (hybrid) gas-electric heat pumps for heating and hot water powered mainly by locally produced PV power and on peak demand by gas-fired condensing boiler. This combination can save up to 40% to 55% on CO_2 emissions from natural gas in a household;
- deployment of smart AC/DC power grid in apartments and smart DC street lighting at district level. These measures and the above ones can operate in parallel and contribute to the flexible electricity grid networks which are described in detail in TT#2 corresponding deliverable;
- Near Zero Energy Building (NZEB) retrofitting which comprises a wide variety of energy savings measures, as for example external thermal insulation of the building envelop, low pressure controlled ventilation, centralized solar DHW production, low energy lighting etc;
- district heating optimization which are based on the monitoring of the hourly energy and water consumptions of the boilers plant and the buildings sub-stations;
- symbiotic waste heat networks consisting of novel operations as collection of waste streams and materials (e.g. the waste heat from household waste incineration plant) which will be turned into biogenic fuel and use of produced biogas as an energy carrier. This can be examined in comparison with the LT & MT heating solutions which are presented in TT#2. These collaborative models for highly efficient processes of energy production are in line

with the current EU policy about promotion of industrial symbiosis in parallel with the waste heat exploitation at building level;

- dedicated applications for citizens implemented through web, tablets, smart phones and TV network, in order to increase the water, waste and energy management and
- smart metering, ESM and ICT based systems for continuous monitoring and interconnection allowing near real-time measuring, failure tracking and energy management at home, building and district level, facilitating the efficient operation among various energy resources and evaluating any potential optimization actions.

The present deliverable describes the pre-pilots on which the IRIS TT1 solutions are based, as well as the demonstrations and replications that are about to be delivered throughout the project. In brief, TT#1 comprises three different solutions which are examined separately, but they can be combined with the solutions of the other transition tracks, in order to formulate a smart city plan with the IRIS project framework. The already mentioned technical solutions have been classified in three different groups:

IS 1.1: Positive Energy Buildings

IS 1.2: Near zero energy retrofit district

IS 1.3: Symbiotic waste heat networks

The table below summarises the planning of the activities per IRIS Solution for Transition Track #1 in the different LH and FCs, in particular:

- **P (Pilot):** knowledge transfer from Lighthouse cities that already have a Pre-Pilot area where the solution has already been tested
- **D (Demonstration):** Lighthouse cities where each of the IRIS solution will be Demonstrated during the course of the project
- **R (Replication):** initial planning for Replication of the solutions in both the Lighthouse and Follower cities

Table 1 : Planning of Pre-Pilot / Demonstration / Replication of the IRIS Solution in the LH and FC

Transition Tracks	Integrated Solutions	Lighthouse Cities									Follower Cities			
		Utrecht			Nice Cote d'Azur			Gothenburg			Vaasa	Alexandroupolis	Santa Cruz de Tenerife	Focsani
#1 Smart renewables and closed-loop energy positive districts	IS-1.1: Positive Energy Buildings	-	-	R	-	D	R	P	D	R	R	R	R	-
	IS-1.2: Near zero energy retrofit district	P	D	R	P	D	R	P	D	R	R	R	R	R
	IS-1.3: Symbiotic waste heat networks	-	-	R	P	D	R	P	-	R	R	R	R	-

1.2 Structure of the deliverable

The structure of this document is accommodated following a generic and adaptable enough structure, to fit to the needs of each Individual IRIS Solution description, as being proposed in the IRIS proposal. The same structure has been used for all corresponding Transition Tracks #1, #2 and #3 Deliverables. Specifically, the deliverable is structured and organized in the following chapters:

Chapter 2 introduces a basic methodology for the process of gathering information from the LH/FC cities and the involved stakeholders. It also presents the interaction phases with the participation of most of the stakeholders and the multiple well-organized ways that have been followed to, at a first level gather the necessary information and, at a second level consolidate and present it in an easy-readable manner.

Chapter 3 provides a summary concerning the pre-pilot, demonstration and replication of IRIS activities, focusing on the varying technological solutions that will be demonstrated and replicated by the LHs and FCs, in the form of summarized Tables. This structure is expected to allow the reader of this Deliverable to gain a fast overview of the individual solutions being pre-piloted, demonstrated and expected to be replicated in each LH and FC.

Chapter 4 provides an overview of how IS1.1 being described in D1.2 is linked with the forthcoming activities in the rest of WPs. Since the information gathered in this Deliverable is acting as the reference point upon which the IRIS will be run, it is important for someone to know what is he/she should expect to be conducted during the next four (4) years of the project. Detailed and more concrete that currently available information will be gathered and monitored in the following WPs. Moreover, key aspects as Business Models development for each of the solutions being described here, also associated with corresponding legal and regulatory environment are expected to be populated by the next WPs.

Chapter 5 presents a very brief overview of the main conclusion derived about the IRIS solutions, after the consolidation of the information being gathered during this period of project running (i.e. nine (9) months) on the levels of a) pre-pilots, b) demonstration and c) replication areas.

Chapter 6 contains the list of references used during the description of the main body and annexes of the deliverable. The reference list is not much extensive, since the provision of primary information, written in this Deliverable originates from the ecosystems of the LHs and FCs.

Chapters 7, 8 and 9 are Annexes that provide the framework and different stages for the collection of data concerning the pre-pilot, the demonstration and the replication planning of the IRIS Solutions 1.1, 1.2 and 1.3, correspondingly. Each of these chapters, presents the application area and the available infrastructure of the pre-pilots, along with a first overview of the infrastructure expected to be used during the demonstration activities. Concerning the demonstration and replication activities, it introduces the potential area, the key technical components to be used, the data management plan, the regulatory framework, the bounds/drivers for each of the LHs/FCs and very top-level information about the business models expected to be developed and applied in the course of IRIS solutions demonstration, needed to foster their maturity and economic sustainability. In short, in the Annexes one can find quite detailed information about different aspects of each of the ISs.

1.3 Relation to Other Tasks and Deliverables

The following table depicts the relation of this deliverable to other activities (deliverables) developed within the IRIS project.

Table 2 : Contribution of D1.2 to deliverables from other WPs

Deliverable Number	Contribution
D5.1, D6.1, D7.1	Report on baseline, ambition & barriers for Utrecht / Nice / Gothenburg lighthouse interventions
D5.2, D6.2, D7.2	Planning of Utrecht / Nice / Gothenburg integration and demonstration activities
D5.3, D6.3, D7.3	General Framework of the integration and implementation plan of the respective IRIS Solution to be demonstrated in Utrecht / Nice / Gothenburg
D8.1	A Roadmap for replication of activities
D8.4, D8.6, D8.8, D8.10	Vaasa / Alexandroupolis / Santa Cruz de Tenerife / Focsani replication plan
D3.2	Sustainable Business Model Dash-board tool
D3.7	Financing solutions for cities and city suppliers

D1.2 contains valuable information for the above-mentioned deliverables, as it covers a variety of topics that will be further analysed and elaborated in their context.

2. Methodology

2.1 Approach to gather information from LH/FC cities and involved stakeholders

The chosen approach served a twofold objective, while ensuring the smooth course of the IRIS project. On the one hand, it drove the process of collecting multiple-type of information (for example technical, business, lessons learned) from all different stakeholders involved in the different IRIS Solutions. The main contribution is provided from the LHs, since these are the most mature ones, having already pre-piloted the list of Solutions. On the other hand, after the consolidation of the first gathered information, it allowed each city (both LC and FC) to have a better understanding of the details of each of the IRIS Solutions. LC and FC are able to better map how the various Solutions can be demonstrated and/or replicated in their territories in a short-term perspective, not more than ten (10) years, as far as available funds become available (concerning especially the FCs).

From the perspective of IRIS aimed goals, sharing of know-how and information in general among the IRIS partners was a major priority. Important was also to enable to adapt such know how to each actor's point of view. This is in the sense that industries' needs and requirements are different from those of the citizens themselves, and in view of that condition multiple aspects have been considered when preparing this deliverable, as those of a) technical, b) regulatory, c) social and d) business aspects.

The existence of five similar deliverables in WP1 (i.e. D1.2, D1.3, D1.4, D1.5 and D1.6) made it necessary to create a common methodology for the information collection. As the deliverables require input from a large number of partners, a key element of the data collection process was the establishment of a strong collaboration between the horizontal partners involved in WP1 activities (i.e. CERTH the leader of T1.1, T1.2 and T1.3, CIVITY the leader of T1.4, and HKU the leader of T1.5) and key representatives of LH and FCs. Moreover, concrete working teams (both technical and managerial) established from all LH and FC ecosystems for the integrated solutions of each transition track.

The communication between the local ecosystems and the horizontal partners took the form of bi-monthly virtual meetings. In addition, CERTH, CIVITY and HKU created questionnaires/templates and circulated them to LH and FCs. The purpose of these templates is to update and gather more detailed information per each of the individual IRIS Solutions, based on the preliminary information included in the proposal document in section 1.3.8. The structure of the questionnaires/templates was general enough in order to fit to the needs of each Individual IRIS Solution description, as being proposed in the IRIS proposal. As Transition Tracks #1, #2 and #3 dealt with similar technologies (i.e. energy and mobility), the same template structure and process were used for the collection of information for D1.2, D1.3 and D1.4. CERTH provided detailed instructions to assist the document preparation process.

2.2 Phases in interaction with stakeholders

The deliverables preparation phase consisted of four phases, as depicted in Figure 1. Each phase involved multiple stakeholders from LHs and FCs, with the local ecosystems providing information based of the above-mentioned templates. In each phase the LH or FCs were asked to fill in specific sections of the template. Subsequently, after being delivered to CERTH, it evaluated the provided information and asked for further clarifications or corrections. A number of iterations/discussions ensured not only high-quality information, but also a high quantity.

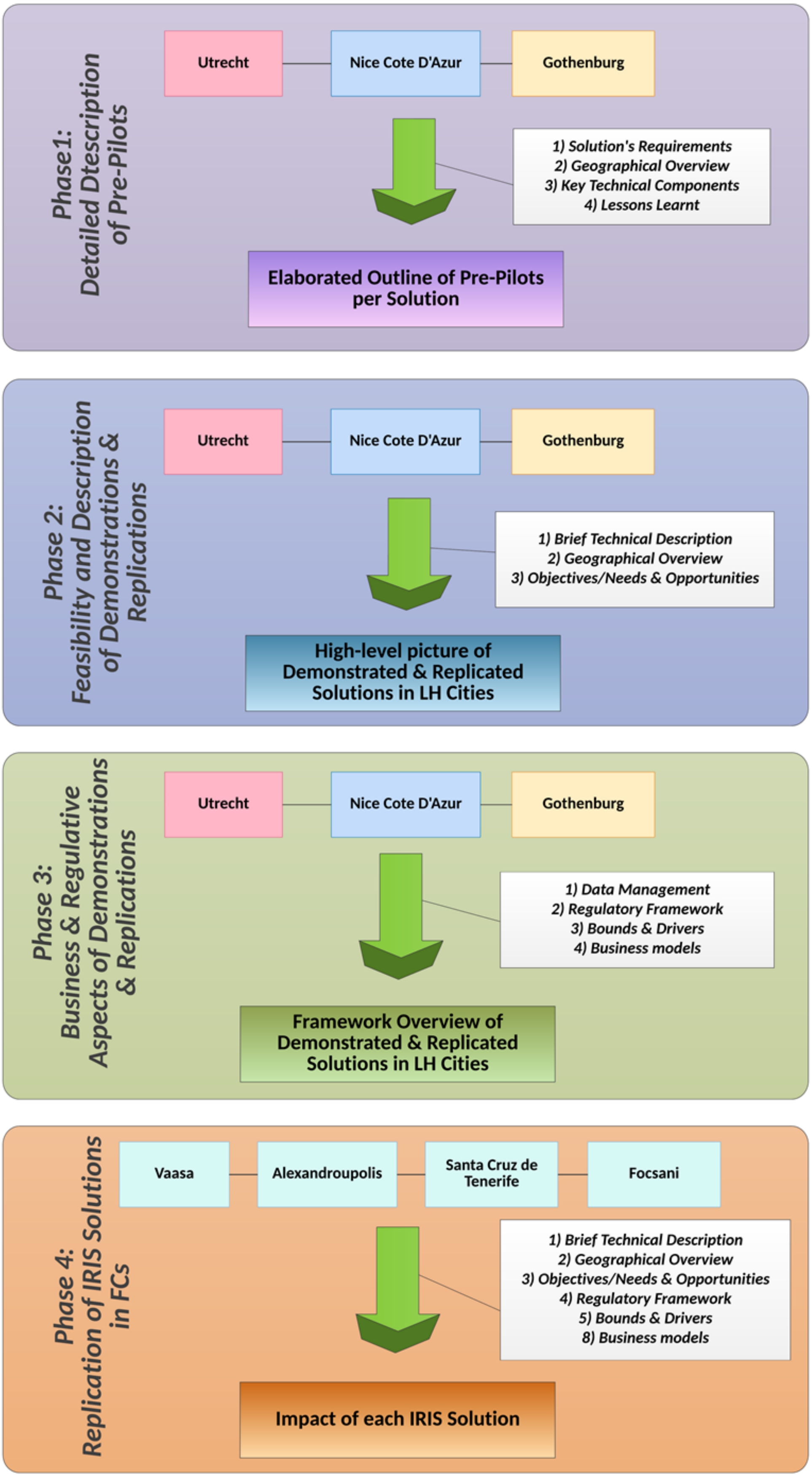


Figure 1 Phases in the preparation of D1.2

The phases with their results are described below and are further linked to each of the different sections of the annexes that present the different integrated solutions of TT1.

Phase 1: Detailed Description of Pre-Pilots **–>** Elaborated Outline of Pre-Pilots per Solution (Solution's Requirements, Geographical Overview, Key Technical Components, and Lessons Learnt).

Phase 2: Feasibility and Description of Demonstrations & Replications **–>** High-level picture of Demonstrated & Replicated Solutions in LH Cities (Brief Technical Description, Geographical Overview, and Objectives/Needs & Opportunities).

Phase 3: Business & Regulative Aspects of Demonstrations & Replications **–>** Framework Overview of Demonstrated & Replicated Solutions in LH Cities (Data Management, Regulatory Framework(s), Technology Bounds & Drivers, and Business models).

Phase 4: Replication of IRIS Solutions in FCs **–>** Impact of each IRIS Solution (Brief Technical Description, Geographical Overview, Objectives/Needs & Opportunities, Regulatory Framework(s), Technology Bounds & Drivers, and Business models).

2.3 Collaboration Procedures

A two-way collaborative relationship was established between IRIS partners that resulted in collecting the required information from both LH and FCs. The collaboration worked on two levels:

1. **At a local level** with regular meetings (every 2-3 weeks) between the partners that are involved in the implementation of the relevant integrated solutions, and
2. **At a project level** with bi-monthly meetings between CERTH, the representatives of LH cities (2 persons from each city) and the representative of FCs (Vaasa).

At the beginning of each phase, CERTH presented the requirements and the type of information that LH and FC representatives needed to gather. After an in-depth discussion, each city representative was able to guide the local partners on the collection of required information. In the local meetings, the city representatives appointed specific tasks to the partners based on their know-how and specialisation. Afterwards, the city representatives consolidated the collected information and were filling in the template, in a dynamic continuous way (according to any required updates). Subsequently, CERTH reviewed and further elaborated the contributions, made comments and asked for clarifications, during every next meeting. This iterative process lasted throughout the whole duration of Task 1.1.

A few times, bi-lateral meetings were organised between CERTH and each LH and FC, always according to the emerging needs and requirements, so that any clarifications and adjustments in the information was being made concretely and mutually agreed. In these meetings, all the relevant partners from the city were participating.

Apart from the virtual meetings, a physical one has significantly contributed to the preparation of D1.2. The **Working Session** that organised during the 2nd Consortium Plenary Board meeting in Gothenburg. It entitled **"Transition Strategy: exchange on pre-pilots"** and aimed to thoroughly discuss the pre-pilot information among core partners involved in WP1, and specific LH and FC partners that had a particular interest in pre-pilots executed in other LHs. CERTH had circulated a detailed presentation of the pre-pilots along with a questionnaire aiming to collect the cities' interests on specific integrated solutions. After the working session, all interested and relevant partners had a better understanding of the planned activities and the replication potential of each of the IRIS solutions, along with the baseline state-of-the-art and know-how basis of that. In that respect, the LHs contribution was of primary value, since in fait they form the core know-how basis among all partners of the IRIS project. The following Table 3 is presenting the time evolution of the relevant task activities throughout its whole life-cycle.

Table 3: Timeline of the different phases during the course of the task activities

Phase	Oct 17	Nov 17	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18	May 18	Jun 18
1									
2									
3						(*)			
4									
Final version									

(*) Physical Meeting – Working Session on Transition Strategy: Exchange on pre-pilots

3. Overview of the Transition Track 1: Smart renewables and closed-loop energy positive districts

The global renewable energy deployment and the international sustainable development goals towards climate protection have been one of the core areas of scientific interest of European Union (EU) for more than two decades. A remarkable growth in renewable energy consumption has been observed across the region from a 9% share in 2005 to 16.7% in 2015 due to the adoption of long-term targets and supporting policy measures. The current goal of EU is to achieve a 20% share of renewables envisioned for 2020. Towards the direction of improving the environmental conditions, the European Council established a new set of energy and climate targets addressing a minimum goal of 27% share of renewable energy consumed within the EU up to 2030 (European Council, 2014) [1]. In the context of this worldwide endeavor, many nations have signed international commitments for reducing greenhouse gas (GHG) emissions, starting with the Kyoto Protocol [2]. The European Union, according to Paris Agreement, brought forward the reduction of global carbon emissions from energy use to zero by 2060 and its maintenance at that level until the end of the century. This long-term decarbonisation strategy has a significant impact for European climate and energy objectives until 2030 [3].

The environmental quality of urban spaces is mainly affected and burdened by the building sector, the transport and the industry. The Green Paper published by the European Union estimated that the residential and tertiary sectors, the major part of which are buildings, account for approximately 40% of the energy consumption and 36% of CO2 emissions consumption in the EU and they are constantly expanding by worsening the fuel poverty and the air pollution. The recently presented new package of measures called "Clean Energy for All Europeans" comprises three proposals concerning the building sector and the sustainable development, which are a) Energy Performance in Buildings, b) Renewable Energy and c) Energy efficiency. Taking into account all the recent global and European targets towards pollution and depletion of fossil fuels mitigation, it is worth mentioning that during the 1970s the International Energy Agency (IEA) proposed the concept of Integrated Energy Planning (IEP) of cities and urban territories. The main methodologies through this concept include [2]:

- Integrated resource planning (IRP)
- Integrated assessment of supply and demand-side options (IASDO) and
- Least-cost planning (LCP)

A case study analysis operated by IRENA shows that there are various cost-effective combinations of renewable energy options to accomplish the 27% target. However, additional potentials are also identified towards exceeding this share and achieving a 33% by 2030 by the full implementation of all renewable energy options under a reference demand scenario.

Solar PV and wind power account for the largest part of capacity additions in the power sector. The potential identified would stand for 327 gigawatts (GW) of installed capacity of wind power and 270 GW of solar power, while other technologies, including biomass, hydropower, geothermal, concentrated solar power (CSP) and marine, contribute a further 23 GW.

Nevertheless, the rising share of renewable sources, which is perfectly legitimate and desirable, will pose new challenges for the operation of EU power systems. A major issue is the evaluation of power system flexibility, in order to deal effectively with the increased variability in generation expected until 2030 which will be examined in detail within TT #2.

Except the deployment and exploitation of renewable sources in electricity sector, we should also consider them for heating and cooling purposes which stand for about half of the energy demand in the EU today. Despite this share, the advances in the development of renewables has been slower than in the power sector.

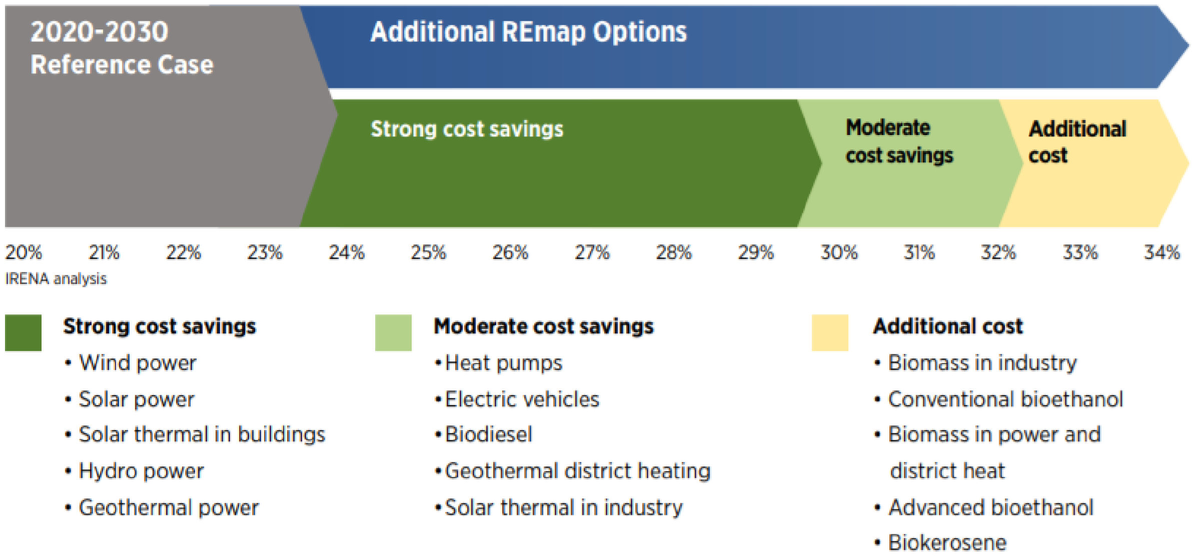


Figure 2 Renewable energy options to exceed the 27% target for 2030 [1]

The Energy Roadmap 2050 introduces six different strategies towards achieving the target of 80% reduction in annual greenhouse gas emissions in 2050 compared to 1990 levels. However, none of these scenarios involve the large-scale implementation of district heating, but instead they focus on the electrification of the heating sector (primarily using heat pumps) and the large-scale implementation of electricity and heat savings [4].

For these reasons, some innovative scenarios were deployed, in the way to deal with this issue and address the large-scale implementation of district heating. Figure 3 presents the primary energy supply for heating and cooling in buildings separate to the rest of the energy system. The results indicate that both the EU-EE and the new scenario induce the same amount of biomass and fossil fuel consumption in 2030 and 2050. The additional heat demand in the mentioned scenario is covered using clean resources. That is the utilization of many large-scale heat pumps in the district heating system, since there is a very large amount of surplus electricity production in the original EU-EE scenario. By using energy management schemes, it is possible to use fewer large-scale heat pumps in a system optimized for the integration of variable and intermittent renewable energy, since the surplus electricity available would be reduced.

Considering the integration of renewable sources and the advances in heating system at district scale, the European Union is oriented to near-zero energy districts which are an important pathway towards optimizing energy efficiency in new construction, thanks to the cost savings and the environmental and economic benefits they can provide [5].

Another aspect, that we should address at district scale concerning the energy efficiency and the energy savings, is the industrial symbiosis. This term refers to business-to-business relationships that mimic symbiotic interactions between organisms, where surplus or waste resources generated by an industrial process are captured and redirected as new input into other processes providing mutual benefits instead of being thrown away. The main objective of this concept is the use of raw materials (e.g. fuels), waste materials and energy flows among several industries, plants and companies for reducing the overall energy consumption and CO2 emissions. In 2015, EU established a roadmap for creating a circular economy society, part of which is the industrial symbiosis. This concept supports the distribution of the economy, promoting a circular mentality and considering waste as resources [6].

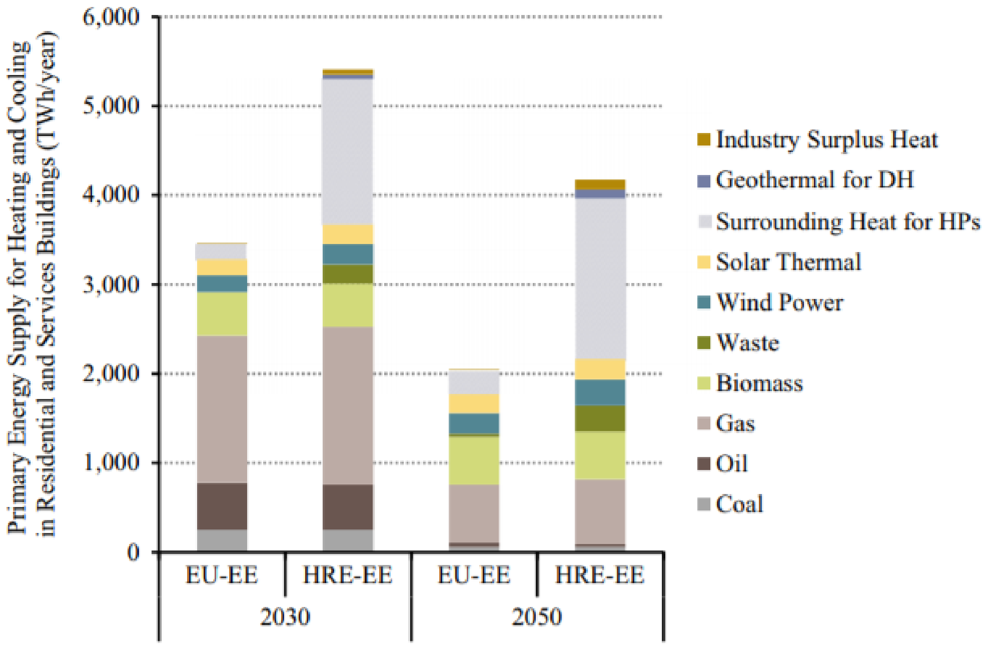


Figure 3 Primary energy supply for heating and cooling in residential and services buildings in the EU-EE and the innovative scenario for the years 2030 and 2050 [4]

Taking into account the goals around the building sector and the urban scale, in relevance with IRIS, TT #1 comprises the key points related to RES integration at building and at district scale promoting the local self-consumption. In addition, it addresses the energy efficiency and to energy savings in the district heating system with the deployment of Low Temperature system. Finally, within the district scale framework, it presents the symbiotic networks and their direct connection with the circular economy promoted by the EU.

In order to cover the business aspects of the proposed systems as well, IRIS will examine and demonstrate a number of business models applicable to each solution which could affect and support the impact and the replicability of the solutions. The given information around these aspects is very limited and only the possible framework is mentioned in the corresponding Annex of this deliverable.

Concluding, the general concept of TT #1 is, in brief, to test and optimize the energy performance and efficiency of integrated renewables in buildings, to expand the idea of integration at district scale in combination with energy efficient district heating networks, but also to deploy the exploitation of waste streams and material promoting the industrial symbiosis and the circular economy. This set of new proposed technology solutions can be considered within the concept of smart grid development and the European energy market aiming at fulfilling the requirements imposed by various stakeholders.

The main objective of this deliverable is to define the framework of the solutions to be demonstrated and replicated in the framework of IRIS, allowing them to be an upcoming opportunity for exchanging know-how, ideas and experiences, before proceeding to the holistic evaluation of them based on the demonstration activities results taking place during the next two-three (2-3) years of the project. Furthermore, expect from technical requirements, other key aspects are also quite sufficiently depicted, such as: a) data collection and management, b) regulatory framework, c) business models and d) any potential bounds and drivers within the city framework.

The next sub-sections describe the scope of each Solution of TT#1, as well as the activities that are to be undertaken. Handy tables provide information about:

- **Pre-pilots:** Key points that describe the proposed solutions and the pre-pilot activities, as well as their area and the lessons learnt.
- **Demonstrations:** Key points that describe the proposed solutions and their demonstration, as well as the area of each LH city that will accommodate it.
- **Replications:** Key points that describe the proposed solutions and their demonstration, as well as the area of each LH and FC that will accommodate it.
- **Perspectives:** Brief information is provided about the needs that have occurred and the opportunities that are presented in the LH and FCs because of the IRIS activities of TT#1. Moreover, bounds and drivers are listed concerning the undertaking of demonstration and replication activities in LH and FCs. Finally, there is the methodology and objectives of the data collection in the demonstration activities by the LH cities.

3.1 IRIS Solution IS1.1 (Positive Energy Buildings)

3.1.1 *Scope and Description*

IS 1.1 mainly addresses the building sector, energy consumption needs and energy savings measures at building scale. As mentioned above, buildings accounts for approximately 40% of energy consumption and 36% of CO2 emissions in the EU. Building energy consumption is mainly related to heating ventilation and air-conditioning (HVAC) systems, domestic hot water (DHW) systems and electrical purposes. In addition, about 35% of the EU's buildings are over 50 years old and almost 75% of the building stock is energy inefficient, while only 0.4-1.2% (depending on the country) of the building stock is renovated each year. Therefore, more renovation actions on existing buildings have the potential to induce significant energy savings, potential reduction of EU's total energy consumption by 5-6% and of CO2 emissions by about 5% (Figure 4).

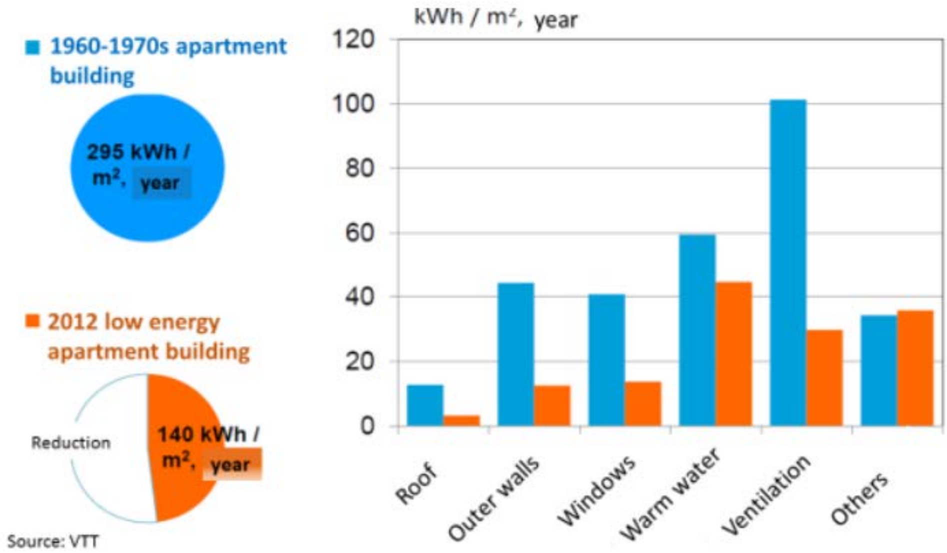


Figure 4 An example of the energy consumption differences between old and modern low-energy buildings [7]

Energy policies of EU cover both new buildings and existing buildings. The European Directive 2002/91/EC, called Energy Performance Building Directive (EPBD), indicates the fact that buildings will have an impact on long-term energy consumption and new buildings should therefore meet minimum energy performance requirements, according to the local climate.

The renovation along with RES integration can improve significantly the energy efficiency of buildings by generating accompanying economic, social and environmental benefits. Buildings with better energy performance provide higher levels of comfort for their occupants and improve health by reducing humidity in homes. It also has a major impact on the affordability of housing bills and on the concept of fuel/energy poverty [11].

Thus, the integration of energy positive buildings is leading a) to maximize the energy consumption from renewable power generation, b) to increase local self-consumption and c) to reduce the household energy bills which is very important especially for the vulnerable groups of consumers [16, 17].

In order to associate the concept of energy positive buildings with the business economic benefits, we can present the Life Cycle Costs (LCC) versus the annual primary energy demand, as in the following figure. In this representation, we can consider the positive energy buildings instead of nZEBs.

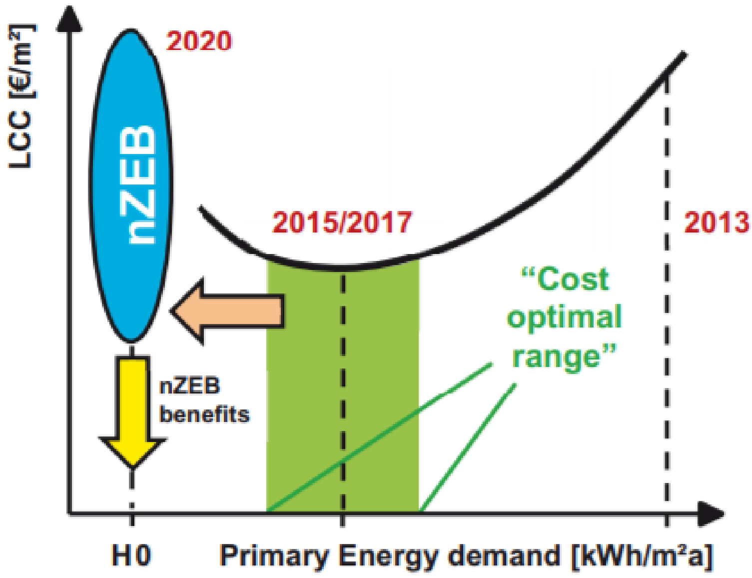


Figure 5 Schematic representation of LCC in current and future situation [8]

Initially, LLCs and primary energy demand are high. By applying building energy saving measures, buildings are already possible within the "cost optimal range". By creating nZEBs (by applying more energy saving measures) LLCs rise. By including additional benefits of a healthy nZEBs (increased comfort, reduced humidity and illnesses) into the LCC calculation, LLCs of nZEBs are reduced.

IRIS's objective is to demonstrate the integration and use of different technologies in buildings, capable of producing excess of energy for cooling and heating along with electricity (Plus-energy blocks), which can be redistributed to any connected with the buildings networks (MV/LV electricity grid or district heating/cooling networks). Gothenburg city has a considerable know-how on necessary technologies, allowing Utrecht and Nice to familiarize themselves with those and replicate them in their territories. The local production of cooling, heating and electricity, together with local energy storages can be integrated in the city energy system to optimize the use of resources. The associated studies and demonstrations of this technology can define and evaluate the value of what it means for humans to play a value-adding role in the ecological systems where they are primary constituents.

The IS1.1 is based on two pre-pilots in the city of Gothenburg and it is going to be demonstrated in Nice and in Gothenburg. The innovative pre-pilots collected in the Lighthouse cities related to Positive Energy Buildings will be the basis for the IRIS demonstration and replication activities.

The following innovative Positive Energy Buildings Solutions are expected to be demonstrated within the IRIS framework:

- **Collective self-consumption at building scale** for commercial and residential customers with the integration of PV panels on the buildings in France. This concept will be tested in **Nice Meridia** on **two positive energy buildings under construction**.
- **Local production at building and at district scale** in **Riksbyggen area** in **Gothenburg**. The total energy will be produced for electricity of solar PV panels, for heat from geothermal energy with heat pumps and for cooling from geothermal energy.

IRIS activities involve the demonstrations based on pre-pilots by the LH cities and the replications by LH and FC. The following table represents the participation of each LH city in the IRIS activities concerning IS1.1:

Table 4: Overview of IS 1.1

<table>
<tr><th></th><th>Pre-pilot</th><th>Demonstration</th><th>Replication</th></tr>
<tr><td>Utrecht</td><td></td><td></td><td>Deep retrofit of buildings</td></tr>
<tr><td>Nice Cote d'Azur</td><td></td><td colspan="2">PV production
Electric storage</td></tr>
<tr><td rowspan="3">Gothenburg</td><td colspan="2">PV production
Electric storage</td><td rowspan="3">TBD</td></tr>
<tr><td colspan="2">Thermal inertia</td></tr>
<tr><td>Deep retrofit
Solar heating system</td><td>Geothermal energy
Water buffer tanks
Storage in boreholes</td></tr>
</table>

- **Utrecht** will take advantage of the knowledge for positive energy new and deep retrofit buildings
- **Nice Cote D'Azur** will extend the PV production and Electric storage from demonstration to replication.
- **Gothenburg** will use the existing expertise of the pre-pilot and it will integrate to demonstration different innovative technologies.

The **main innovative technologies** which will be used are the followings:

- energy efficient building envelopes, appliances, ventilations systems etc. to minimise the use of energy
- local production of electricity with solar PV
- local production of heat from geothermal energy (2-300m deep boreholes with heat pumps)
- local production of cooling from geothermal energy (2-300m deep boreholes, without chillers)
- electrical storage, Li-Ion batteries
- short time thermal storages, buffer tanks and the thermal inertia of the building frame
- long-time thermal storage (2-300m deep boreholes)

All these aspects will be demonstrated on the context of a) optimum design and use of building services, b) user behaviour laws promoting careful attitude and definition of thermal comfort zones.

Another **innovative element** is the constant oversight of the new technologies implementation which contributes to a certain extent to the efficiency and improvement of the solution.

Most technologies are already at (TRL9), because they are already implemented in the context of similar sustainable solutions. On the other hand, concerning the electrical storage, Li-Ion batteries are still at TRL 8, since this technology is currently developed, and it has not been widely implemented due to its cost. On the other hand, concerning the electrical storage, Li-Ion batteries are still at TRL 8, since this technology is currently developed, and it has not been widely implemented due to its cost. In addition, the thermal inertia and the long-time thermal storage are more recent technologies. During the project, these components will be integrated, tested and evaluated against the performance expectations, increasing the TRL after the end of the project.

Two tables presenting an overview of the pre-pilot, demonstration and replication of the IS 1.1 solutions at the LH and FC (only replication) are included in the following subsections, while the details are included in the annexes to this deliverable.

3.1.2 *Overview of pre-pilot, demonstration, replication of LH Cities*

		Utrecht	Nice Cote D' Azur	Gothenburg
Pre-Pilot	Key Figures / Points			**Pre-Pilot 1:** Integration in **4 "sunhouses"** energy saving and energy producing technologies: The combination of technologies to corresponds to **3 Use Cases**: 1. **2 Houses** including: a) solar collectors on the roof (for heating water), b) heat recovery from ventilation, c) additional insulation on the roof, d) glazed balconies and built-in staircases , e) low energy windows, f) new laundry rooms, g) individual measurement and h) storage battery tanks 2. **House 3** including: a) solar heating system (solar collector) connected to the district heating system and b) several solar cells connected to the mains 3. **House 4** will retrofit PV panels **Pre-Pilot 2:** Green building with glazed indoor environment comprising: a) 50 m2 of solar cells on the roof, b) air conditioning systems with low pressure drop, c) high efficiency on heat recovery and recovery of heat from the server room etc. It is connected to district heating and the premises are heated via radiators (controlled by VAV).
	Area			# 1 District of Gardsten in the northern suburbs of Gothenburg # 2 District of Krokslatt
	Lessons Learnt			**Pre-Pilot 1:** • Reduction of energy consumption and switch to

		Utrecht	Nice Cote D' Azur	Gothenburg
Demonstration				sustainable activities • Raise of socio-economic potential of the district (e.g. vacancies decreased, no empty apartments, new jobs etc.) • Self-sufficiency of the district concerning the heating • Increasing portion of PVs **Pre-Pilot 2:** • Reduction of energy consumption according to national regulations • Residents' satisfaction with the indoor climate and thermal comfort
	Key Figures / Points		Collective self-consumption at building scale will be tested on two positive energy buildings under construction. The concept is about to make several electricity consumers located in one single building benefit from the electricity produced by a PV system installed on the same building. Comprising the following: 1. PV 89 kWc, 445m2 and 179,4 kWc, 848m2 respectively 2. Electric battery storage 3. District heating and cooling system	Integration of local production of cooling, heating and electricity, together with local energy storages in the city energy system to optimize the use of resources and minimise primary energy needed. The system will include: 1. 140 kWp solar PV 2. Heat from geothermal energy with heat pumps (230m deep boreholes) 3. Cooling also from geothermal energy 4. Local energy storages of water buffer tanks 5. Thermal inertia of the building 6. Long-time storage in the boreholes 7. 200 kWh 2nd life Li-Ion batteries The house will be connected to the electrical grid, the DHN and also with a nearby office building to exchange energy for cooling purposes.
	Area		Nice Meridia district	Riksbyggen's brf Viva next to Chalmers campus Johanneberg

		Utrecht	Nice Cote D' Azur	Gothenburg
Replication	Key Figures / Points	Deep retrofit of buildings 8 potential buildings of InterVAM type (DoA)	The solution tested in the demonstration area will be duplicated.	No available data yet
	Area	No available data yet	Nice Eco Valley district	Additional new areas
Perspectives	Opportunities & needs	• Increase in RES production • Establishment of a robust DHN • Sustainable heating system technologies • Contribution to the building companies' projects and to socio-economic development	• Self-consumption helps European consumers and businesses to control their energy bill • Self-consumption lessens the burden on regional medium and low voltage grids • Self-consumption increases retail competition and helps market transformation • Self-consumption makes consumers active players of the energy transition	• Use of resources optimization and primary energy requirements reduction • Short - time and long - time thermal storage • Reduction in GHG emissions • Contribution to local trading system projects and to socio-economic development
	Data Collection			No available data yet
	Bounds & drivers	No available data yet	No available data yet	No available data yet

3.1.3 *Overview of the replication of Follower Cities*

	Vaasa	Alexandroupolis	Santa Cruz Tenerife	Focsani
Key Figures / Points	Positive energy buildings technologies adjusted to local conditions including: • Energy efficient building envelopes, appliances, ventilations systems etc. to minimise the use of energy (TRL9) • Local production of electricity with solar PV (TRL9) • Local production of cooling from geothermal energy (2-300m deep boreholes, without chillers) (TRL9) • Short time thermal storages, buffer tanks and the thermal inertia of the building frame (TRL7->9) • Long time thermal storage (2-300m deep boreholes) (TRL7->9)	Particular focus on energy efficient buildings, since 40% of the total energy consumption of the Municipality is due to the inadequacy of the building stock. Technologies to be replicated: • Local solar PV electricity production • Utilisation of geothermal energy • Electrical storage with Li-Ion batteries • Short and long term thermal storage applications	Positive energy will be implemented on two public buildings, including the following specific technologies: • Energy efficient building envelopes, appliances, ventilations systems etc. to minimise the use of energy • Local production of electricity and hot water with solar PV and thermal panel	
Area	Ravilaakso	Kallithea-N.Chili	Two public buildings of the municipality in San Andrés District	
Opportunities & needs	• Stops using fossils fuels • Reduction in GHG emissions • Increased use of renewable energy resources • Use of resources optimization and primary energy requirements reduction • New smart buildings integration • Development of demand/response flexible networks and behavioral change of end-users	• Energy efficiency of Heating and Cooling system • New smart buildings Integration • Increase share of RES in the energy mix • Reduction in GHG emissions	• Increase of energy production from RES, especially PV • Reduction in GHG emissions • Demonstrate public leadership on RES	
Bounds & drivers	Cost-effective solutions should be adopted for long winter period: **Technical:** High level of insulation and triple-windows **Financial:** Cost of energy positive buildings is	**Technical:** Deep renovation of existing building stock towards positive energy building may be considered as a technical barrier and as a driver for the development of solutions required for the specific climate conditions of Greece	No available information yet	

	regarded too high when comparing to the selling price and the market behaviour should be changed, so that customers will require housing where energy cost is clearly lower compared to current market.	(south Europe) **Legal:** It can be considered as a low impact incentive and therefore, current framework is considered as neutral in terms of positive energy buildings. **Social:** Private ownership of apartments and houses constitutes a significant barrier for the potential implementation of such project (e.g. in apartment buildings). **Financial:** The increased capital of such projects constitutes an important barrier, considering the fact that there is no incentive (e.g. tariff of excess energy). **Environmental:** The implemented measures provide the opportunity to achieve a substantial reduction in CO_2 emissions and to improve the indoor climate of the buildings.		

3.2 Overview of Solution IS1.2 (Near Zero Energy Retrofit District)

3.2.1 *Scope and Description*

The concept of positive energy buildings can be expanded at district level forming self-sufficient urban regions. An article titled "Building the Cities of the Future with Green Districts" examine the concept of "green districts". They define a green district as "a densely populated and geographically cohesive area that is located within a city and employs technologies and design elements to reduce resource use and pollution." In the way to understand how the energy balance is adjusted within a near zero energy district, we should consider the system boundary of a near-Zero Energy Building which is a core component of it.

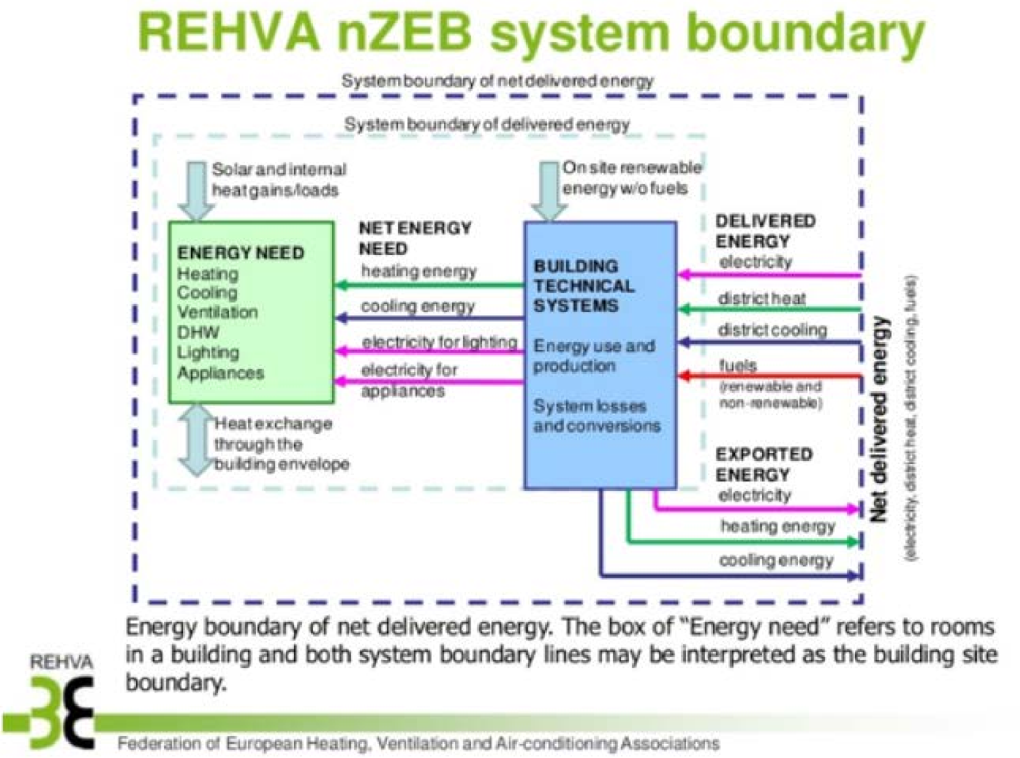


Figure 6 Scheme of delivered- and on-site-energy energy production and their influence on energy calculations [9]

The above figure addresses the energy requirements and the system specifications and boundaries while taking into account the energy exchanged with the district heating network for heating and cooling purposes, expect that for electricity [10].

The orientation to near zero energy district has a consequence a) to maximize energy production and consumption from RES, b) to increase self-consumption at district scale, c) to decrease the household bills in combination with better comfort levels and d) to develop the integration of energy sustainable solutions in a wider area with different individualities [12, 13].

IRIS aims to demonstrate the integration and use of different technologies in existing apartment buildings capable of covering their energy needs, concerning electricity, heating and cooling. The focus of this solution is integration solutions to create a Near- Zero Energy Retrofit district, by reducing energy consumption and increasing renewable production. The value of this solution for the citizen lays in more stable and lower housing bills, in combination with higher comfort/less draught and humidity in homes.

The IS1.2 is based on 3 individual pre-pilots in Utrecht, 3 pre-pilots in Nice and two pre-pilots in Gothenburg. The solution is going to be demonstrated in Utrecht, Nice and Gothenburg. The innovative pre-pilots collected in the Lighthouse cities related to Near Zero Energy Retrofit Destrict will be the basis for the IRIS demonstration and replication activities.

The following innovative Near Zero Energy Retrofit District Solutions are expected to be demonstrated within the IRIS framework:

- Near zero energy building (NZEB) retrofit in social housing sector
- Smart street lighting
- Smart hybrid heat pumps
- Energy efficient deep retrofitting
- District heating optimization
- Citizen Utilities Savings through Awareness
- House with integrated technologies in façade and roof
- Geothermal energy for preheating incoming ventilation

IRIS activities involve the demonstrations based on pre-pilots by the LH cities and the replications by LH and FC. The following table represents the participation of each LH city in the IRIS activities concerning IS 1.2.

Table 5: Overview of IS 1.2

<table>
<tr><th></th><th>Pre-pilot</th><th>Demonstration</th><th>Replication</th></tr>
<tr><td rowspan="2">Utrecht</td><td rowspan="2">Building's retrofitting
PV panels
Wind energy
DC street lighting
Smart hybrid heat pump</td><td colspan="2">PV panels
HEMS TOON
Refurbishing towards NZE
Smart (hybrid) electric heat pumps</td></tr>
<tr><td>Smart AC/DC power grid</td><td>LT district heating
DC switchbox</td></tr>
<tr><td>Nice Cote D'Azur</td><td>Deep retrofitting
Solar DHW
Smart metering
Monitoring
Applications
Optimization actions</td><td>Commissioning service
Optimization of distribution system
Smart metering</td><td>Optimization of heating load curve</td></tr>
<tr><td>Gothenburg</td><td>Deep retrofitting
Geothermal energy</td><td>Building Integrated PVs (BIPV)</td><td>Integrated solar PVs
Interconnection with DC cable</td></tr>
</table>

- **Utrecht** will focus on buildings retrofitting, but it will also integrate PV panels, Smart heat pumps and Smart AC/DC grid. In, addition, the DC street lighting will be addressed in pre-pilot stage.
- **Nice Cote D'Azur** will demonstrate and replicate some of the technologies used in the pre-pilot with emphasis on commissioning, optimization actions and smart metering.
- **Gothenburg** will check retrofitting solutions, but mainly the PV building integration.

The **main innovative technologies** which will be used are the followings:

- high share of locally produced and consumed renewable power at district scale making PV profitable without subsidies (TRL9)
- PV and LT for the DHN partly serving the district (TRL8->9)
- innovative home energy management system HEMS TOON (TRL8)
- energy savings thanks to refurbishing towards NZE 4-storey apartment buildings (TRL9)
- smart (hybrid) gas-electric heat pumps for heating and hot water (TRL8->9)
- energy savings thanks to smart AC/DC power grid in apartments (TRL7->8)
- smart DC street lighting at district level (TRL7->8)
- commissioning process to check from the design to the operation that innovative technologies have been correctly implemented (TRL:8)

As a next stage, these solutions are integrated into one smart micro-grid at district level, a stepping stone towards a NZE district composed of existing buildings with mainly social housing apartments.

Some technologies are already at (TRL9), because they are already applied and tested during similar projects and initiatives. In the framework of this project, the components which are under TRL9 will be integrated, tested and evaluated against the performance expectations with the scope of increasing the TRL after the end of the project.

Two tables presenting an overview of the pre-pilot, demonstration and replication of the IS 1.2 solutions at the LH and FC (only replication) are included in the following subsections, while the details are included in the annexes to this deliverable.

3.2.2 *Overview of pre-pilot, demonstration, replication of LH Cities*

		Utrecht	Nice Cote D' Azur	Gothenburg
Pre-Pilot	Key Figures / Points	**Pre-Pilot 1** including: 1. Prefabricated front parts, equipped with solar panels on the outside and a heating unit on the inside 2. Integrated PV panels and wind energy installation **Pre-Pilot 2** including: 1. Retrofitting of existing lampposts with innovative armatures including controls for dynamic lighting, remote monitoring and sensoring 2. Self-sufficient (powered by individual PV-cells) lampposts 3. 69 LED luminaires have been installed **Pre-Pilot 3** including: 1. Smart hybrid heat pump combining a small heat pump (powered by locally produced PV power) with the (existing) high-efficiency gas-fired condensing boiler	**Use Case 1** including: 1. External thermal insulation of the building envelop 2. Replacement of exterior joinery 3. Thermal insulation of rooftop terraces with repair of the waterproofing 4. Thermal insulation of basements 5. Installation of low pressure controlled ventilation with self-adjusting air inlet 6. Rolling out of excess flow valves on all domestic hot water draw-off points 7. Installation of a centralized solar DHW production 8. Implementation of low energy lighting in the common space **Use Case 2** including: 1. Monitoring of the hourly energy and water consumptions of the boilers plant and the buildings sub-stations 2. Identify optimization actions at district heating and buildings scale **Use Case 3** including: 1. Smart metering 2. Data collection 3. Dedicated application for tenants and for social landlord 4. Individual coaching	**Pre-Pilot 1** including: 1. Retrofitting to passive house 2. Solar PV panels 3. Triple-glazed window upgrade 4. Heat recovery ventilation (MVHR) unit with 85% heat recovery efficiency 5. Installed new PHI-certified windows 6. Insulated attic 7. Insulated façade and included balconies into thermal envelope **Pre-Pilot 2** including: 1. Geothermal collected from boreholes for preheating incoming ventilation to no lower than -5 degrees Celsius during winter
	Area	Overvecht district, Bicycle lane Papendorpsepad, Groningen	Les Moulins	North-eastern part of Gothenburg, Chalmers Johanneberg Campus

		Utrecht	Nice Cote D' Azur	Gothenburg
	Lessons Learnt	**Pre-Pilot 1:** • Feasibility of renovation of a high rise building with deep energy savings measures combined with production of PV panels • Additional energy production is needed through wind generator or PV panels • Feasible cost reductions by starting producing the pre-fabricated parts on an industrial scale **Pre-Pilot 2:** • Lower costs as there is no need to install pipes and cables from the main power grid to the public area • No need for converters • DC cables are thinner than AC cables **Pre-Pilot 3:** • Cost reduction for space heating and hot water • Savings up to 40% - 55% on CO_2 emissions from natural gas in a household	**Use Case 1:** • Energy bill reduction for tenants by a factor of 3 regarding baseline situation • Positive effects on thermal comfort conditions • Many building pathologies have been corrected thanks to these measures • Improvement of living environment for tenants due to the renovation and beautification of the exterior common area **Use Case 2:** • Data collected since the beginning of the pre-pilot have not been analysed yet, since it is an on-going process **Use Case 3:** • Time savings and improvement of relationship with tenants through the problem report function • Time savings and improvement of relationship with tenants through the inside temperature monitoring, in case of claims from the tenants related to the heating • Improvement of relationship with tenants through communication and coaching about new space heating and ventilation • Reduction of insurance cost due to the water consumption real time monitoring • Reduction of unpaid rents due to tenants savings	**Pre-Pilot 1:** • The consolidate conclusions are not available yet **Pre-Pilot 2:** • Increasing property savings per year • Reduction of energy peaks with subsequent reduction of CO2 emissions • Costs savings for energy suppliers

		Utrecht	Nice Cote D' Azur	Gothenburg
Demonstration	Key Figures / Points	Demonstrate how energy streams can be jointly used in such a way that a maximum of RES penetration at district-scale becomes possible (storage of locally produced electricity in 2nd life batteries) including: 1. PV panels on the roofs of the apartment buildings and the schools 2. Home Energy Management Systems (EMS) TOON 3. Energy savings as a result of refurbishing towards near energy zero building 4. Smart (hybrid) electric heat pumps for the production of heating and hot water 5. Energy savings as a result of smart AC/DC power grid in apartments	Refurbishment of five degraded mid-rise and high-rise buildings Corresponding to: **#Use Case 1**: Implementation and test of the REPERE method, a commissioning service to assess the real energy performance and savings related to building energy refurbishment **#Use Case 2:** Optimization of the energy distribution system in buildings **#Use Case 3:** Test of new energy awareness services, including smart metering to track water and energy consumption, data collection through wireless sensors, so as to raise awareness and promote behavioral change	• Demonstration of how Building Integrated Photovoltaics (BIPV) can be used in façade and roof renovation process • Solar panels with amorphous silicon and with monocrystalline silicon will be tested and analysed. • Analysis of how different solar panels work on different types of shading The PV panel system also include: 1. String optimisation 2. Inverters (DC/AC) 3. Battery function
	Area	Kanaleneiland Zuid district	Les Moulins	Johanneberg district
Replication	Key Figures / Points	• PV panels on the rooftops of the apartment buildings • Home Energy Management Systems (EMS) Eneco TOON • Energy savings resulting from refurbishment towards near energy zero building • Smart (hybrid) electric heat pumps for the production of heating and hot water / Low Temperature District heating for heating and hot water • DC switchbox pilots in 4 apartments	No available data yet	Renovation project consists of four multi-family houses: • Roof construction of integrated solar PV • Interconnection with a DC cable to enable exchange of electricity between the houses
	Area	Kanaleneiland and Overvecht	Les Moulins	Kviberg district

		Utrecht	Nice Cote D' Azur	Gothenburg
Perspectives	Opportunities & needs	• Renewal of the energy infrastructure • Heating and cooling system • Software equipment development • Stable and lower housing bills in combination with higher comfort in homes • Local renewable production	**#Use Case 1:** • Facilitate the identification and mitigation of any issues related to the process of building refurbishment • Compare the predictions in the design phase of the building's energy requirements with the real energy performance monitored • Tease out differences related to poor implementation or defaults from differences related to occupants 'misbehaviour' • Propose corrective measures designed to bridge the possible gap between forecast and measured energy performance • Advise users to ensure proper use of building-plant system and practices through the monitoring of their energy behavior **#Use Case 2:** No available data yet **#Use Case3:** No available data yet	• RES contribution to Near Zero Energy Buildings • Investigation of the feasibility of the innovative insulation components
	Data Collection	• Energy consumption on the household's level • Energy consumption and production on the apartment building level • Electricity production of the PV panels • Consumption of locally produced electricity with the PV panels • DC electricity consumed by households (AC/DC switchbox) • DC electricity consumed by street lighting • The amount of CO2 savings can be	No available data yet	• Data of solar electricity production and usage, including allocation and transmission between the different house bodies • Ambition to visualise energy flows for all tenants in the houses

		Utrecht	Nice Cote D' Azur	Gothenburg
		calculated easily by the production and consumption data		
	Bounds & drivers	**Technical:** Insulations measures will be applied to reduce energy demand of the apartment building **Legal:** Currently there is uncertainty with households regarding financial incentives for electricity production with solar panels. **Social:** In order for the renovation to take place, 70% of the tenants need to agree with the renovation plans **Financial:** Potential driver for the renovation is the fact that provides tenants with the opportunity to lower their expenses for housing **Environmental:** The implemented measures provide the opportunity to achieve a substantial reduction in CO_2 emissions and to improve the indoor climate of the homes	No available data yet	The same as in Utrecht

3.2.3 Overview of the replication of Follower Cities

	Vaasa	Alexandroupolis	Santa Cruz Tenerife	Focsani
Key Figures / Points	Retrofitting of buildings, so as to improve their energy efficiency near to 0-energy level with increase of the use of renewable energy The main technologies to be used are those mentioned in the introduction of the solution	The technologies of main interest include: • Solar PVs • Energy management systems for households • Smart gas-electric heat pumps • Smart AC/DC power grid • Smart DC street lighting • Smart micro-grids	Transformation of two pairs of public social housing into low carbon buildings, including energetic and building envelope audit in order to define a set of measures for energy saving as well as to measure PV and hot water solar Other technologies of main interest include: • Energy management systems for households • Smart DC street lighting • Smart micro-grids	Interested in increasing energy efficiency and utilization of renewable energy sources for several public and administrative buildings. Energy efficiency measures including: • Retrofitting the buildings • Thermal insulation of buildings • Improvements of the heating system of the buildings • Utilization of PV panels for electricity generation for own consumption and for exporting into the grid • Utilization of passive solar panels for heat generation for domestic warm water and for heating • Modernization of street lighting using LED technology and possible PV panels for charging
Area	Ristinummi in eastern part of Vaasa	Western part of the city	Eastern part of the city of Santa Cruz de Tenerife	Main district, Municipality
Opportunities & needs	• Renewal of the energy infrastructure • Reduction of CO2 emissions • Increased use of renewable energy resources and local renewable production • Use of resources optimization and primary energy requirements reduction • Behavioural changes through	• Near Zero energy performance of buildings • Behavioural changes through energy awareness services • Smart metering, Display monitors and apps • Use of resources optimization and primary energy requirements	• Near Zero energy performance of buildings • Creating a replication model	• Near Zero energy performance of buildings • Behavioural changes through energy awareness services • Smart metering, Display monitors and apps • Creation of value to utilities companies through improvement of customer relationship • Smart and renewable street lighting

	energy awareness services	reduction		• Creating a replication model
Bounds & drivers	**Technical:** Challenges with retrofitting are high when building standards have been higher already than in central of south Europe (double windows, insulation etc.) **Legal:** Retrofitting will require decision from the Pikipruukki or VOAS and most likely external funding sources (state, EU) have to be in place for the replication activity **Social:** Employment, integration etc. should be improved together with technical improvements to the buildings **Financial:** Poor families do not have funds to invest on retrofitting or pay extra cost for retrofitting (possible increase in rent does not compensate decrease in utility bills **Environmental:** Old housing stock is large and impacts to emission and energy consumption are higher than with new buildings	**Technical:** Novel technologies such as hybrid heat pumps may present a technical barrier. The need to develop nearly zero energy retrofitted districts will act as a driver for development of technical solutions required **Legal:** Currently there is uncertainty with households regarding financial incentives for electricity production_with solar panels **Social:** Private ownership of the replication constitutes a significant barrier for the potential implementation of such project **Financial:** Potential driver for the renovation is the fact that it provides tenants with the opportunity to lower their expenses for housing **Environmental:** The implemented measures provide the opportunity to achieve a substantial reduction in CO2 emissions, and to improve the indoor climate of the homes	**Technical:** Technologies related to PV, solar heated domestic hot water are already mature (TRL9). There is an PV heating domestic water system that need to be further study to reduce heat loss in tube transportation. **Legal:** Currently there is still some uncertainty with households regarding financial incentives for electricity production with solar panels. **Social:** Renovation plans in social housing are complicated because it normally requires some social economic input to these initiatives. And depending the state of the situation regarding building stake holding the possibilities will vary. This requires careful communication with the tenants and good communication to clarify pros en cons of various measures. **Financial:** Potential driver for the renovation is the fact that it provides tenants with the opportunity to lower their expenses for housing. This is very relevant as this is a neighbourhood with a high share of low-income households. This is, however, also a potential barrier as tenants are seeking guarantees on presented benefits before they are willing to accept the renovation.	**Technical:** One bound can be Due to different specific issues for any analyzed case/building the utilization of a certain technology cannot be possible. A driver in this case can the fact that in Romania these solutions have not been implemented before on a large scale, so today there can be used the best available technologies on the market. **Legal:** There are still Bounds regarding legal framework, especially with lack of some secondary legislation. On the other hand, Romanian legal framework should completely align to EU legislation, which can be considered as a Driver for the future project development. **Social:** There are still a need for increasing the awareness of population regarding the energy efficiency concept and utilization of renewable energy sources. **Financial:** On the local/national level there is a bound regarding the available financing from the Government. On the other hand, there is available financing through different EU funded programs. **Environmental:** All energy efficiency measures and utilization of renewable energy sources can surely lead to reducing pollutant emissions and thus reducing environmental impact.

3.3 Overview of Solution 1.3 (Symbiotic waste heat networks)

3.3.1 *Scope and Objectives*

This solution addresses the concept of Industrial symbiosis which is a cooperation where two or more industrial partners carry out joint solutions to obtain mutual benefits. The most common being companies exchanging resources in terms of material, water and energy. In other words, one company's byproduct/side stream becomes the input of the other company in its direct or indirect production. Full utilization of residual flows is often the purpose, preferably in a cascade. Otherwise (down-cycled) lower-value streams are "recycled" in productions where quality satisfies the need. One example is deionized cooling water that can be included directly as makeup water or steam (higher temperature). It becomes useful district heat quality (lower temperature) after serving in a process. Another example being organic wastewater from which energy can be utilized in different ways before ordinarily treated.

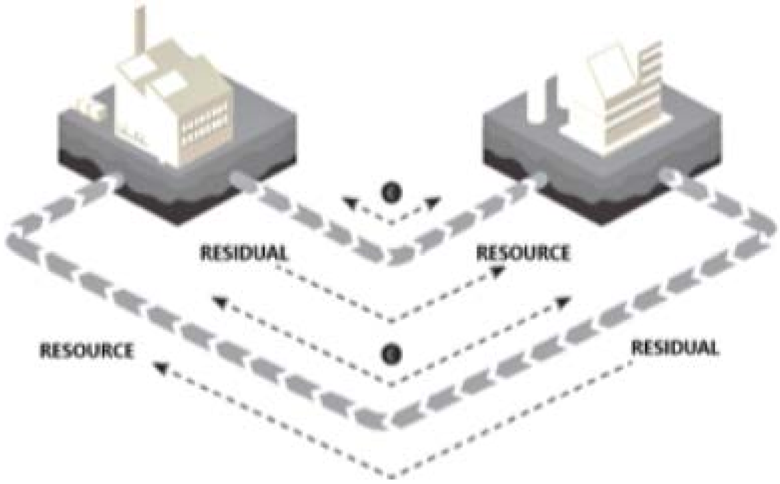


Figure 7 The concept of industrial symbiosis [6]

IRIS aims to replicate already conducted studies and demonstrations for waste heat utilization, originating from different plant sources, as an alternative high efficiency pathway for energy production, in line with EU policy makers about promotion of industrial symbiosis, already having proven that citizens can benefit from that. These activities will be super-visioned by smart energy management schemes (SEMS), for which all three LHs have a considerable know-how to develop and apply in real-life actions.

The IS1.3 is based on 1 pre-pilot in Nice and 2 pre-pilots in Gothenburg. The solution is going to be demonstrated in Nice. The innovative pre-pilots collected in the Lighthouse cities related to Positive Energy Buildings will be the basis for the IRIS demonstration and replication activities.

The following innovative Near Zero Energy Retrofit District Solutions are expected to be demonstrated within the IRIS framework:

- High energy content biogenic fuels from sewage sludge plant for the production of heat and electricity
- Biogas is upgraded to natural gas for heating purposes
- Connection between a ferry and the District Heating system

IRIS activities involve the demonstrations based on pre-pilots by the LH cities and the replications by LH and FC. The following table represents the participation of each LH city in the IRIS activities concerning IS1.3:

Table 6 : Overview of IS 1.3

	Pre-pilot	Demonstration	Replication
Utrecht			Heat production from waste water treatment
Nice Cote d'Azur	Waste heat production for heating and electricity	Waste heat recovery system (WWTP)	Renewable energy based on district heating/cooling networks
Gothenburg	Connection of city DHN to 1 ferry		TBD

- **Utrecht** will replicate the heat production waste water treatment in the operating DHN.
- **Nice Cote D'Azur** will the extend the waste heat production and recovery to replication.
- **Gothenburg** will use the already tested biogas production and connection of city DH to ship solutions and it will extend them in replication level.

The **main innovative technologies** which will be used are the followings:

- Smart collection of waste streams (TRL8)
- Use of produced biogas as an energy carrier for mobile services (TRL9)

Such schemes for the production of either heat or of added value fuels (biogas is upgraded to natural gas quality and injected to the natural gas grid and sold manly as vehicle fuel (cars, buses, trucks), TRL8 can be exchanged.

An additional innovative element lies on the development of a new toolbox (SEMS), which will supervise the flow path of such energy symbiotic streams. Gothenburg has already developed a smart toolbox in the framework of CELSIUS Smart Cities (TRL8), while Utrecht already operates the Aquifer Thermal Energy System (ATES) (TRL8) and Nice the Heart Smart Grid platform (TRL8).

Two tables presenting an overview of the pre-pilot, demonstration and replication of the IS 1.3 solutions at the LH and FC (only replication) are included in the following subsections, while the details are included in the annexes to this deliverable.

3.3.2 Overview of pre-pilot, demonstration, replication of LH Cities

		Utrecht	Nice Cote D' Azur	Gothenburg
Pre-Pilot	Key Figures / Points		Operations a municipal sewage sludge plant which, after dehydrating the sewage sludge, produces high energy content biogenic fuels for the production of heat and electricity. During the sewage sludge post-treatment step, additional waste heat is produced, covering part of the heat needs of residents. 3 domestic heat networks totaling an installed capacity of 95 MW and serving a population of 11,000 equivalent housing and some industrial buildings are connected to the household waste incineration plant	**Pre-Pilot 1:** Upgrading plant for biogas Biogas is produced in the city sewage water treatment plant from municipal sewage via digestion (60 000 MWh/year). **Pre-Pilot 2:** Connection of the city DH system to one ferry. This removes the need for the ferry to use diesel for heating while moored, thus reducing emissions and improving air quality.
	Area		Nice Eco Valley district	Arendal, Port of Gothenburg
	Lessons Learnt		• Good thermal efficiency of the global process • Potential of heat recovery increase • Generation of climate-relevant emissions such as CO2, N2O, NOx and NH3	**Pre-Pilot 1:** • Production is stable and safe • The plant is reaching the limit of its production capacity **Pre-Pilot 2:** • Improvement of citizens' quality of life, since demonstrator start-up has drastically reduced GHG and acoustic emissions in the area next to the harbour • Oil use reduction • Reduced CO2 emissions • Sort payback period (<2 years)
Demonstration	Key Figures / Points		The demonstration leans on a waste heat recovery system that is conceived as a low temperature district heating network. This will be sourcing waste heat energy at the outflow batch of the Haliotis waste water	

			treatment plant (WWTP) (Summer: 25-30°C / Winter: 13-8°C)	
	Area		Grand Arenas District	
Replication	Key Figures / Points	Local project partner Eneco is currently examining the feasibility to utilize the heat produced at the waste water treatment plant in the adjacent area of Overvecht in Utrecht, after first pumping its temperature up to 70°C.	Replication potential of the dashboard development with pre-condition of development/extension of renewable energy-based district heating/cooling networks	No available data yet
	Area	Kanaleneiland and Overvecht	Grand Arenas District, Nice Eco Valley district	No available data yet
Perspectives	Opportunities & needs	• Environmental objectives and energy mix • Dashboard – public acceptance • Transparency between citizens and public infrastructures	• Waste heat recovery – overall environmental and economic benefit • Dashboard – Customer focused monitoring • Dashboard – software development	No available data yet
	Data Collection		Following data might be used: • Geographic data and geo-tagged data • Energy consumption data (heating, cooling, electricity) • Energy imports (Grid) • Local renewable energy production (PV, district heating/cooling network) • Weather data / metrological data • Air quality data • Road and public transport data	
	Bounds & drivers	No available data yet	• The "energy transition for green growth act" leads French local authorities to define a local "Territorial Energy and Climat Plan" • The Metropole of Nice Cote d'Azur, with more than 500.000 inhabitants, has therefore its local action plan.	No available data yet

3.3.3 *Overview of the replication of Follower Cities*

	Vaasa	Alexandroupolis	Santa Cruz Tenerife	Focsani
Key Figures / Points	Two power plants (one combined heat/electricity and one based on waste) where extra heat could be used or put in a heat storage Novel elements are: • Smart collection of waste streams (TRL8) • Use of produced biogas as an energy carrier for mobile services (TRL9)	Development of an energy project that utilises waste heat TAP AG will utilise the waste heat of the compression station for district heating of residential buildings, industries and greenhouses		
Area	Stormossen	Ferres		
Opportunities & needs	• Waste heat recovery • Real-time monitoring of processes and outcomes • Utilization of waste streams	• Waste heat recovery – Energy Savings • Reduction in GHG emissions • Business, Economic and Social Contribution		
Bounds & drivers	• Wärtsilä´s excess heat is already used and in other industrial locations do not have so much excess heat that could be fitted on current DHN.	• **Technical:** The development of extensive district heating network can be considered as a technical barrier. • **Social:** The success of such high cost project is also based on the increased number of consumers. There, the acceptance of the project from the citizens of the area is crucial and can potential be a barrier. • **Financial:** The budget of the waste heat utilization project to be examined is estimated more than 30 m€. Therefore, funding of such project is considered as a barrier. • **Environmental:** The implementation of waste heat DHN provide the opportunity to achieve a substantial reduction in CO2 emissions.		

4. Next Steps (in cooperation with WP3 and WP5-WP8)

D1.2 is the first step towards the creation of a detailed transition strategy for the smart renewables and closed-loop energy positive districts (TT1). This transition strategy will be further developed in many tasks where the information provided in D1.2 sections will further be analysed and elaborated. In particular, the following deliverables will be based on D1.2:

- **D1.7: Transition Strategy, Commissioning Plan for the demonstration & replication (M12):** This report will provide a detailed transition strategy plan, comprising of the demonstration, replication and opinions exchange planning among cities / administrations / cities planners and all involved stakeholders, on the basis of the analysis of all the defined solutions in the five IRIS transition tracks.
- **D5.1 / D6.1, D7.1: Report on baseline, ambition & barriers for Utrecht / NCA / Gothenburg lighthouse interventions (M12):** This report will provide precise and realistic specification of ambitions, activities and planning for each of the interventions planned, running in parallel and in close cooperation with activities in WP1 on the extraction of requirements for the 5 Transition Tracks, including baseline definition of citizen energy and mobility behaviour, along with setting up of the monitoring principles and early business modelling development.
- **D5.2, D6.2, D7.2: Planning of Utrecht / NCA / Gothenburg integration and demonstration activities (M12):** This report will provide the coordination structures and procedures concerning governance, communication, monitoring and impact analysis, local risk assessment, periodic reporting, and planning of integration and demonstration activities in each of the LH cities.
- **D5.3, D6.3, D7.3: Launch of T.T.#1 activities on Smart renewables and near zero energy district (Utrecht / NCA / Gothenburg) (M24):** Report describing the set-up of demonstration activities and initial experiences of operation regarding the IRIS solutions and citizen engagement activities in T.T #1 in each of the LH cities
- **D8.1 A Roadmap for replication of activities (M25):** The roadmap (business/financing plan) will summarise the replication of activities for demonstration plans and post-project replication with a Gantt chart and a Work Breakdown Structure (WBS), as well as a schedule per task, responsible partner related subtasks, related deliverables, and dependencies on other tasks.
- **D8.4, 8.6, 8.8, 8.10 Vaasa / Alexandroupolis / Santa Cruz de Tenerife / Focsani replication plan (M36):** A replication plan (business/financing plan) for post-project replication in each of the FCs.
- **D3.7: Financing solutions for cities and city suppliers (M24):** A Report that will map and present financial pathways for IRIS solutions.

5. Conclusions

D1.2 provides preliminary planning of the demonstration and replication activities of TT1: Smart renewables and closed-loop energy positive districts. The document defines each solution's requirements/specifications (geographical, technical, operational, legislative, regulatory framework, business etc.) before the solutions are being deployed and demonstrated in the selected LH cities and replicated as well in the FCs. The deliverable's preparation process initiated the exchange of knowledge and opinions between the Lighthouse and Follower cities on how each of the IRIS solutions can be in the best way integrated into their site.

The deliverable includes a quite detailed description of the pre-pilot areas, based on the available information of the applied technologies from the relevant experienced consortium partners. The description comprises the initial requirements and technical specifications concerning the application of the solution. The document supports the Transition Track's aims to increase the RES integration and the exploitation of the waste heat streams both at building and at district level within the context of the envisioned Smart Cities. In addition, it gives insight for the replication of the conceived IRIS solution, which will be demonstrated, taking into consideration not only the individualities and the specific needs of the LH cities but also the needs and the objectives of the FCs which are not yet clearly illustrated.

The present deliverable is not a study, but a collection of data and information concerning the early planning of the IRIS demonstrations and replications. Thus, there are no actual yet available concrete "conclusions" to which the IRIS partners can be driven to. The primary purpose of that was, among others, the exchange of ideas and know-how among the partners, in order to create a clearer view of the demonstration and replication activities between and among the LHs and FCs.

Some general comments could be derived mainly from the combined examination of the different undertakings:

IS 1.1 mainly addresses the case of Positive Energy Buildings:

- The demonstration activity in Nice indicates the driver and the upcoming advantages of the PV panels integration to buildings.
- The case is studied at a consumer scale, so as to identify the different benefits taking into account the various stakeholders.
- The tested system is a great opportunity to examine the benefits and the losses of PV integrated systems, since PV feed-in tariffs have been reduced according to regulation framework, but it is worth mentioning the increasing potential of local self-consumption which induces energy bills reduction.
- The role of AC/DC inverter is also tested in relation to energy efficiency and energy savings and the individuality of French legal framework concerning the Low Voltage (LV) feeder presents the changes in system configuration among countries and the potential impacts on system's performance.
- To comply with the French legal framework, energy consumers and PV system must be connected to the same Low Voltage (LV) feeder.
- In the demonstration activity in Gothenburg the integration of renewables in buildings in combination with storage capacity and energy management is examined. This system can highlight the combined benefits from the synergy between different technologies and the contribution to grid flexibility.

IS 1.2 principally presents the case of Near Zero Energy Retrofit District:

- Within the framework of Utrecht's demonstration activity, the integration of high renewables penetration at district scale is tested in parallel with near zero energy housing retrofit and energy efficient smart street lighting taking into account the exploitation of energy streams and the deployment of smart components for heating and cooling purposes. This combination can maximize the RES penetration at district scale. A feasibility study will reveal many aspects and potential barriers.
- The importance of energy performance and savings assessment through commissioning services, the optimization actions in distribution systems, smart metering and data collection will be emerged in demonstration of Nice Cote d'Azur. These additional measures and services optimize by some aspects the deployment of near zero district system, because they give an overall view of the system performance and indicate the system's problems by failure tracking.
- The case of Building Integrated Photovoltaics (BIPV) which will be examined in the demonstration of Gothenburg, will show the role of various parameters related to the building's external envelope towards efficient evaluation of solar panels' performance. In order to optimize the system operation and the upcoming advantages, string optimisation, inverters (DC/AC) and battery function will be deployed.
- In the way to expand the near zero energy district in large scale systems, several and various regulatory issues, barriers and drivers related to local and country conditions should be taken into account. As for example, financial incentives, energy performance compensation, balancing regulation, covenants etc.

IS 1.3 mainly indicates the case of Symbiotic waste heat networks:

- Through the examination of a waste heat recovery system that is conceived as a low temperature district heating network and the deployment of a "Local Energy Management Dashboard", it is possible to assess real time or near to real time information of the energy and environmental performance of the system in the community by mapping all energy streams at district scale.
- There are also various legal and economical constraints that concern the promotion of industrial symbiotic networks which have many benefits for the citizens.
- Among the related issues, the feasibility of the business case for district heating operators should be examined taking into account the fact that the network is operated by private companies and regulated tariffs.
- Concerning the regulatory framework within the French region, ADEME is involved in the sectors of environmental quality and management, transports and renewable energy. This agency is for coordination and facilitation of environmental protection and energy management. Thus, its role should be thoroughly considered for the deployment of symbiotic networks within France. Local action plans should be also taken into account and be checked in parallel with national and European plans.

Other two key points, which concern all the three cases, are the following:

- The citizen engagement has a significant role in the configuration grid flexibility which is mainly based on the interactive relationship between the aggregator and end-user. It proves to be quite difficult to ensure a high citizen engagement.
- The integration of customer-oriented applications and city platform is quite important for the motivation of end-users.

The related Deliverables that are based on the present one (D5.3, D6.3, D7.3 and D8.1) that will deliver the demonstrations and replications are expected to drive to more solid conclusions.

D1.2 is the first step towards the creation of a detailed transition strategy for the smart renewables and closed-loop energy positive districts. This transition strategy will be further developed in the context of WP3, WP5, WP6, WP7 and WP8. These work packages include tasks that will present in detail the information provided by D1.2.

The optimal collaboration and communication between the local ecosystems and the horizontally involved partners contributed significantly to the competition of the deliverable's objectives and set the ground for achieving the project's overall goals.

6. References

1. IRENA, Renewable Energy Prospects for the European Union, 2018
2. Giuliano Dall'O'et al., On the Integration of Leadership in Energy and Environmental Design (LEED) ND Protocol with the Energy Planning and Management Tools in Italy: Strengths and Weaknesses, Energies 2013, 6, 5990-6015; doi:10.3390/en6115990
3. The Paris Agreement. 2018, United Nations
4. D. Connolly et al., Heat Roadmap Europe: Combining district heating with heat savings to decarbonise the EU energy system, Elsevier, Energy Policy 65 (2014) 475–489
5. Zero Energy Schools. U.S. Department of Energy - Better Buildings Initiative. https://betterbuildingsinitiative.energy.gov/accelerators/zero-energy-district
6. Industrial Symbiosis in a Circular Economy. Energy Crossroads Denmark. http://www.energycrossroads.org/industrial-symbiosis-circular-economy/
7. Paloheimo, E. 2004. Rakennusten ikä. Taloussanomat 1.4. Hakupäivä 24.11.2015
8. Roadmap to nearly Zero Energy Buildings in 2020, REHVA Journal – March 2015
9. Scheme of delivered- and on-site-energy energy production and their influence on energy calculations. In Kurnitski, J. 2011. Nearly zero energy buildings (nZEB) - definitions and performance levels, REHVA, Presentation 8.2.2011, SITRA. Hakupäivä 4.12.2015
10. Overview of support activities and projects of the European Union on energy efficiency and renewable energy in the heating and cooling sector, in Framework Programme 7 and Intelligent Energy Europe programmes of the European Union. 2016, European Commission
11. Atanasiu, B., et al., Europe's Buildings Under the Microscope: A country-by-country review of the energy performance of buildings. 2011, BPIE
12. Schmidt, D., et al., Low Temperature District Heating for Future Energy Systems. Energy Procedia, 2017. 116: p. 26-38
13. Communication from the commission to the European Parliament, the Council, the European Economic and social Committee and the Committee of the Regions: An EU strategy on heating and cooling. 2016, European Commission
14. Yi DOU et al, Potential of Waste Heat Exchange Considering Industrial Location Changes: A Case of Shinchi-Soma Region in Fukushima, Japan, March 2017, DOI: 10.2208/jscejer.73.II_353
15. Biljana Mileva-Boshkoska et al., Modeling and Evaluation of the Possibilities of Forming a Regional Industrial Symbiosis Networks, Social sciences, January 2018
16. Miguel Á. García-Fuentes Et al, Retrofitting of a Residential District under Near Zero Energy Buildings Criteria, Proceedings, November 2017
17. Synthesis Report on the National Plans for Nearly Zero Energy Buildings (NZEBs), JRC Science for Policy Report, 2016
18. E2District, Horizon 2020 Research and Innovation project. http://e2district.eu/
19. HSB Living Lab. https://www.hsb.se/hsblivinglab/
20. IBIS Power Technologies, PowerNEST. http://www.ibispower.eu/products/powernest-2/
21. Stedin, Slimme Meter. https://www.stedin.net/slimme-meter/overzicht-handleidingen
22. Milieu Centraal, Warmtepomp. https://www.milieucentraal.nl/energie-besparen/energiezuinig-huis/energiezuinig-verwarmen-en-warm-water/warmtepomp-combi-en-hybridewarmtepomp/

7. Annex for IRIS Solution IS-1.1: Positive Energy Buildings

7.1 Pre-Pilot Areas Description and Available Infrastructure

7.1.1 *Utrecht Pre-Pilot*

(Not applicable for IS1.1)

7.1.2 *Nice Cote D'Azur Pre-Pilot*

(Not applicable for IS1.2)

7.1.3 *Gothenburg Pre-Pilots*

Pre-Pilot 1: Sunhouses in Gårdsten area

The City of Gothenburg, Gårdstensbostäder, formed an owner's directive in 1997 to develop the technical and social status of a very declining residential area. Towards this direction, the city took over the decision to try in 4 "sunhouses" energy saving and energy producing technologies. In the following figure, there is an overall view of the "sunhouses" in Gardsten.

Figure 8 Gårdsten Solhus ("sunhouses" with solar panels on the roofs)

The combination of technologies to the 4 "sunhouses" corresponds to four (4) main Use Cases:

- **Use Case #1 & #2: Solhus 1 and Solhus 2** are the working names of the two renovation projects that were part of two EU projects (within THERMIE) in 1997-2000 and in 2002-2004 respectively. Both included 1) solar collectors on the roof (for heating water), 2) heat recovery from ventilation (mechanical ventilation, where heat from exhaust air heats incoming air via heat exchangers), 3) additional insulation on the roof, 4) glazed balconies and built-in staircases , 5) low energy windows, 6) new laundry rooms (additional generation of waste heat from the washing huts' drying room is involved), 7)individual measurement (electricity, heating, water) and 8) storage battery tanks. These houses are depicted in Figure 9. The solar collectors produce approximately 600 MWh/year. ***The main***

energy efficiency improvement in Solhus 1-2 was obtained from the installation of new heat recovery units on ventilation. The combination with the other energy efficient technologies radically decreased the energy consumption of the total 500 appartments. The EU contribution amounted to about 4% of the total renovation cost of just over SEK 100M (incl. renovation of apartments, which came from Gothenburg city).

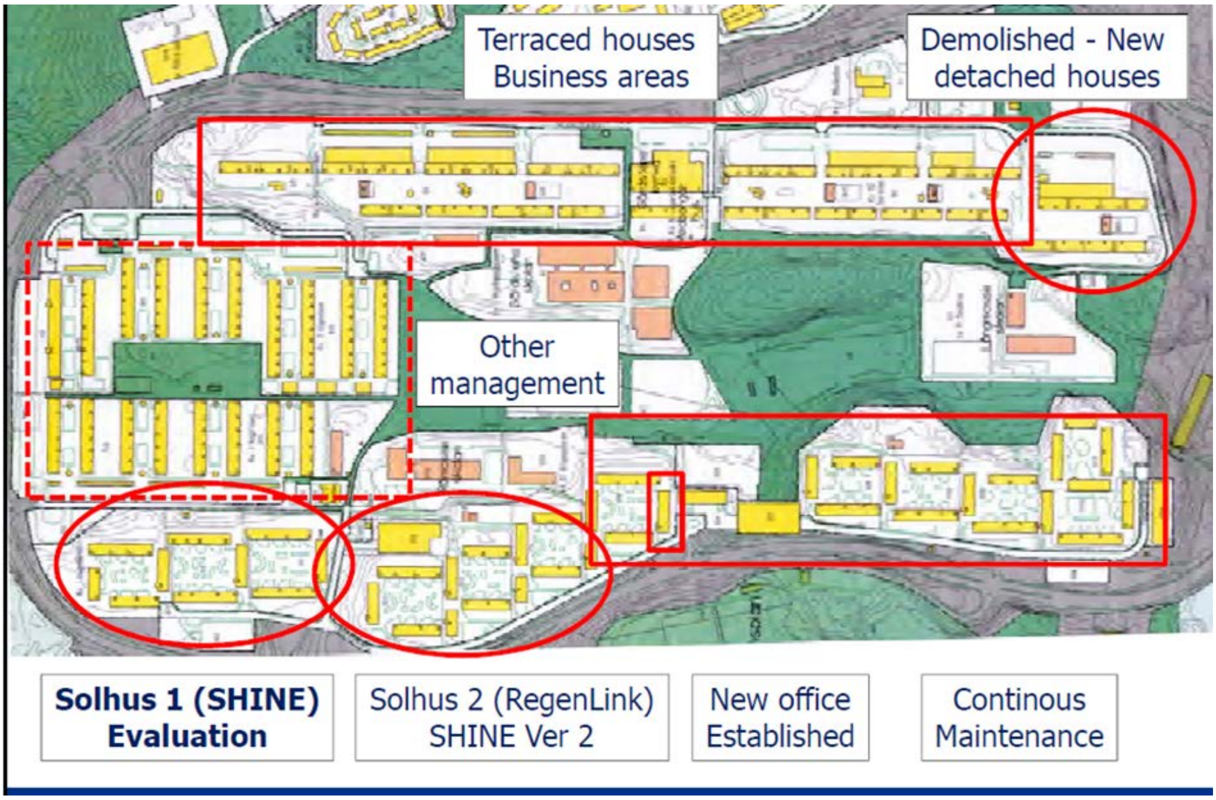


Figure 9 Lay-out of Gårdsten « Solhus 1-2 »

- **Use Case #3: Solhus 3** was the next renovation project, finished in 2014. It comprises 418 apartments. It comprises a) a solar heating system (solar collector) connected to the district heating system and b) several solar cells connected to the mains More specifically, there are 4 rooftops with solar panels, a house with solar balconies and another house with solar panels which provide hot water to the District Heating Network. **In Solhus 3 and 4**, focus has shifted from solar heating to Photovoltaics (PV).
- **Use Case #4: Solhus 4** will retrofit PV panels on the remaining 14 three-storey apartment buildings in the area, aiming to be completed in 2018.

The main reasons for switching from solar thermal to PV are 1) that the district heating pricing has been changed to low rates in the summer, **2)** solar cell costs have been reduced thanks to positive international market development and **3)** there are subsidies for solar cells.

The renovation of the "Solhus" was very comprehensive and included a number of measures as shown in Figure 10.

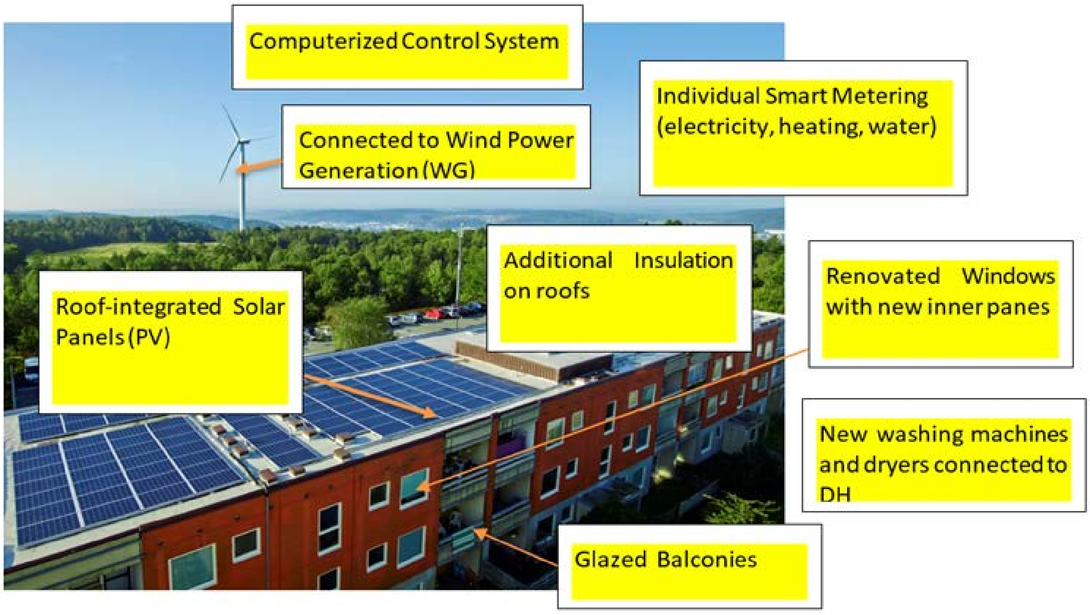


Figure 10 Sunhouse view with the applied technologies inlcuded

Thus, there are now three (3) Solhus "sunhouse" projects in Gårdsten and a fourth (4rth) nearing completion. The installed capacity of wind power is 2 MW (5,000 MWh/year). This corresponds to half of Gårdsten´s apartment's total electricity needs and reduces CO2 by about 4000 tonnes/year.

7.1.3.1 Pre-Pilot Area and Geographical Overview of Pre-Pilot 1

The buildings are located in the district of Gårdsten in the northern suburbs of Gothenburg. Gårdsten was built in 1969-1972 with about 3,300 apartments in 3-and 6-storey houses. An aerial view of Gardsten is presented in Figure 11. Over the years, Gårdsten developed more and more negatively with a large proportion of empty apartments, high relocation and social concern. In 1996, Gårdsten was considered one of Sweden's most problematic suburbs with high levels of unhealth and unemployment. Therefore, the municipal property group Förvaltnings AB Framtiden 1997 formed Gårdstensbostäder, where the entire public property portfolio was collected. Its mission was to develop the district by engaging the residents to participate in the area's development and to stimulate the emergence of jobs, public and commercial services. In 2000, Gårdsten joined the so-called "Storstadsatsningen" which had the same goal. The work has yielded results that have been given awards. The "Sun-houses" constitute an example of how Gårdstensbostäder are putting efforts into developing the area.

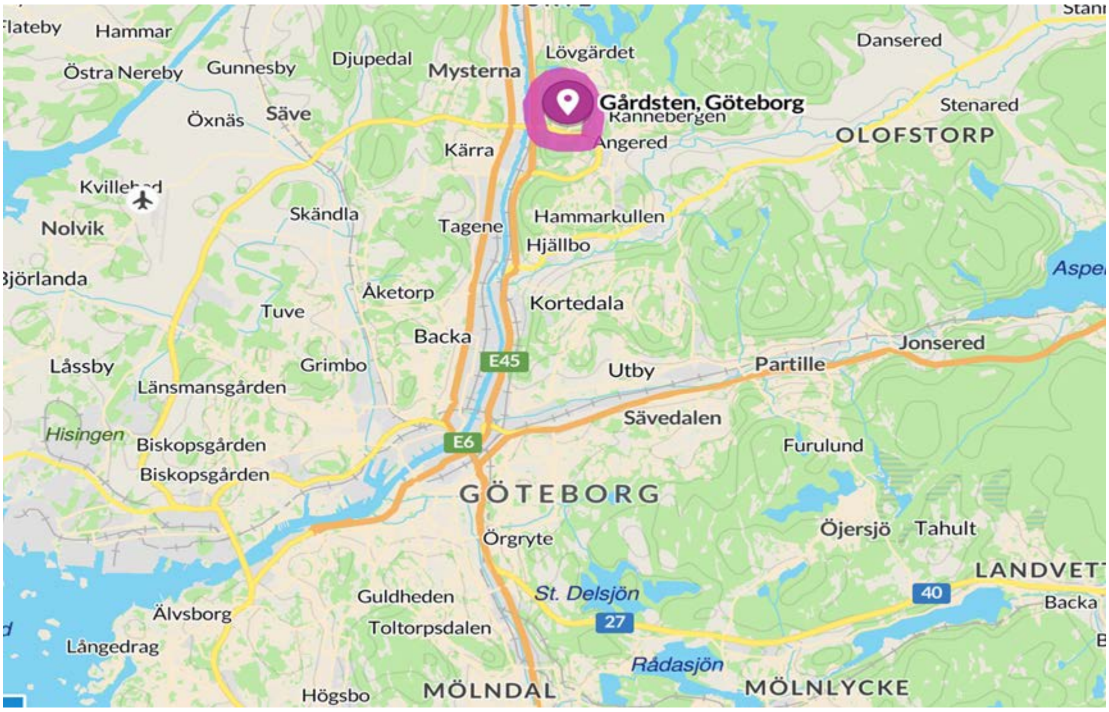


Figure 11 Gothenburg and Gårdsten

Figure 12 : Aerial view of Gårdsten

7.1.3.2 Key Technical Components of Pre-Pilot 1

The following Table elaborates the currently available thorough information of the considered key innovative elements of the pre-pilot:

Table 7 Key Technical Components of the Gothenburg Pre-Pilot 1 in IS 1.1

Components	Technical Specification	Area/Positioning of the pre-pilot
Solar collector - type, number, power (kW)	- Solhus1-2: Six roofs (six farms) each with approximately 230 m2 active solar collector area, each about 160 kW (heating power), together 1000 kW. Connected to sub-stations, preheating hot water. - Solhus 3: A roof (a farm) with 150 m2 solar catchment area, approximately 100 kW (heating power) connected to the district heating system. - Together, more than 1500 m2 generates in the order of 6 x 100 + 50 = 650 MWh (heat) / year.	- Solhus 1-2: Solar heating systems 1998-2004 consists of prefab ceiling modules (from Derome) on new pulp roofs in six high-rise buildings. - Solhus 3: The solar heating system (solar collectors) 2010 is mounted on a rack on the roof of a high-rise building.
Solar PV panels (type, number, power (kW)	- Solhus 3: First stage, four roofs (four yards) with 50 + 3 x 25 kW = 125 kW. - Second stage, three ceilings (three yards) with approximately 3 x 40 kW. - Third stage (in progress), 3 x20 kW supplement on three roofs (three farms) and approximately 3 x 40 kW on three roofs (three farms). - Together more than 400 kW, which generates on the order of 400 x 0.9 = 360 MWh (el) / year. - Solhus 4 (under construction): Retrofit to 14 buildings, 3 000 m2, 400 MWh/year.	- Solhus 3: The solar panels (solar cells) 2013 - are mounted in connection with the changing of roof tops on flat roofs. The first with a low stand (welded in the roof) with low tilt, the latter on a high stand with a greater inclination.
Wind power (type, power (kW):	- 2 MW Accounts for about 50% of the electricity consumption in the district. - Generates on the order of 5000 MWh (el) / year.	Newly established industrial area at Gårdstensberget.

Energy storage (type, quantity, capacity (kWh):	- There are six storage tanks, one for each solar heating system Solhus 1-2. - There are 14 kWh battery packs connected to several solar plants in Gårdsten. - There are three battery packs of 14 kWh in connection with solar cell installations at Gårdstensbostäder. - There are one or more batteries connected to solar cell installations on new rental houses built by Dickson's foundation, opened on January 10, 2018. - The main reasons are 1) It's a topical subject, 2) Getting experience, and 3) To support a local company - BoxOfEnergy who uses used batteries from Volvo.	- Sub-centers Solhus 1-2.
Reuse of waste heat from laundry rooms	Washing machines and drying rooms connected to district heating (which to a large extent consist of waste heatand solar heating).	In most laundry rooms, at least 10.
(Heat pumps producing heat from geolayer)	No	No
Sun balconies	Yes	The towers have glazed balconies.
Low energy window	Some windows have been replaced with new low U-value windows, in other (double-linked) windows, one panel has been replaced by low-emission glass.	

Individual metering	Water, heating and electricity	

7.1.3.3 Lessons Learnt by the implementation of the Solution in the Pre-Pilot 1

The cost of renovating Solhus 1 was 5,612 kr / m2, where energy efficiency measures amounted to SEK 1,070 / m2. Only energy efficiency measures that had a repayment period of less than 20 years were implemented. The property's energy consumption decreased from 5,000 MWh / year to 2,700 MWh / year, which corresponds to 263 kWh / m2 and 145 kWh / m2 respectively. Households also decreased their consumption from 32 kWh / m2 to 25 kWh / m2. Despite the already big reduction, Gårdstensbostäder continues to work actively to reduce energy consumption and to switch to more sustainable alternatives. "At the moment we are going to mount solar cells on the balconies in the solar house. We are also in the process of purchasing a number of electric cars, "said Michael Pirosanto, CEO of the property owner Gårdstensbostäder.

The Solhus projects have been part of a greater effort to raise the socio-economic potential of the district. In addition to a reduced energy consumption, vacancies decreased, in 2010 no apartments were left empty. Crime in the area decreased from 180 crimes per 1,000 inhabitants to 87 crimes per 1,000 inhabitants. 1,600 new jobs were conveyed during the construction years.

Today, the district is nearly self-sufficient concerning heating, where approximately 27 000 MWh are generated annually by the district's thermal power station. There is an increasing proportion of PVs, the target is to have 500 MWh electric energy generated by photovoltaics by 2019. The buildings in the pre-pilot district are highly energy efficient and can be used for temporary heat storage (Figure 13). The Sunhouses in Gårdsten successfully implemented appliances (washing machines and dryers) connected to DH along with several sustainable renovations.

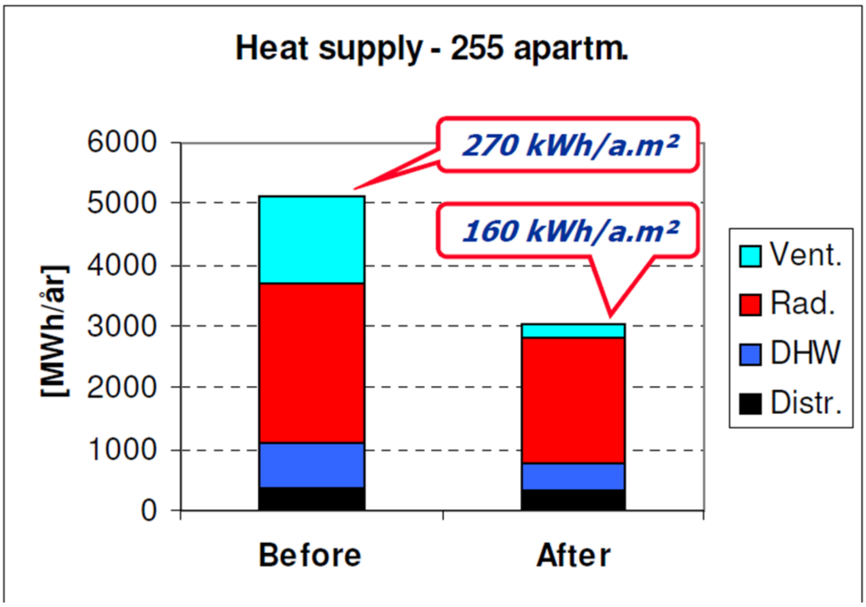


Figure 13 Energy Performance before and after renovation (credit: Jan-Olof Dalenbäck)

Below is a list of the ***Linked Projects***:

- SHINE (EU THERMIE)
- Regen-Link (FP5 EESD) The objectives of REGEN-LINK are: 1. To demonstrate energy efficiency, the application of innovative technologies and the reduction of C02 emissions in urban areas and buildings which are being regenerated; 2. To integrate efficient (renewable) energy technologies in the designs for renovation and new buildings in regeneration areas; 3. To integrate innovative enerStrogy efficient measures as standard features of the regeneration programs of social landlords.
- Stoomversnelling
- FED
- m2M Grid
- CELSIUS Smart Cities

To foster international cooperation and innovation, the City of Gothenburg participates in many European networks and programmes; EUROCITIES, Climate-KIC, European EIT Climate-KIC network, the EIP Smart Cities, Communities, ERRIN and POLIS.

Pre-Pilot 2: Krokslätt Office Building

Kängurun 21 is a through-and-through green building characterized by its glazed indoor environments that provide a thermal buffer zone and are favorable to the building's energy needs. In addition, these spaces allow for social co-existence as well as ecological diversity as the spaces also contain a large number of plant species. Overall, this shows that the building clearly stands for the district's vision as part of the sustainable city. Below are the measures that have been taken for the energy upgrade of the building:

- Early on, energy targets were set up with the builder Husvärden AB. The goal was to achieve "Green Building" including the so-called "Green Building" operating electricity part. This means that total energy use should not exceed 75 kWh / m2 and year, including non-heating electricity use.The energy goals are achieved by optimizing the technology available and making full use of it. A predominantely need (presence)-based control of all systems. This applies to control of lighting, power to computers, ventilation flows and control of heat and cooling to the premises.The techologies which are integrated in the building are the following: Air conditioning systems with low pressure drop, high efficiency on heat recovery and recovery of heat from the server room are other ways to keep energy consumption down.
- The property is connected to district heating and the premises are heated via radiators sequentially controlled by the VAV (Variable Air Volume) system for cooling the rooms.
- Cooling is supplied though the air, so that the outdoor air can be used for cooling as long as possible. The cooling machines are speed-controlled and also work as combined exhaust air/outdoor air heat pumps the few days when there is a need to heat the supply air in addition to what the rotary heat exchanger can provide.
- On the roof there are also about 50 m2 of solar cells that generate electricity to the property.
- The building has very large window areas. In order to limit heat losses in winter and solar heating in summer, low emission glazing is used, as well as external automatic motorized sunshade, controlled by current weather and season, to the east, south and west have been chosen to limit heat losses and prevent sunlight from coming in.

7.1.3.4 Pre-Pilot Area and Geographical Overview of Pre-Pilot 2

The house was completed in December 2010 and is spread over 4,200 m2 on 6 floors, where the ground floor contains conference rooms and classrooms, dining rooms and technology areas.

Figure 14 Bengt Dahlgren AB's new energy-efficient office building

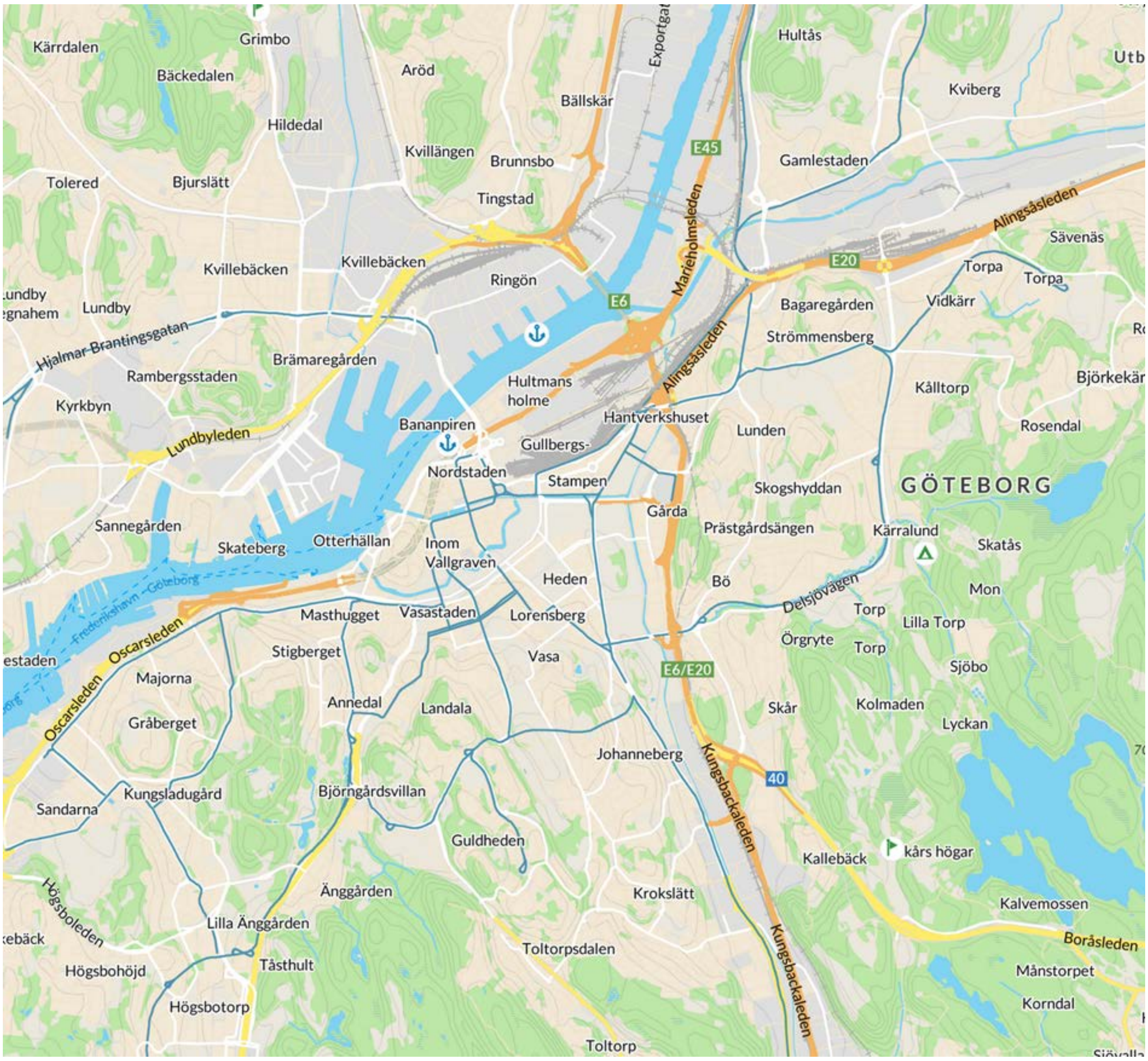


Figure 15 Location of the Krokslätt Green Office building

7.1.3.5 Key Technical Components of Pre-Pilot 2

The following table presents the technical specifications of the components of the pre-pilot:

Table 8 Key Technical Components of Gothenburg Pre-Pilot 2 in IS 1.1

Main Component	Technical Specifications	Area of the pre-Pilot
PV (Type, Number (#), Capacity (kW)):	50 m2 of solar cells, 6 kW peak power, 4 600 kWh annual output	On roof of building

Storage (Type, Number (#), Capacity (kW)):	115 bore holes in rock, depth 230 m. Storage capacity of approx. 3 GWh/year	80 holes below parking garage, 35 holes by building B21:1
Ancillary Equipment Type #1 (generation of waste heat from washing huts drying room, followed by required specifications, e.g. Number #, Capacity (W), Max Temperature (90C)):	District heating approx.. 1,6 MW	
Ancillary Equipment Type #2 (heat pumps producing heat from geothermal energy, e.g. Number #, etc.):	Cooling heat pumps, approx.. 1,4 MW heating and 1.4 MW cooling. Several smaller heat pumps for tap water heating	
Ancillary Equipment Type #3 (solar balconies, followed by required specifications):	New buildings have automatically controlled motorised external sun shading of Varema type. Total area approx.. 1800 m2	
Ancillary Equipment Type #4 (glazing of balconies, followed by required specifications):	Windows in new buildings are triple glazed, double Argon filled, energy saving glass with double layers of low-emittive material. U-value 0,5 – 0,75W/m2 °C	

7.1.3.6 *Lessons Learnt by the implementation of the Solution in the Pre-Pilot 2*

- National regulations stipulated a maximum energy consumption of 100 kWh/m2/yr at the time of construction, since this limit has been reduced to 65 kWh/m2/year.The monitoring of the property's energy use for 3 years shows energy consumption (real estate + heating) of 42 kWh / m2 and year and total purchased energy is 75 kWh / m2 and year, which is better than calculated.
- The residents are very satisfied with the indoor climate and thermal comfort, albeit there were some initial fluctuations of the temperature during the first year of operation.

7.2 Demonstration in the Lighthouse Cities

7.2.1 *Utrecht Demonstration*

(Not applicable for IS1.1)

7.2.2 *Nice Cote D'Azur Demonstration*

7.2.2.1 Use Case and Brief technical description

With regulatory reduction of PV feed-in tariffs, the cost (benefit) of PV-generated energy becomes significantly lower than the cost of grid-supplied energy. By consuming self-generated PV energy, customers can reduce their energy bills (resulting in amortization of the investment for the PV system and profits from the subsequent savings), gain autonomy from the utility and have control and transparency of energy generation and consumption. Germany and Australia are two of the first global markets for self-consumption PV systems.

In 2017, France's government introduced a new set of regulatory framework for the grid connection of self-consumption PV systems that opened the gate to the take-off of self-consumption PV systems in France at several scales:

- Individual self-consumption at **consumer scale** is the most common way to self-consume the energy produced by a PV system. This solely requires the connection of the PV system to the private grid of the consumer.
- Collective self-consumption at **building scale** is a recent way to make several electricity consumers located in one single building benefit from the electricity produced by a PV system installed on the same building.

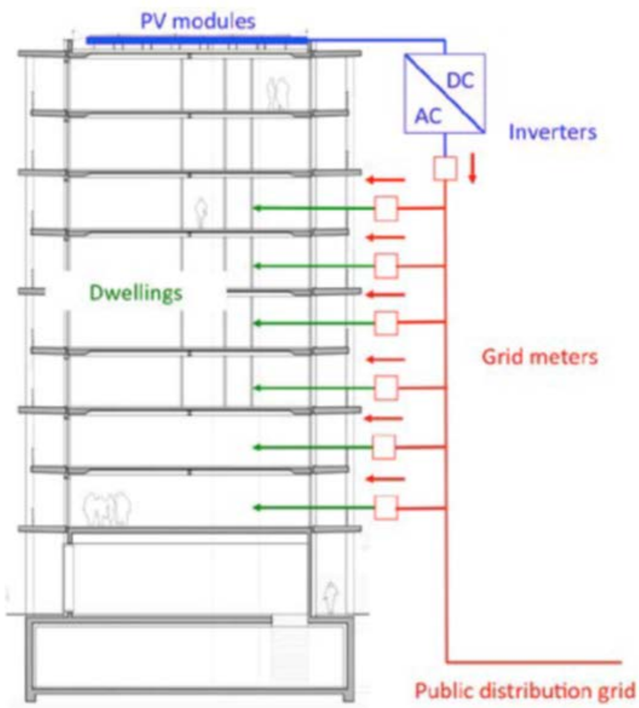


Figure 16 Collective self-consumption at building scale with a public grid

(source: SMARTER TOGETHER - Report on collective self-consumption of Photovoltaic)

(Colour code: red=public distribution grid; green=private LV grid; blue=PV system)

- Collective self-consumption at **block scale** is similar to self-consumption at building scale but in this case, electricity consumers are located in several buildings rather than only one. These buildings can be built on the same plot or on several plots with public streets in between. To comply with the French legal framework, energy consumers and PV system must be connected to the same Low Voltage (LV) feeder.

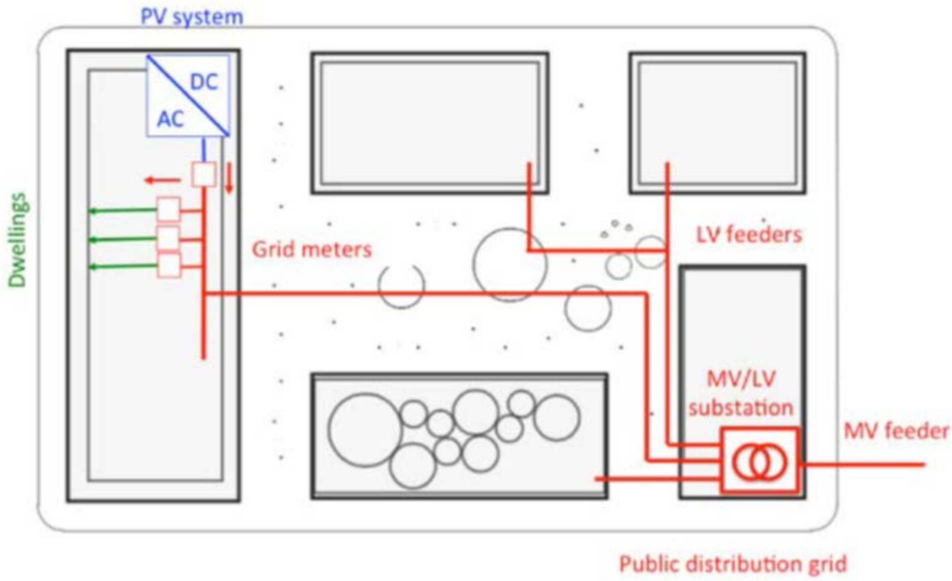


Figure 17 Collective self-consumption at block scale with a public grid

(source: SMARTER TOGETHER)

Collective self-consumption at building scale is a new concept for commercial and residential customers in France while only a small number of projects have been done in Europe so far. **This concept will be tested** in Nice Meridia on **two positive energy buildings under construction**.

7.2.2.2 Demonstration Area and Geographical Overview

The solution will be tested on two positive energy buildings belonging to the same building block that are actually constructed in Nice Meridia. Spread over 26 hectares (with a potential of 200 hectares), this new urban area under development is located at the heart of Nice. Nice Meridia is dedicated to green technologies, as well as to the development of innovative solutions for healthcare and mobile contactless services.

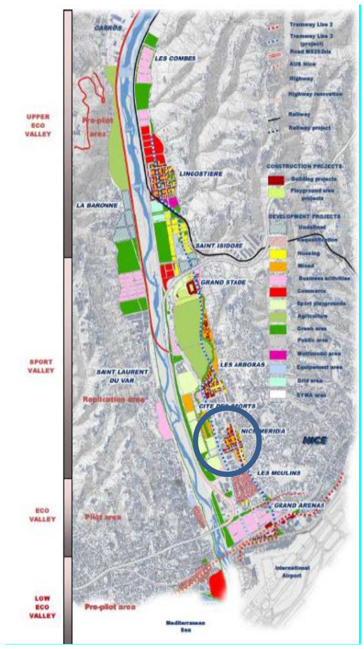
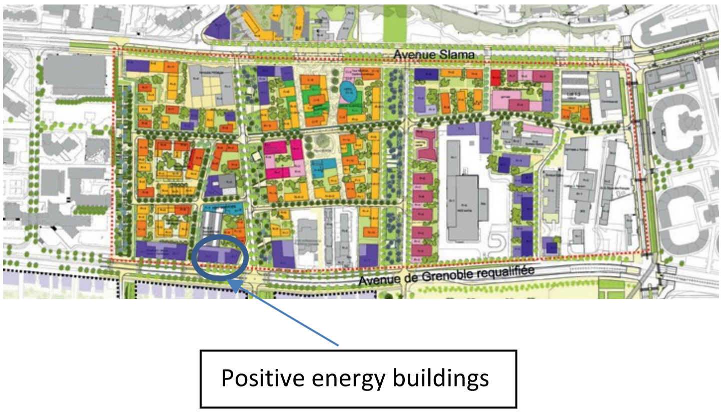
	

Figure 18 Nice Meridia demonstration area - Overview	**Figure 19 Nice Meridia demonstration area – Ground plane**

The table below lists the main features of the two positive energy buildings under construction that will host the use case:

Table 9 Main features of the two buildings supporting the demonstration

Building name	PALAZZO MERIDIA	IMREDD
Picture		
Building category	Office building	Educational building
Building owner	NEXITY (private)	Nice university (public)
End of construction	April 2019	September 2019
Total floor area (m^2)	7860	4970
Total height (m)	34.75	15.66
Energy target	Positive energy building	Positive energy building
Energy system	District heating &cooling system	District heating &cooling system

PV surface (m²)	445 m² on roof top	848 m² on roof top
Type of storage system	Electric battery	Electric battery

7.2.2.3 Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Demonstration

There are many reasons that advocate for the development of the collective self-consumption:

- Self-consumption helps European consumers and businesses to control their energy bill. Self-consumption does not only provide cheap electricity to consumers; it also protects them against volatile energy prices.
- Self-consumption lessens the burden on regional medium and low voltage grids. Energy that is consumed at the same location where it is generated no longer has to be transported over the grid, reducing congestion issues and bottlenecks, for the benefit of Distribution System Operators (DSO).
- Self-consumption increases retail competition and helps market transformation. The relationship with the consumer is the most important factor of differentiation between energy suppliers. The winners will be those retailers able to deliver new services. Offering self-consumption solutions is an obvious pillar of such strategies.
- Self-consumption makes consumers active players of the energy transition, a key objective of the Energy Union.

The main objective of this use case **is to assess the benefits and analyse the barriers** (legal, financial, technical) that prevent the development of the collective self-consumption market at building scale.

One sub-objective will be to experiment different technologies to increase the ratio of PV self-consumption. The two major ones are energy storage, mainly using batteries, and active load shifting, which is an important part of the concept demand side management (DSM). Literature shows that it is possible to increase the relative self-consumption by 15% to 25% with a battery storage and between 5% and 15 % with DSM, both compared to the original rate of self-consumption. These figures will be evaluated during the monitoring on the two positive energy buildings that will host the use case.

Depending on the revenue of selling PV generated electricity to and cost of buying electricity from the grid, increased self-consumption using these options or combinations of them can be profitable for owners of PV systems. Cost-efficiency of these different technologies will also be analysed.

7.2.2.4 Key technical components

Hardware:

Table 10 Hardware Key Technical Components of Nice Cote D'Azur Demonstration in IS 1.1

Main Component	Technical Specifications	Area / Positioning	IRIS partner
PV installation:	445 m² of PV panels on roof top 1) PV arrangement and Capacity: 89 kWc (Si-mono)	Palazzo Meridia building	Not yet fixed

Storage installation:	Please specify: 1) Type of technology: NA 2) Arrangement and capacity: NA 3) Battery system: NA	Palazzo Meridia building	Not yet fixed
PV installation:	848 m² of PV panel on rooftop 1) PV arrangement and Capacity: 179,4 kWc	IMREDD building	Not yet fixed
Storage installation:	Please specify: 1) Type of technology: NA 2) Arrangement and capacity: NA 3) Battery system: NA	IMREDD building	Not yet fixed

Software:

Table 11 Software Key Technical Components of Nice Cote D'Azur Demonstration in IS 1.1

Main Component	Technical Specifications	Demonstration Area	IRIS partner
Smart Meters (Number, Type, Granularity of data, etc.):	NA		Not yet fixed
Communication Platform (for shortage and surplus exchange between buildings):	NA		
Available Algorithms and a short description of them:	NA		

7.2.3 *Gothenburg Demonstration*

7.2.3.1 *Use Case and Brief technical description*

Gothenburg will demonstrate integrating storage capacity and responsible management of energy at district scale as well as create mobility services for commuters, students and tenants due to the low availability of parking space. This approach reduces losses in the system and greatly increases the efficiency of the overall district heating system. The local production of cooling, heating and electricity, together with local energy storages can be integrated in the city energy system to optimize the use of resources and minimise primary energy needed.

Specifically, a sub-district **Riksbyggen area** consisting of 6 buildings with 132 apartments will be finalized. Local production will consist of electricity from 140 kWp solar PV, heat from geothermal energy with heat pumps (230m deep boreholes), cooling also from geothermal energy, but without chillers. Local energy storages will consist of water buffer tanks, the thermal inertia of the building, long-time storage in the boreholes and 200 kWh 2nd life Li-Ion batteries. The house will be connected to the electrical grid, the DHN and also with a nearby office building to exchange energy for cooling purposes.

The aim is to create solutions that enable a positive energy balance in districts and create an attractive, social inclusive campus and neighbourhood.

In **Campus Johanneberg**, 50+ buildings, some with excess energy, will take part in a local trading system project with EU-funding called Fossil-free Energy District (FED).

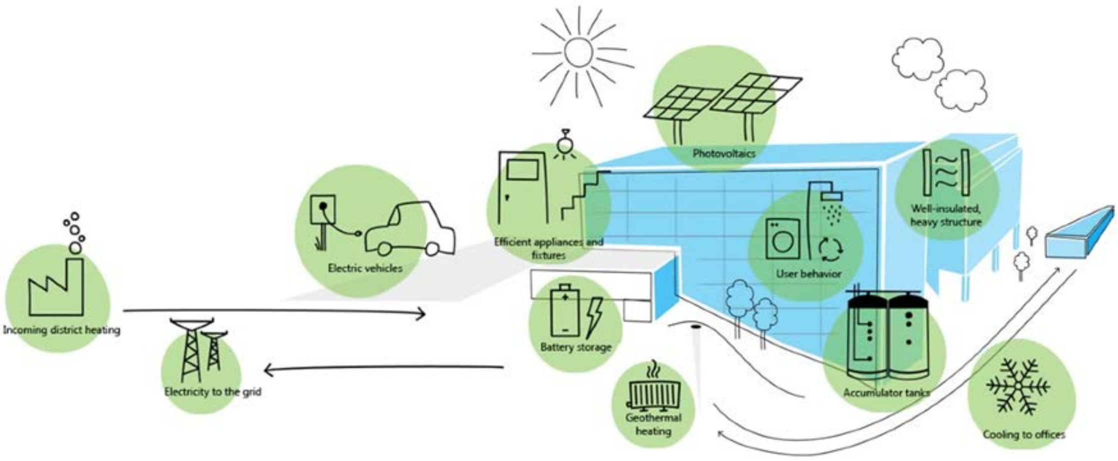


Figure 20 The components of the flexible energy system in Riksbyggen's housing association Viva

7.2.3.2 Demonstration Area and Geographical Overview

Riksbyggen's brf Viva is situated next to Chalmers campus Johanneberg. It is a housing association consisting of 132 apartments in 6 residential buildings, with 2 additional buildings for technical functions and common areas such as a bike garage, an orangery, etc. Viva is built in a steep wooded slope, which puts special demands on the groundwork and foundational work. Over the span of seven years, ideas and concepts have been collected elaborated to develop Viva into Sweden's most innovative and sustainable housing project. Thereby, a large number of issues have been dealt with, aiming at making Viva inductive to social cohesion, causing minimal negative environmental impact, and challenging the predominant view of a housing in today's Sweden.

Figure 21 A bird view of the housing association Viva

Figure 22 One of Viva's pairs of buildings as seen from the upper servicing road. N.B. the lack of parked cars

7.2.3.3 Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Demonstration

The main findings are whether Viva will indeed be a positive energy building, on an annual balance, with regards to the buildings' energy use. This includes asserting that the energy trading with the adjacent office building performs within the foreseen span, that the 2nd life batteries have an expected capacity remaining after being installed into the building, and that the energy management software can optimize energy flows as hoped. If it does, OPEX for the housing association could be lowered in comparison to a contemporary building without Viva's energy system.

The objectives and the upcoming opportunities of the demonstration are presented in the following table:

Table 12 Objectives/Needs & Opportunities of Gothenburg Demonstration in IS 1.1

Opportunities	Needs/Objectives
Use of resources optimization and primary energy requirements reduction	Developing management and control systems that can deal with the combination of small scale RES production (PV and downhole heat exchangers) and large scale supply (external grids for electricity and district heating).
Short - time and long - time thermal storage	Reliance on incineration of waste for district heating – to large extent fossil material – needs to be eliminated by adoption of low carbon energy production and moderating the demand for heating and cooling. Deployment of innovative, renewable based solutions to heat/cool buildings and neighbourhoods are needed since most of the building stock dates back to the 1960s-1970s and lack sophisticated systems for monitoring and control.
Reduction in GHG emissions	According to the Green Bonds of 2013, the city wants to reduce residents' consumption-based greenhouse gas emissions concerning climate impact.
Contribution to local trading system projects and to socio-economic development	The constant economic and social development of an area, which is aimed at students, is always desirable and intended.

7.2.3.4 *Key Technical Components*

Hardware:

Table 13 Hardware Key Technical Components of Gothenburg Demonstration in IS 1.1

Main Component	Technical Specifications	Area of the pre-Pilot	IRIS partner
PV (Type, Number (#), Capacity (kW)):	140 kWp roof-top solar PVs		Riksbyggen, Göteborg Energi,
Battery (Type, Number (#), Capacity (kW, Ah)):	10-14 2nd life Li-Ion batteries from electrical buses, aiming for 200 kWh		Riksbyggen, Göteborg Energi,

Storage (Type, Number, capacity):	Water buffer tanks, thermal inertia of buildings, long-term storage in the boreholes		Riksbyggen, Göteborg Energi
Ancillary Equipment Type #1 (houses connected to electrical grid, DHN and nearby office building to exchange energy for cooling purposes):	Connection to the grids for electricity and district heating. Maximum effect from solar cells and batteries towards the grid are 168 kW		Riksbyggen, Göteborg Energi,
Ancillary Equipment Type #2 (heat from geothermal energy):	Heat pumps for the downholes in a joint energy central, as well as for hot tap water in each pair of buildings		Riksbyggen, Göteborg Energi,

Software:

Table 14 Software Key Technical Components of Gothenburg Demonstration in IS 1.1

Main Component	Technical Specifications	Demonstration Area	IRIS partner
Management and control software	Software to coordinate the energy flows for several plausible service cases		Riksbyggen, Göteborg Energi,

7.3 Replication Planning in the Lighthouse and Follower Cities

7.3.1 *Utrecht Replication*

Social housing corporation BOEX will invest heavily in deep retrofit of 12 apartment buildings during the IRIS project period, regenerating them from label E/F to A. In 2015-2016 five similar apartment buildings have already been refurbished . However, BOEX's ambition is to go a step further and transform the apartments into Near Zero Energy homes and contribute to a Near Zero Energy district. The IRIS project is the perfect opportunity to realize this innovative target, by demonstrating and replicating integrated smart energy and mobility solutions at district level. The 12 four-storey apartment buildings consist of 48-65 apartments each. Of these buildings 8 are of the so-called InterVAM type of which 14.000 apartments were built in the Netherlands in 1960's, of which 6.500 in Utrecht alone. The 4 other buildings are of the so-called Bredero type, another standardized construction method that was widely applied as well; from 1948-1973 13.000 apartments have been built in the Netherlands. This implies a high local and national replication potential for the integrated smart solutions demonstrated in the Utrecht lighthouse project [1].

The ***replication solution*** will be defined in a later stage.

*7.3.1.1 **Replication Area and Geographical Overview***

The knowledge on positive energy new buildings will be replicated for new and deep retrofit buildings in the city adjusted to local conditions. Feasibility studies will be executed and building companies will be challenged in the procurements policies.

*7.3.1.2 **Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication***

In general, the replication will produce benefits for a) the environment, b) the quality of life, c) the citizens' energy and mobility bills, and d) better services for the citizens.

At first, the key findings that are expected from the replication of the solution should be presented.

At a second level, there should be a reference of the benefits for any operating market operator doing business in the specific demo area.

Below there are some indicative opportunities and objectives for the replication solution:

Table 15 Objectives/Needs & Opportunities of Utrecht Replication in IS 1.1

Opportunities	Needs/ Objectives
Increase in RES production	According to its 2016 SEAP (Strategic Energy Action Plan), Utrecht wants to have buildings heated by RES. The city also wants the number of PV-systems to grow from 4000 in 2015 to 10000 in 2020.
Establishment of a robust DHN	Utrecht needs to make the DHN more energy and cost effective, by using lower temperatures & sustainable biomass to fuel the district heating system.
Sustainable heating technologies	Utrecht wants to have buildings heated by RES (power & waste heat) rather than by natural gas. From 2018 onwards, Eneco will provide district heating generated using biomass.
Contribution to the building	Utrecht intends to strengthen the building (construction) sector

companies projects and to socio-economic development	in the area towards the overall economic development and the creation of new vacancies.

7.3.2 Nice Cote D'Azur Replication

7.3.2.1 Replication Area and Geographical Overview

The solution tested in the demonstration area will be duplicated in the Nice Eco Valley district.

7.3.2.2 Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication

In general, the replication will produce benefits for a) the environment, b) the quality of life, c) the citizens' energy and mobility bills, and d) better services for the citizens.

At first, the key findings that are expected from the replication of the solution should be presented.

At a second level, there should be a reference of the benefits for any operating market operator doing business in the specific demo area.

Below there are some indicative opportunities and objectives for the replication solution:

Table 16 Objectives/Needs & Opportunities of Nice Cote D'Azur Replication in IS 1.1

Opportunities	Needs/Objectives
Increase of energy production from RES, especially PV	RES production should increase thanks to PV (14 GWh today) and hydraulic production reinforce in the northern alpine area (750 GWh today). LTE (Law on Energy Transition) to foster local renewable production. To become energy neutral districts, a high penetration of decentralized RES in the district and convergence between electricity production, cooling & heating system is required.
Battery Storage	The dependence of RES (PV) production on weather conditions imposes the availability of storage devices.
Energy efficiency of Heating and Cooling system	In an increasing energy consumption perspective, the district needs to produce renewable energy for heating and cooling new office and residential buildings.
New smart buildings Integration	New buildings will be smart building – smart grid ready, with electricity storage systems, highly efficient insulation and geothermal network connection to reach positive energy level.
Development of demand/response flexible networks and behavioral change of end-users	The overloading electrical networks, due to increased needs, requires training and involvement of end users, so to produce and distribute the energy properly.

7.3.3 Gothenburg Replication

The ***replication solution*** will be defined during WP8.

7.3.3.1 *Replication Area and Geographical Overview*

This solution will be studied to cover additional areas, where new buildings will be built, in the city of Gothenburg.

7.3.3.2 *Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication*

In general, the replication will produce benefits for a) the environment, b) the quality of life, c) the citizens' energy and mobility bills, and d) better services for the citizens.

At first, the key findings that are expected from the replication of the solution should be presented.

At a second level, there should be a reference of the benefits for any operating market operator doing business in the specific demo area.

Below there are some indicative opportunities and objectives for the replication solution:

Table 17 Potential Objectives/Needs & Opportunities of Gothenburg Replication in IS 1.1

Opportunities	Needs/Objectives
Use of resources optimization and primary energy requirements reduction	Developing management and control systems that can deal with the combination of small scale RES production (PV, wind, etc.) and large scale supply such as from the external grid or district heating and cooling.
Short - time and long - time thermal storage	Reliance on incineration of waste for district heating – to large extent fossil material – needs to be eliminated by adoption of low carbon energy production and moderating the demand for heating and cooling. Deployment of innovative, renewable based solutions to heat/cool buildings and neighbourhoods are needed since most of the building stock dates back to the 1960s-1970s and lack sophisticated systems for monitoring and control.
Reduction in GHG emissions	According to the Green Bonds of 2013, the city wants to reduce residents' consumption-based greenhouse gas emissions concerning climate impact.
Contribution to local trading system projects and to socio-economic development	The constant economic and social development of an area, which is aimed at students, is always desirable and intended.

7.3.4 *Vaasa Replication*

The specific solutions that City of Vaasa will follow on demonstration areas a) energy efficient building envelopes, appliances, ventilations systems etc. to minimise the use of energy (state of the art technology) (TRL9), b) local production of electricity with solar PV (TRL9), c) local production of heat from geothermal energy (2-300m deep boreholes with heat pumps) (TRL9), d) local production of cooling from geothermal energy (2-300m deep boreholes, without chillers) (TRL9), e) electrical storage, Li-Ion batteries (TRL8), f) short time thermal storages, buffer tanks and the thermal inertia of the building frame (TRL7->9), g) long time thermal storage (2-300m deep boreholes) (TRL7->9).

The knowledge on positive energy new buildings will be replicated for new buildings in the city adjusted to local conditions. Primary replication area is Ravilaakso for new buildings (except solution c and e above, which could be replicated for example to University Campus or social/student housing projects). Feasibility studies will be executed and building companies will be challenged in the procurements policies. City need to be active on the construction of new energy efficient buildings to have impacts to emission and energy consumption already in short term. As lifecycle of a building is about 100 years impacts on new buildings will be slow progress. More focus need to be given to retrofitting old housing stock where impacts and benefits are bigger.

Solutions in local conditions related to retrofitting need to be studied thoroughly due to the reason that building standards have been higher than in central or south Europe and improving energy efficiency could be more costly and produce less savings than in demonstration areas.

Generally, there are huge potential with replication on existing housing stock in Vaasa and Finland. Especially if retrofitting can be done in cost effective methods and gained energy savings will cover investment cost without increasing citizen´s rents. Positive energy buildings need to be attractive to the investors.

7.3.4.1 *Replication Area and Geographical Overview*

A new mainly residential area, Ravilaakso will be constructed starting from 2020. Area is located within 1000 meters distance to the city centre. Ravilaakso is an old trolling track with area about 30 ha. Ravilaakso will establish a vision for a future energy efficient and innovative neighbourhood for about 2000 – 2500 inhabitants. Area includes blocks with both townhouses and apartment houses that are architecturally high level, interesting open public spaces and local business premises. Ravilaakso will create a city-like, lively, diverse and active city district next to the city centre. The aim is that the area will act as a showcase and a living lab for energy-efficient and sustainable solutions where innovative companies can test their products and services in an enabling environment.

New Ravilaakso will include about 140.000 – 150.000 m2 construction rights and the construction period will take about 10 years to complete. The pre-construction of the area has started already in 2017.

The old trolling track was build in 1950´s and it is situated in old seabed which gradually trough postglacial earth lifting has transformed into a small valley. Today the height of ground is about 1 meter above sea level.

A research project is ongoing studying potential of renewable energy in the area, modelling use and management of energy with different scenarios, including 0- or positive energy buildings, smart grids, 4th generation of low-temperature district heating and cooling system, geothermal and solar systems with required automation systems for buildings, blocks and in area level.

Figure 23 Location of Ravilaakso demonstration area	Figure 24 Visualisation of Ravilaakso demonstration area

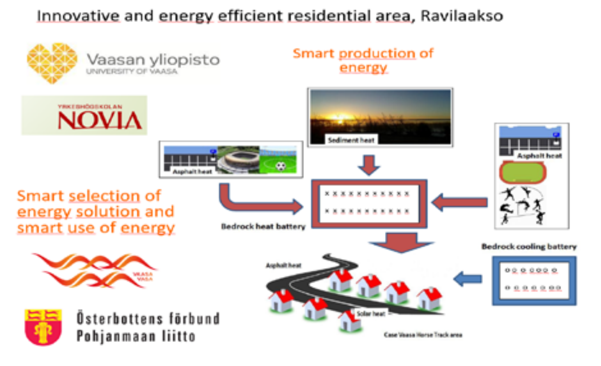


Figure 25 Preliminary concept of energy solution

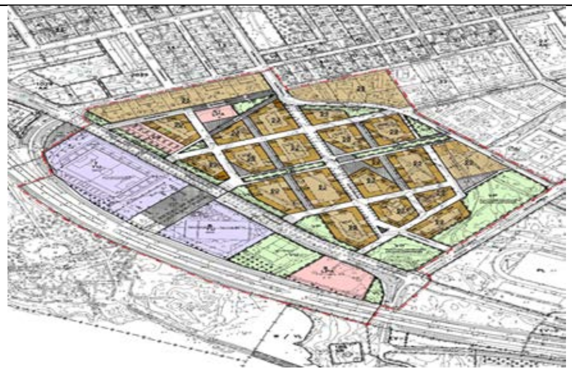


Figure 26 Preliminary detailed urban plan

7.3.4.2 Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication

Main objective for City of Vaasa is to gradually reduce use of fossil fuels and replace those through use of renewable resources and to be CO2 neutral. In general, the replication will produce benefits to the environment by reducing CO2 emissions and improving quality of life as well as financial benefits by reducing the citizen's energy bills.

Citizen's should benefit on reduced energy bills.

Construction companies and related building automation companies could benefit by adopting innovative technologies and improving their opportunities in the market.

Below, there are the main objectives and the emerging opportunities of the replication solution:

Table 18 Objectives/Needs & Opportunities of Vaasa Replication in IS 1.1

Opportunities	Needs/Objectives
City of Vaasa stops using fossils fuels.	Fulfilling political commitment to be CO2 neutral by 2030.
Reduction in GHG emissions	According to the Green Bonds of 2013, the city wants to reduce residents' consumption-based greenhouse gas emissions concerning climate impact.
Increased use of renewable energy resources.	Political decision to only purchase green energy.
Use of resources optimization and primary energy requirements reduction	Developing management and control systems that can deal with the combination of small scale RES production (PV, wind, etc.) and large scale supply such as from the external grid or district heating and cooling.
New smart buildings integration	New buildings will be smart building – smart grid ready, with electricity storage systems, highly efficient insulation and geothermal network connection to reach positive energy level.
Development of	The overloading electrical networks, due to increased needs,

demand/response flexible networks and behavioral change of end-users	requires training and involvement of end users, so to produce and distribute the energy properly.

7.3.5 *Alexandroupolis Replication*

Municipality of Alexandroupolis targets to replicate innovative solutions demonstrated in the lighthouse cities of the project with particular focus on energy efficient of buildings, local solar PV electricity production, utilisation of geothermal energy, electrical storage with Li-Ion batteries and short and long term thermal storage applications. Alexandroupolis is already advanced in some of the technologies listed in this solution, such as solar PV and solar thermal, however, the building stock is characterized as inefficient and is responsible for more than 40% of the total energy consumption of the Municipality. Local conditions will introduce an important challenge in the replication process, mainly due to increased cooling demand of buildings as opposed to demonstration areas of the lighthouse cities. The knowledge on positive energy new buildings will be replicated for new buildings in the city adjusted to local conditions. Feasibility studies will be executed and building companies will be challenged in the procurements policies. Retrofitting towards positive energy buildings constitutes a challenge for Alexandroupolis and therefore, the feasibility of such solutions will be thoroughly examined.

The replicability potential of such projects is considered as significant for Greece and South Europe. In particular, retrofitting towards positive energy buildings has important replicability in public buildings, residential buildings and tertiary buildings in Alexandroupolis and Greece. Low construction activity of Greece may result in lower replicability of new positive energy building in Alexandroupolis and Greece.

7.3.5.1 *Replication Area and Geographical Overview*

A new area has been recently added to the city plan including 4,500 hectares of available land for construction activities. A feasibility study for developing positive energy buildings in a neighborhood of this area will be developed taking into consideration knowledge gained and lessons learned from solutions tested in demonstration areas of the project.

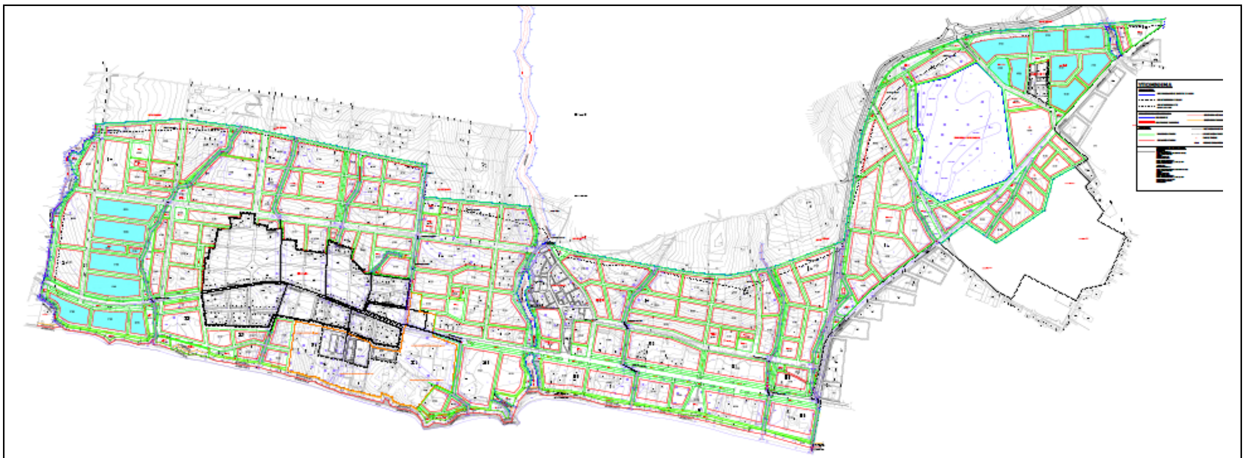


Figure 27 City plan of area "Kallithea-N.Chili" of Alexandroupolis

Municipality of Alexandroupolis has already installed Renewable Energy technologies in 8 public buildings (4 kindergardens, 2 open centers for protection of elderly people, 1 church institution and 1 cultural center in the city), 6 of them located within the city of Alexandroupolis. These buildings will be examined for the feasibility of being retrofitted towards positive energy buildings.

Figure 28 Location of six public (municipal) buildings with RES technologies

7.3.5.2 *Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication*

The following table presents the objectives and the opportunities from the replication solution.

Table 19 Objectives/Needs & Opportunities of Alexandroupolis Replication in IS 1.1

Opportunities	Needs/Objectives
Energy efficiency of Heating and Cooling system	In an increasing energy consumption perspective, the district needs to produce renewable energy for heating and cooling new office and residential buildings.
New smart buildings Integration	New buildings will be smart building – smart grid ready, with electricity storage systems, highly efficient insulation and geothermal network connection to reach positive energy level.
Increase share of RES in the energy mix	Increase the installed capacity of RES technologies within the city (private and public) with particular focus on solar energy (PV and solar thermal)

Reduction in GHG emissions	According to the Green Bonds of 2013, the city wants to reduce residents' consumption-based greenhouse gas emissions concerning climate impact. Alexandroupolis has a target of 20% reduction of CO_2 emissions by 2020.

7.3.6 *Santa Cruz de Tenerife Replication*

The specific solutions that City of Santa Cruz de Tenerife regarding positive energy will be implemented on two public buildings of the municipality in San Andrés District.

The specific solutions that City of Santa Cruz de Tenerife will work on demonstration areas a) energy efficient building envelopes, appliances, ventilations systems, etc. to minimise the use of energy, b) local production of electricity and hot water with solar PV and thermal panel.

7.3.6.1 Replication Area and Geographical Overview

Santa Cruz de Tenerife has initiated the process to transform an industrial refinery into to a new part of the city. The city aspires to grow to this area since it is limited by Anaga mountains on the East, on the North by La Laguna and on the South by the sea. This new area is about 500.000 m2 and placed at 15 minutes on foot to the city center and very well communicated with other cities. One of the most important uses for these new part of the city will be green zones and city facilities. Mobility and accessibility for citizenship will be key as well as R&D and innovation for smart and green cities.

Figure 29 Aerial overview of Santa Cruz area

This initiative has a long-term perspective and it is on its initial steps. The IRIS goal of Santa Cruz de Tenerife is to develop its smart city strategy and define a operational zone to implement replication activities on the coming years. This new industrial area represents the most promising opportunity for the city to fully developed all lessons learnt on IRIS.

On the other hand, there are other parts of the city where to implement replication actions from the current moment. The main area for energy positive building is called San Andrés at the East side of the city limited by Anaga mountains and by the sea. There are other replication actions which might take place scattered across the city.

Figure 30 Aerial view of San Andrés at the East side of the city

Figure 31 Geographical overview of replication area

Figure 32 Infrastructure overview of replication area

7.3.6.2 Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication

The main objective for city of Santa Cruz de Tenerife is to contribute to mitigate Climate Change by reducing use of fossil fuels and the increasingly usage of renewable resources. In general, the replication will produce benefits for a) the environment, b) the quality of life, c) the citizens' energy and mobility bills, and d) better services for the citizens.

Table 20 Objectives/Needs & Opportunities of Santa Cruz de Tenrife Replication in IS 1.1

Opportunities	Needs/Objectives
Increase of energy production from RES, especially PV	RES production should launch and be boosted, so as to use its wide capacity and profit from this high irradiation (over 2800 hours/year). LTE (Law on Energy Transition) to foster local renewable production.
Reduction in GHG emissions	According to the Green Bonds of 2013, the city wants to reduce residents' consumption-based greenhouse gas emissions concerning climate impact.
Demonstrate public leadership on RES	Help to re-boost private trust on these technologies on buildings.

7.4 Data Collection and Management

7.4.1 *Utrecht*

Not applicable for IS 1.1.

7.4.2 *Nice Cote D'Azur*

The Data Collection will be provided in WP6.

7.4.3 *Gothenburg*

The Data Collection will be provided in WP7.

7.5 Regulatory Framework

7.5.1 *Utrecht*

Nationwide building standards for new and deeply retrofitted buildings applies. As of 2020 nearly-zero-energy-building standard will be introduced. Preliminary standards were introduced in 2015 and evaluated by market parties. The cities is the regulatory authority responsible for enforcing these building standards whenever building permit are granted. For existing buildings bigger deep renovations require building permits and they need to comply with the requirements for new buildings if they are economically, technically and functionally feasible.

Further see the description of the regulatory framework for solutions 1.2 which also applies for this solution.

7.5.2 *Nice Cote D'Azur*

The Regulatory Framework will be provided in WP6.

7.5.3 *Gothenburg*

The Regulatory Framework will be provided in W7.

7.5.4 *Vaasa*

Nationwide regulatory framework for both new and old buildings structures and energy performance applies. Cities have regulatory authorities who are responsible to supervise adequate energy certifications or energy studies whenever building permit is granted. Regulatory framework for new buildings is based on primary energy and on average shares of RES in national level. For old buildings bigger renovations requiring building permit have to fulfil same requirements as there would be for new buildings if they are economically, technically and functionally feasible. Although better energy efficiency has to be reached.

As for metering, smart meters (AMR) have to be on apartment level in electricity. Water is also individually measured but data collection is voluntary. Heat is measured typically with smart meters (AMR) at the building level. All metering have to fill standards. Electrical metering will be more easily available to 3rd parties via "Datahub"-project, but in most cases data is already available to them.

7.5.5 *Alexandroupolis*

The regulatory framework on energy performance of buildings is based on National Greek Law 4122/2013 and the Ministerial decision DEPEA/oik. 178581 (KENAK) that introduces to the Greek legislation the European Directive 2010/31/EC. Municipality of Alexandroupolis has the authority to issue all the new construction licenses for new or refurbished buildings and is responsible for approving the energy performance studies that require to fulfill the national regulations. In case of refurbishment of buildings, the law applies only if the energy saving measures are technically and economically feasible. RES technologies are obligatory for covering at least 60% of domestic hot water demand.

7.5.6 *Santa Cruz de Tenerife*

New political situation in the country together with European Commission policy creates the expectation of the suppression of the "Sun tax".

7.5.7 Foscani

Not applicable for IS 1.1.

7.6 Bounds and Drivers for LH/FC

7.6.1 Utrecht

See the description of bounds and drivers for solutions 1.2 which also applies for this solution.

7.6.2 Nice Cote D'Azur

Information will be provided in WP6.

7.6.3 Gothenburg

Information will be provided in WP7.

7.6.4 Vaasa

Building regulations and building standards defines the norm that constructors need to follow. Any extra demand have to be technically and financially viable for investor. With local conditions with long winter period it is challenging to define cost-effective solutions that would suit to Vaasa and Finland. High level of insulation and triple-windows have been common for long time already. Most likely solutions that are accepted by house-owners and construction companies are increased use of renewable energy and smart solution related to energy consumption. At the moment cost of energy positive buildings are regarded too high when comparing to the selling price. The market behaviour should be changed that customers will require housing where energy cost is clearly lower compared to current market.

7.6.5 Alexandroupolis

1) Technical. The technologies for the transition to positive energy buildings are currently considered as state-of-the-art. Deep renovation of existing building stock towards positive energy building may be considered as a technical barrier and as a driver for the development of solutions required for the specific climate conditions of Greece (south Europe).
2) Legal. The current regulatory framework supports positive energy buildings as far as new constructions are concerned and in particular, in case of positive energy building, the building factor is increased. It can be considered as a low impact incentive and therefore, current framework is considered as neutral in terms of positive energy buildings. In addition, there is uncertainty in respect to excess energy that is produced from positive energy buildings. No particular framework is currently valid in Greece.
3) Social. Private ownership of apartments and houses constitutes a significant barrier for the potential implementation of such project (e.g. in apartment buildings). Agreement is needed and therefore careful communication with owners is required to clarify pros en cons of such an investment.
4) Financial. The increased capital of such projects constitutes an important barrier, considering the fact that there is no incentive (e.g. tariff of excess energy).
5) Environmental. The implemented measures provide the opportunity to achieve a substantial reduction in CO_2 emissions, and to improve the indoor climate of the buildings.

7.6.6 *Santa Cruz de Tenerife*

Respective information will be provided in WP8.

7.6.7 *Foscani*

Not applicable for IS 1.1.

7.7 Business models

Surplus energy trading between legal entities in a district (GOT) - Heat/cooling and electricity will be traded in real time. A market place will be created, facilitating energy trading and provision of system services and providing sustainable and viable business opportunities. New applications and services through 3rd party innovation schemes are expected to be developed in 55 buildings with at least 3 legal entities.

Surplus energy trading between positive energy building and utility (GOT) - Surplus energy trading between buildings and utility company based on hourly spot prices on electricity and district heating. Electrical storage provided including optimization of heat and electrical storages and switching of heat sources as a service.

Surplus energy trading between legal entities (GOT) - Multi-family house with geothermal energy supply cooling energy to nearby office building using dedicated pipes. The “waste heat” from the office building can charge the available boreholes.

7.7.1 *Utrecht*

Respective information will be provided in WP5.

7.7.2 *Nice Cote D’Azur*

Respective information will be provided in WP6.

7.7.3 *Gothenburg*

Respective information will be provided in WP7.

7.7.4 *Vaasa*

City of Vaasa interested on developed business models that are feasible in local conditions and regulatory framework, especially related to surplus of energy.

Surplus energy trading between legal entities in a district. Heat/cooling and electricity should be traded in real time. A market place will be created, facilitating energy trading and provision of system services and providing sustainable and viable business opportunities. New applications and services through 3rd party innovation schemes are expected to be developed.

Surplus energy trading between positive energy building and utility. Surplus energy trading between buildings and utility company based on hourly spot prices on electricity and district heating. Electrical storage provided including optimization of heat and electrical storages and switching of heat sources as a service.

Surplus energy trading between legal entities. Multi-family house with geothermal energy supply cooling energy to nearby office building using dedicated pipes. The “waste heat” from the office building can charge the available boreholes.

7.7.5 *Alexandroupolis*

Surplus energy trading between buildings in a district – Alexandroupolis will examine the feasibility of surplus heat/cooling and electricity trading for a future neighborhood. The development of a market place that facilitates energy trading and provision of system services will be examined. The potential development of new applications and services through 3rd party innovation schemes will be part of the business model examination.
Surplus energy trading between positive energy building and utility – The feasibility of surplus energy trading between buildings and utility company based on hourly spot prices on electricity will be examined. Electrical storage provided including optimization of heat and electrical storages and switching of heat sources as a service.

7.7.6 *Santa Cruz de Tenerife*

Surplus energy trading between positive energy building - Surplus energy trading between buildings and utility company based on hourly spot prices on electricity.

7.7.7 *Foscani*

Not applicable for IS 1.1.

8. Annex for IRIS Solution IS-1.2: Near Zero Energy Retrofit District

8.1 Pre-Pilot Areas Description and Available Infrastructure

8.1.1 *Utrecht Pre-Pilot*

Near zero energy building (NZEB) retrofit has been demonstrated in terraced houses in the Utrecht region and is currently being demonstrated in apartment buildings in the Overvecht district. In the Kanaleneiland Zuid district, no NZEB retrofits have been demonstrated.

No district wide PV systems have been demonstrated in the Utrecht area. Only a few **PV** panels are installed on BOEX's apartment buildings. Electricity produced with these PV panels is utilized for common energy services like operating elevators and lighting the porches.

Smart hybrid heat pumps have amongst others been pre-piloted in the north of The Netherlands. Smart street lighting has been pre-piloted in the city of Amsterdam and the city of Utrecht has pre-piloted dynamic street lighting. This was undertaken by Luminex, which is a local partner, and it is subsidiary of the company Eneco.

8.1.1.1 Pre-Pilot Area

Pre-pilot 1 – Use Case #1: NZEB retrofit in social housing sector in the Overvecht district

IRIS partner Bo-Ex (housing corporation) is a pioneer in testing NZEB-solutions. Figure 33 shows one of their apartment buildings in the adjacent district Overvecht (street: Henriëttedreef), where a modular renovation system is being demonstrated in an apartment building similar to the type of apartment buildings included in the demonstration at Kanaleneiland Zuid. The text around the photo indicates the ambitions of Bo-Ex in the pre-pilot project Inside Out.

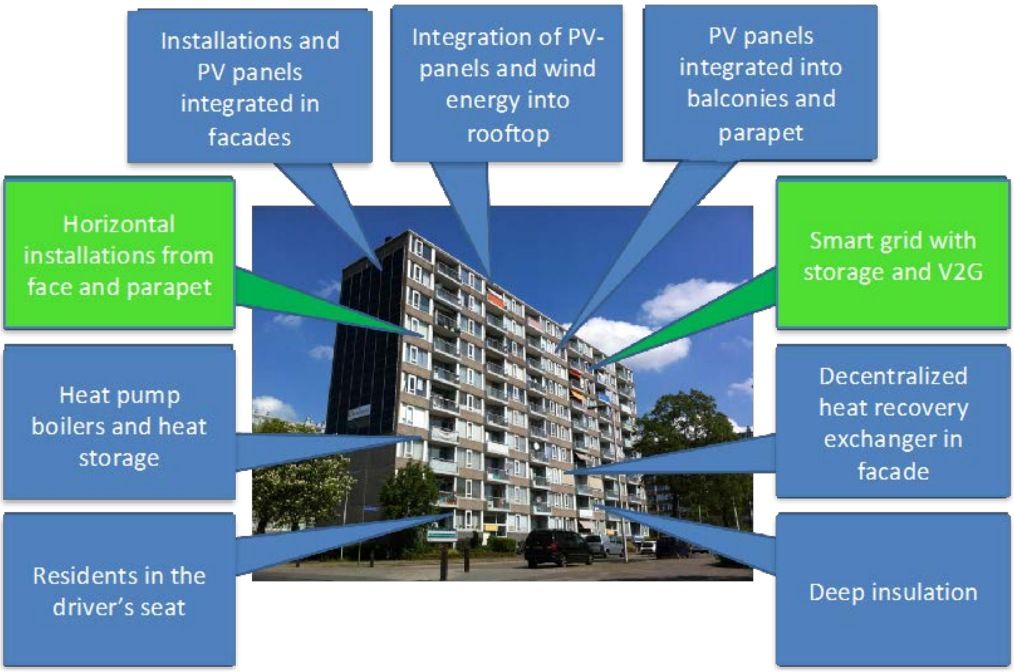


Figure 33 An InterVam apartment building owned by social housing sector Bo-Ex (street: Henriëttedreef). The south facade is covered with PV-cells.

The modular - Inside Out concept - systems includes:

- The Inside Out concept consists of prefabricated front parts, equipped with solar panels on the outside and a heating unit on the inside. These parts can be quickly and efficiently applied to replace the existing facades of the high-rise apartment building. Pre-fabricated head section parts are equipped with the central heat pump installations and include pipes to distribute the heat to the individual buildings.
- An installation that integrates PV panels and a wind energy installation. This installation, called the PowerNEST[1], is designed for building of 5 levels and higher. Due to limited roof space and the presence of ventilation pipes and other installations, today's solar technology are only able to supply full power to buildings up to 3 levels. PowerNEST lifts the roof area 4 meters up and even extend from the roof edge making 120% of the total roof area available for solar. Under the solar roof a lined-up installation of funnels and turbines is installed along the roof edge to capture the façade interacting flow and accelerate it towards the turbines to produce electricity.

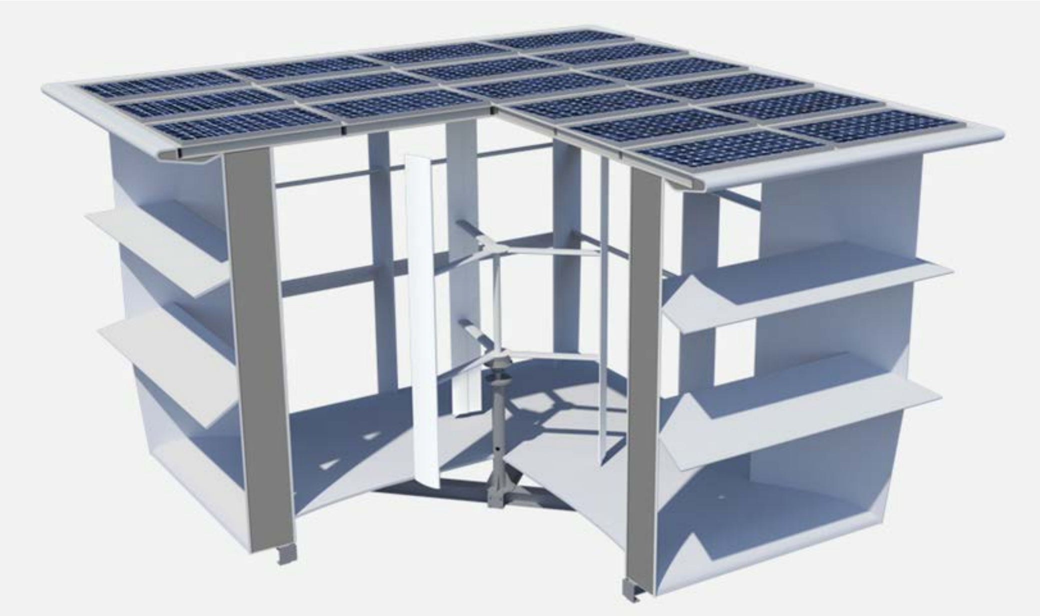


Figure 34 PowerNest Installation

From the implementation of the pre-pilot, it was concluded that:

- It's feasible to renovation a high-rise building toward an energy supplying building by implementing deep energy saving measures, combined with sustainable energy generation with solar panels on the roof and on all facades. Besides additional energy production is necessary through either through a wind generator or additional solar panels.
- The additional investment compared to a label-B renovation amounts to € 38 k to 50 k € per apartment. This make the current business case not yet feasible for the building owner.
- Cost reductions seem feasible by starting producing the pre-fabricated parts on an industrial scale. Estimated market size for the Inside Out concept is 55,000 apartments, ie 500 to 1,000 high-rise buildings in the Netherlands.

Pre-pilots – Use Case #2: Smart street lighting

In the Netherlands several projects with smart street lighting have been executed. A frontrunner is the company Luminext, affiliated with IRIS partner Eneco. Luminext retrofits existing lampposts with innovative armatures including controls for dynamic lighting, remote monitoring and sensoring. The lampposts are self-sufficient (powered by individual PV-cells), interconnected via a DC-network. They are able to provide WIFI. Several pilot have been executed in the Netherlands among others in the Amsterdam harbour area.

In the long run costs for this system are lower than conventional street lighting,because there is no need to install pipes and cables from the main power grid to the public area. Besides there is no need for converters and DC cables are thinner than AC cables – all of which saves money on raw materials and investments.

Figure 35 Smart street lighting by Luminext in Amsterdam

Lampposts are combined with innovative LED luminaires including controls for dynamic lighting and remote control. The lampposts are self-sufficient (powered by nearby PV-cells) and interconnected via a DC-network.

Utrecht municipality has pre-piloted dynamic street lighting since 2010. Along the 2,5 km bicycle lane Papendorpsepad between Utrecht and Nieuwegein 69 LED luminaires have been installed (installation by Stedin/Joulz, luminaire brand: CityTec). ***The yearly energy consumption is 2700 kWh, a reduction of 50% compared to conventional street lighting; two nearby wind turbines provides the energy.***

Figure 36 Bicycle path in Utrecht provided with dynamic street lighting from CityTec (source: IBU, Utrecht Municipality, Arthur Klink)

Pre-pilot – Use Case #3: Smart hybrid heat pumps

A smart hybrid heat pump is a system producing heat and hot water in homes from the outside air or from the extract air (when the heat pump integrated into the ventilation device). A smart hybrid heat pump combines a small heat pump (powered by locally produced PV power) with the (existing) high-efficiency gas-fired condensing boiler (for peak demand in space heating and hot water for kitchen and bathroom).

Pre-pilots have been executed in Groningen. ***Smart hybrid heat pump can save up to 40% to 55% on CO_2 emissions from natural gas in a household[2].***

Various products have been launched recently on the Dutch market, like the Ventiline from Nefit-Bosch, the Elga from Techneco and the HP CoolCube from Itho Daalderop. The Ecolution from Inventum is a smart hybrid ventilation heatpump using from the mechanical ventilation system for heating (solo) or for heating and hot water supply combination.

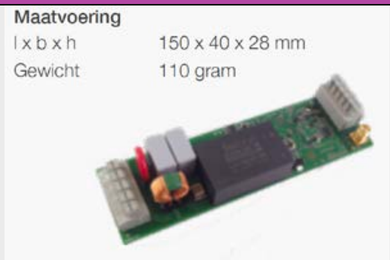
Figure 37 Smart Hybrid Heat Pump

8.1.1.2 Key Technical Components

The following Table elaborates the currently available thorough information of the considered key innovative elements of the pre-pilot:

Table 21 Key Technical Components of Utrecht Pre-Pilot in IS 1.2

Main Component	Technical Specifications	Area of the pre-Pilot
Integrated PV panels and wind generating unit	Plan size 6X6m Wind & Solar capacity • 3.1 kWp Turbine • 6.8 kWp Solar Production of 1 unit placed on a 30 meter high building • 270-610 kWh/m2/yr • 9.6-21.9 MWh/yr	Overvecht: Henriettedreef
PV panels integrated in the façade, balcony and parapet	PVs to supply loads such as elevators and lighting	Overvecht: Henriettedreef
Smart Street Lighting	• 42 dynamic, dimmable LED luminaires controlled remotely • Lights are directly sourced with electricity through an independent DC grid power by electricity produced from nearby floating solar panels and a miniature wind turbine. • Cyclist can control lamination levels through an app.	Amsterdam harbour area
Smart Street Lighting: dynamic outdoor lamp controller (OLCs)	Most recent generation of dynamic controller for remote control of lighting. Includes Micro-LAN for wireless sensors (does not include external antenna).	Luminext products are installed in various areas.

Main Component	Technical Specifications	Area of the pre-Pilot
		
Smart Street Lighting: segment controller	The segment controller manages and control the lamps via the Outdoor Lamp Controllers. In addition, the controller maintains communication with the server via the Wide Area Network. Includes: • Integrated GPRS/UMTS modem/router • Energy use: 4 Watt (nominal) 	Luminext products are installed in various areas.
Smart Street Lighting: segment controller: GeoLight App	With the Geolight App cyclist can control lighting levels on the cycling lane while passing. Based on GPS location detected by the smartphone, the app can determine whether the foot or bicycle path should be illuminated. This happens automatically when user enter the activation zone.	In the Amsterdam Harbour area

8.1.1.3 *Lessons Learnt by the implementation of the Solution in the Pre-Pilot*

- The inside-out concept revealed that it's feasible to renovation a high-rise building toward an energy supplying building by implementing deep energy saving measures, combined with sustainable energy generation with solar panels on the roof and on all facades. Besides additional energy production is necessary through either through a wind generator or additional solar panels. It furthermore showed that further cost reductions are necessary to make the business case feasible for the building owners. Cost reductions seem feasible by starting producing the pre-fabricated parts on an industrial scale.
- The pre-pilot with smart street lighting showed that in the long run costs for this system are lower than conventional street lighting, because there is no need to install pipes and cables from the main power grid to the public area. Besides there is no need for converters and DC cables are thinner than AC cables – all of which saves money on raw materials and investments.

Below is a list of the ***Linked Projects***:

- Stroomversnelling
- Rendement voor iedereen
- "Stjärnhus" Stacken
- HSB Living Lab
- FosterREG
- STEP-UP
- EU-GUGLE

8.1.2 *Nice Cote D'Azur Pre-Pilot*

Pre-pilot 1 – Use Case #1: energy efficient deep retrofitting

France has formally established a NZEB definition for existing buildings and has set primary energy use requirements for renovation. The requirements for major renovations of existing buildings are less strict than the ones defined for new buildings (80 kWh/m².year).

Cote d'Azur Habitat, a social housing company located in Nice together with the municipality of Nice and the National Agency for Urban Renewal launched an ambitious renovation programme with general objectives to demonstrate the feasibility (technical, financial and social) of innovative low energy renovation processes for buildings.

Started in 2010, the renovation programme in Les Moulins is planned over 10 years, as a first step of a larger development in the Ecovallée district, to be completed within 20 years.

8.1.2.1 Pre-Pilot Area 1 and Geographical Overview

The pre-pilot of Les Moulins (2 969 social dwellings built during the 70's, around 12 000 inhabitants, an enclave of degraded mid-rise and high-rise buildings with a shared district heating) focused on three high-rise buildings: Tower 31 (106 flats - 6571 m²), Tower 32 (106 flats - 6537 m²) and Tower 42 (106 flats - 6439 m²) (Figure 38 and Figure 39).

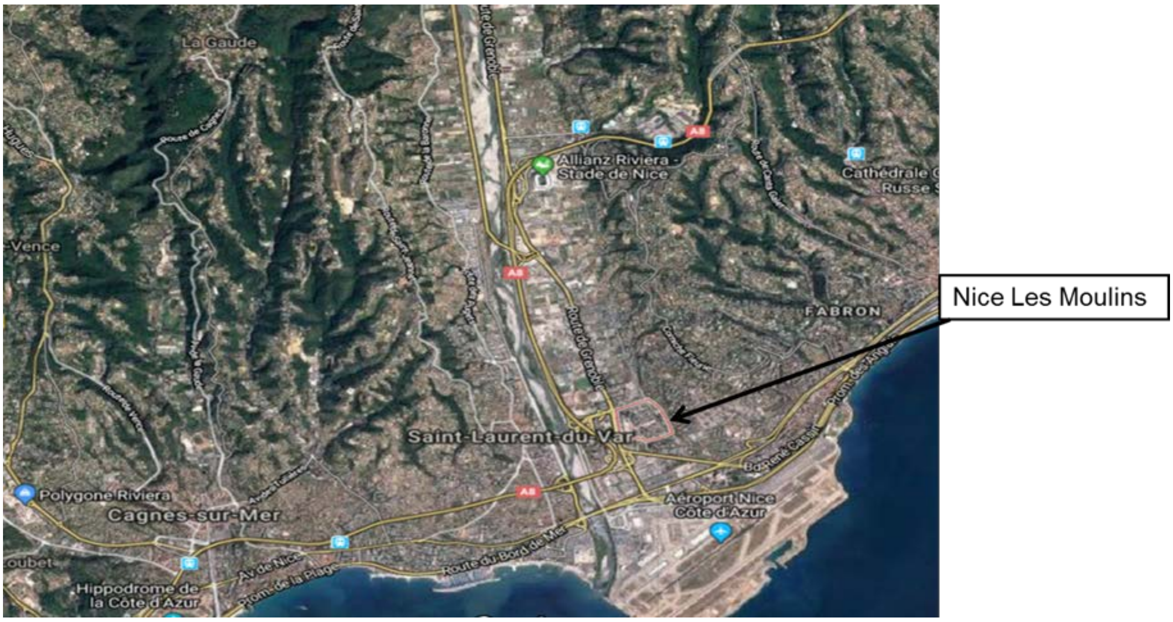


Figure 38 Location of Les Moulins pre-pilot area – Overview

Figure 39 Location of Les Moulins pre-pilot area – Refurbished buildings

From 2010 to 2013, a NZEB renovation was performed on Towers 31, 32 and 42 with the objective to eradicate insalubrious housing and reduce the primary energy consumption of the buildings from 130 kWh/m².year to 40 kWh/m².year. The following energy conservation measures were implemented:

- External thermal insulation of the building envelop: reduction of surface losses, treatment of thermal bridges (excluding balconies) and improvement of summer thermal comfort by maintaining high thermal inertia inside the dwellings.
- Replacement of exterior joinery.
- Thermal insulation of rooftop terraces with repair of the waterproofing.
- Thermal insulation of basements.
- Installation of low pressure controlled ventilation with self-adjusting air inlet.
- Rolling out of excess flow valves on all domestic hot water draw-off points (60% reduction in water consumption, resulting in a similar reduction in energy consumption for the DHW).
- Installation of a centralized solar DHW production (about 175 m² of thermal collectors and three solar storage tanks of 2000 litres each with a 2000 litres auxiliary tank).
- Implementation of low energy lighting in the common space.

Figure 40 NZEB renovation – Outside view (before and after)

Figure 41 NZEB renovation – Inside view (after)

8.1.2.2 *Key Technical Components of Pre-Pilot 1*

The following Table elaborates the currently available thorough information of the considered key innovative elements of the pre-pilot:

Table 22 Key Technical Components of Nice Cote D'Azur Pre-Pilot 1 in IS 1.2

Main Component	Technical Specifications	Area of the pre-Pilot
External Walls insulation:	External wall insulation composite system incorporating 17 cm of mineral wool, a ventilated air space and a fiber cement finish cladding (R = 4.75 m^2.K / W)	External walls of towers 31, 32 and 42
Waterproofing replacement and Roof insulation:	Waterproofing replacement and roof insulation with 16 cm of polyurethane (R = 6.4 m^2.K / W) with chipping protection	Roof of towers 31, 32 and 42
Double glazing Windows:	Installation of PVC joinery double glazing windows with argon blade (U = 1.7 W / (m^2.K))	External windows of towers 31, 32 and 42
Ventilation system:	Installation of a controlled mechanical ventilation system running at low pressure (40 Pa)	One ventilation system per tower(31, 32 and 42)
Lighting system:	Installation of compact fluorescent bulbs in replacement of traditional incandescent bulbs associated with manual timer controls.	Common spaces (corridors and stairwells) of towers 31, 32 and 42

8.1.2.3 Lessons Learnt by the implementation of the Solution in the Pre-Pilot 1

The following lessons were learnt from the pre-pilot:

- Buildings 31, 32 and 42 had never been retrofitted since their construction in 1975. ***The NZEB renovation programme allowed an energy bill reduction for tenants by a factor of 3 regarding baseline situation.***
- Tenants immediately felt the positive side effects of energy conservation measures on either summer or winter thermal comfort conditions.
- Many building pathologies have been corrected thanks to these measures. Maintenance works have been drastically reduced because of the renovation.
- In addition, the renovation and beautification of the exterior common areas have brought a real well-being to tenants who currently enjoy embellished common parts.
- Finally, the residentialization that consists in the installation of fences, gates, green spaces and new garbage disposal has led to an improvement in the living environment of tenants.

Pre-pilot 2 – Use Case #2: district heating optimization

The Moulins neighbourhood District Heating is including 3 natural gas boilers of 7 MW, with a total installed power of 21 MW, to distribute hot water (80°C to 65°C according to the outside temperature) to 28 Côte d'Azur Habitat buildings and 2 Métropole Nice Côte d'Azur buildings (a swimming pool and a school).

The 28 Côte d'Azur Habitat substations are supplying the hot water for ground floor heating and domestic hot water.

The third boilers is used when the outside temperature is under 5°C. During summer, the district heating is only used to produce domestic hot water.

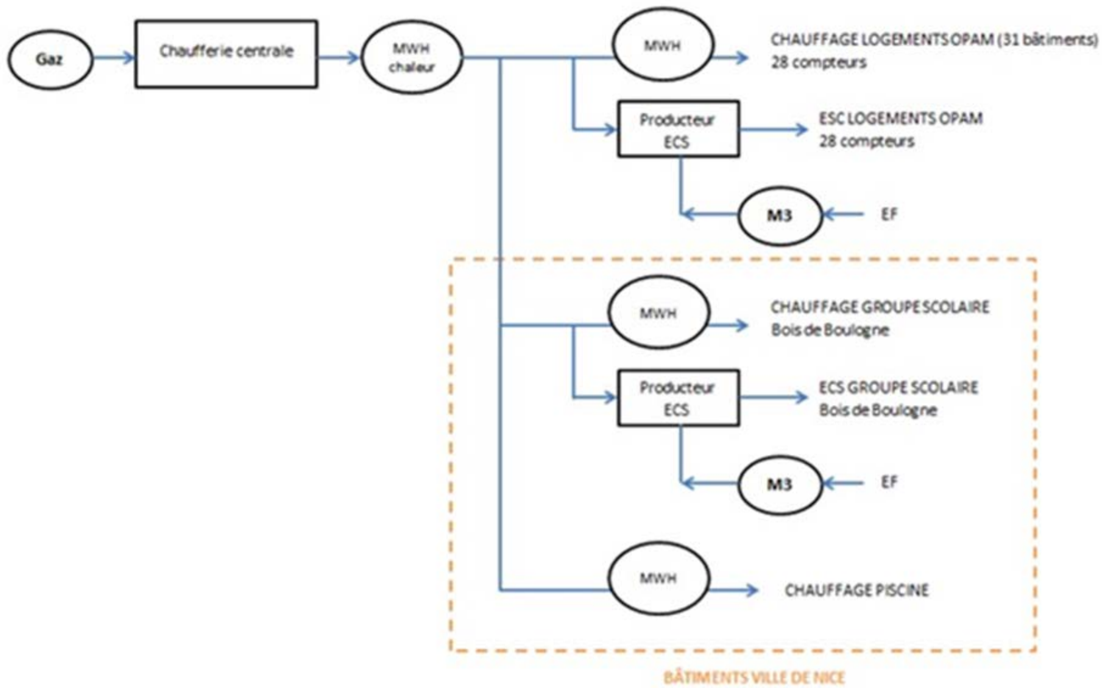


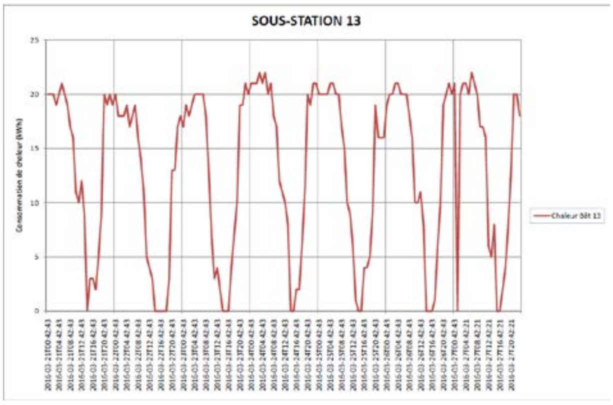
Figure 42 District Heating structure of Nice pre-pilot in Côte d'Azur

Through the monitoring of the hourly energy and water consumptions of the boilers plant and the 28 Côte d'Azur Habitat buildings sub-stations, the purpose of the pre-pilot was to identify optimization actions at district heating and buildings scale.

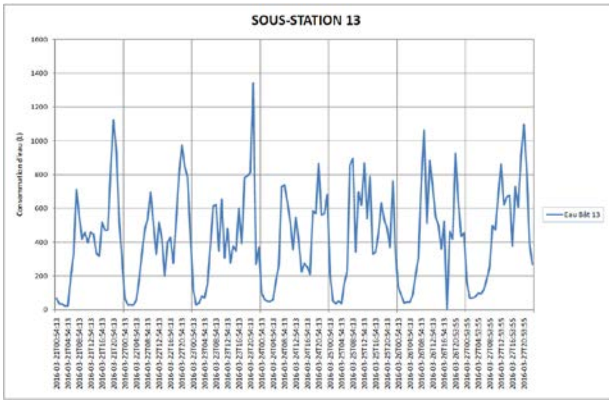
The pre-pilot was implemented during Q4 2014 and Q1 2015 and terminated in December 2017.

The data collected though the monitoring, which was first implemented in April2015, can be used for:

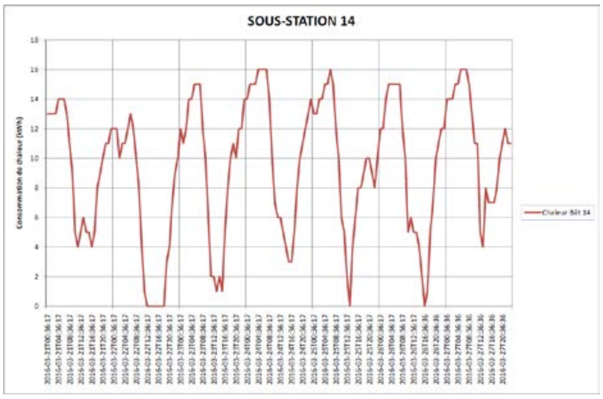
- Analyzing and evaluating the thermal dynamic behavior for the Moulins district buildings
- Comparing the energy consumption before and after the energy optimization actions
- Measuring and assessing the impact of the thermal retrofitting actions on buildings 13 and 14 which was implemented late in 2017
- Assessing the load curve optimization which was implemented in 2019



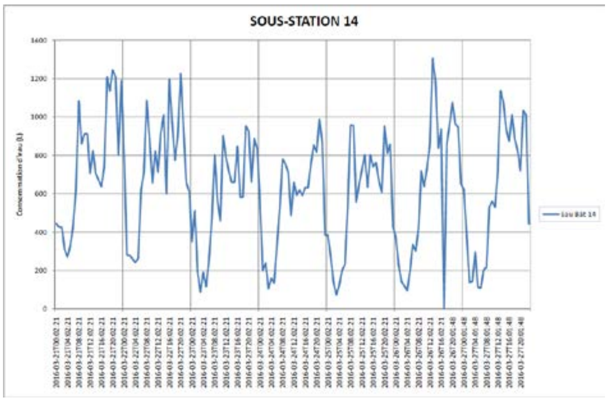
Tower 13 - Hourly heat (space heating and hot water production) consumptions from 21 to 27 March 2016



Tower 13 - Hourly hot water consumptions from 21 to 27 March 2016



Tower 14 - Hourly heat (space heating and hot water production) consumptions from 21 to 27 March 2016



Tower 14 - Hourly hot water consumptions from 21 to 27 March 2016

Figure 43 Energy consumption of buildings 13 & 14 before the thermal retrofitting

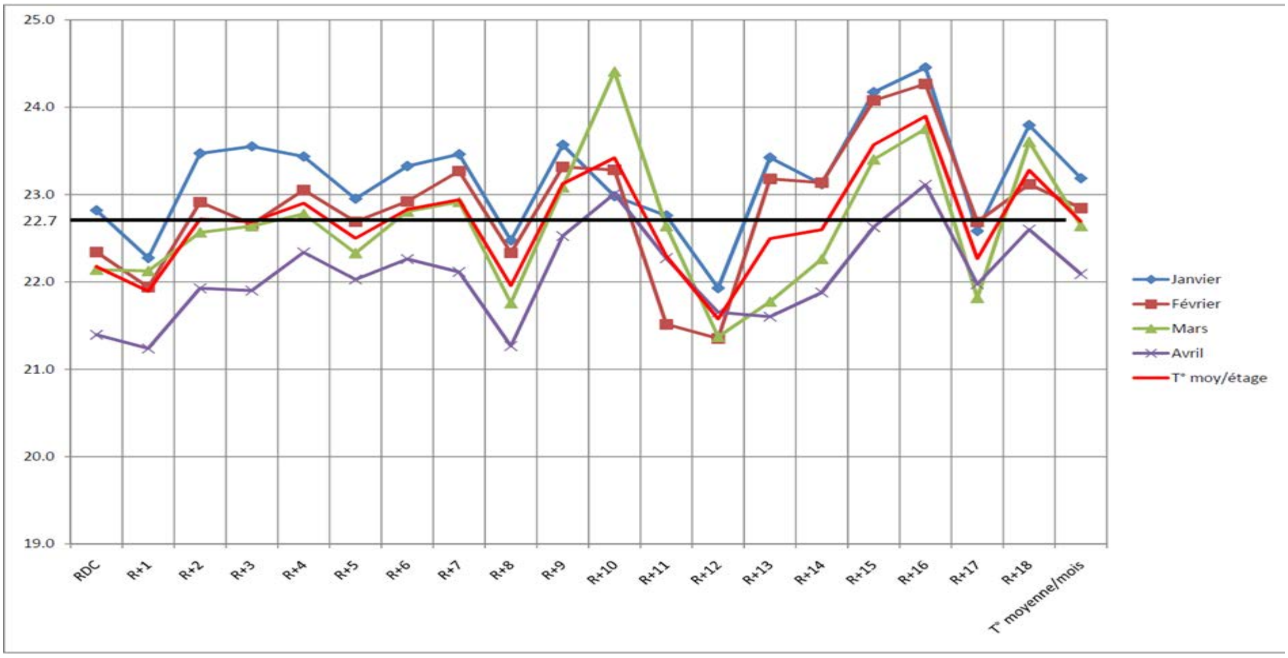


Figure 44 Average inside temperatures per level and per month (January, February, March and April 2016)

8.1.2.4 Pre-Pilot Area 2 and Geographical Overview

The pre-pilot district heating is located in the Moulins neighbourhood which is mainly composed of collective social housing buildings owned by Cote d'Azur Habitat.

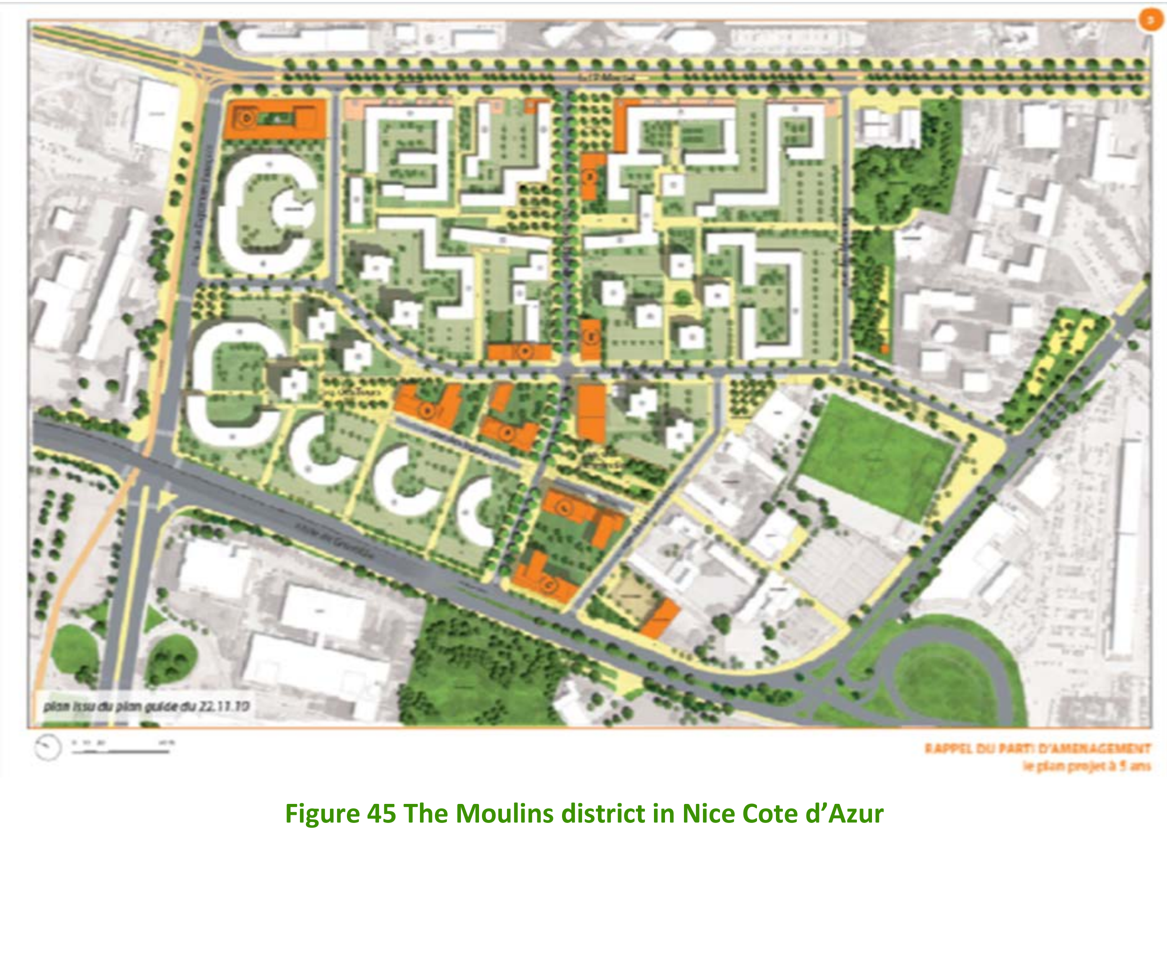


Figure 45 The Moulins district in Nice Cote d'Azur

8.1.2.5 *Key Technical Components of Pre-Pilot 2*

The following Table presents a detailed description of the different Components having been integrated in the past to form the specific Solution, along with their main technical specifications:

Table 23 Key Technical Components of Nice Cote D'Azur Pre-Pilot 2 in IS 1.2

Main Component	Technical Specifications	Area of the pre-Pilot
Monitoring devices:	The monitoring devices consist in Homerider 468 MHz radio heads implemented on existing energy and water meters : 1) 2 energy meter radio heads in the hot water boiler plant 2) 30 energy meter radio heads in the district heating substations 3) 28 water meter radio heads in the district heating substations  Existing water meter with Homerider radio head  Existing energy meter	
Communication devices:	Several radio wave Homerider repeaters were installed in order to improve the quality of the radio signal	Repeater at the top of a buidling 

8.1.2.6 *Lessons Learnt by the implementation of the Solution in the Pre-Pilot 2*

The project is still on-going, so all the data collected since the beginning have not been analysed thoroughly and there are no concise conclusions yet. The overall evaluation of the data collected during this process will give feedback for the technical and economic performance of the solution to demonstration activities. The conclusions will also give an indication of the efficiency of the optimization actions not only at buildings, but also at district scale and the level of integration capability of the solution.

Pre-pilot 3 – Use Case #3: Citizen Utilities Savings through Awareness (CUSA)

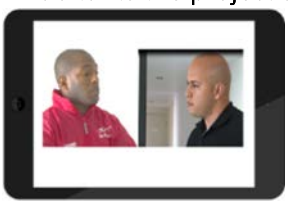
Veolia has been developing since years solutions to promote citizen engagement in order to boost the efficiency of urban services (water, waste and energy management). The CUSA solution enables inhabitants to manage their consumptions of sanitary hot and cold water, space heating and electricity. The solution is also aimed at generating savings for landlords (time, money, insurance reduction) in order to reach the appropriate business model.

This solution is based on three pillars:

1. **Smart metering**: change behaviour regarding utilities consumption needs to measure these consumptions and present it to the citizens in order for him/her to understand the link between behaviour and consumption.

2. **Display and apps**: it enables the inhabitant to monitor and analyze their energy and water consumptions with the help of the coaches, and define adapted savings targets.

3. **Individual coaching**: a personalized support will be delivered by Equitia (a specialized company in behaviour change strategies) and Adam (a non-governmental organization very present in the neighbourhood) to the tenants. The goal of this support is to explain to the inhabitants the project and how to use the display panels in order to get full benefits from it.



The Nice CUSA pre-pilot included :

1. **Smart metering** (hot water, cold water, space heating, inside temperature) and **data collection** through wireless sensors network mesh implemented by m2ocity (now Birdz)

2. **Data collection** from Linky electricity meters implemented by ENEDIS
3. **Dedicated application** supplied by KTC :
    a. for tenants, which were implemented through web, tablettes, smart phones and TV network
    b. for social landlord
4. Individual coaching of tenants through behavioural strategies experts (Equitia) and local social non-governmental organization (neigbourhood NGO Adam), individual reporting to monitor savings for tenants and landlord.

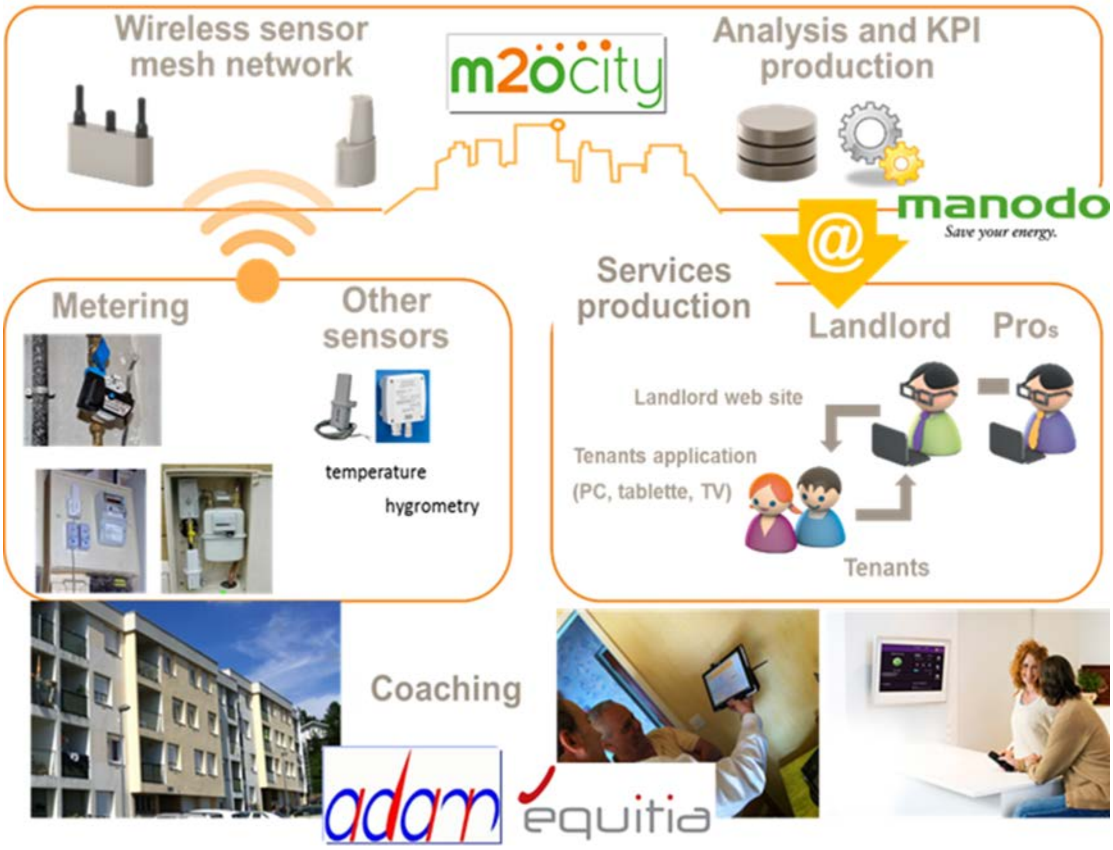


Figure 46 Nice CUSE pre-pilot Concept

The **CUSA application dedicated to tenants** is including:

- a real time follow-up of monitored utilities (hot water, cold water, heating, electricity)
- the savings reporting expressed in m3, kWh and euros, calculated on the basis of savings targets set up during the coaching process
- a data base on good practices to reduce the utilities consumptions
- functionalities to communicate with the landlord (tenants to the landlord and landlord to the tenants)
- problems report which allow the tenants to alert on any problem or failure occurring within the dwellings or in the neighbourhood

8.1.2.7 *Pre-Pilot Area 3 and Geographical Overview*

The CUSA pre-pilot is including two buildings and 186 dwellings located in the Moulins district. The pre-pilot started in 2014 and finished at the end of 2017.

Figure 47 Nice CUSA pre-pilot area

	
Tower 31 Construction date : 1970 106 dwellings	Alandier building Construction date : 2014 80 dwellings

Figure 48 The two buildings of the Nice CUSE pre-pilot

This pre-pilot refers to the following sub use cases:

1. **Sub Use Case #1 - Tower 31 (106 dwellings)**, where the following KPIs are examined:
    a. **Savings for the tenants (cold and hot water)**

    Further to the recruitment process which took place beginning of 2015, around 90% of the tenants declared to be interested in participating to the experiment.

    Around 40% to 50% of the tenants have no access to web, tablettes or smart phone interfaces, the tenants portal was implemented through the TV screen using Hybrid Broadcast Broadband TV (HbbTV) standard in order to involve most of the people of the Tower 31.

    Due to the bad optical fiber connection supplied in the building and the use of inappropriate/too old TV by the tenants, only 45 apartments could participate.

    The experiment could be split in two periods, 2016 and 2017.

    The smart phone application was only available till beginning 2017, which allow to evaluate this other interface in 2017 on the 45 apartments who already participated. Unfortunately, it was not possible to reach more tenants since then, because of the delay to get the application.

    b. **Savings for the tenants (electricity)**

    When the Linky smart meters were installed during Q3 2015, the Homerider electricity trackers were demounted, and it was then not possible to follow-up the electricity consumptions of the 106 tenants. In the framework of the recent partnership with ENEDIS, it will be possible in the future to access to the electricity load curves through an API. In the meantime, ENEDIS supplied the load curves of 19 tenants who has agreed to communicate these data, which are not yet analysed in January 2018.

    c. **Use of the tenants portal**

    On the 45 tenants who participated in 2016 and 2017, 65% used the tenants portal at least one time in 2017. Hereafter is an analysis of how many of them connected to the portal at least one time per month.

    The portal was mainly used to check the water and energy consumptions, but it is important to note that the coachs made periodic analysis of the tenants consumptions as indicated in the coaching process. Furthermore, there is no link between the reached savings and the number of connections to the portal.

    The other use of the portal is the problems report : through the portal, it is possible to identify and define the problems in order to address directly to the landlord, which is aiming at improving the communication and make save time to the tenants and the landlord. There was 191 problems report during 2016 and 2017 for the Tower 31, among them 9 have been made through the portal (5 coming from participating tenants and 4 from non participating tenants).

    d. **Energy savings at building scale**

    The data coming from the inside temperature sensors implemented in each apartment have been analysed in order to understand the thermal behaviour of the building and improve the heat distribution control.

2. **Sub Use Case #2 – Alandier building (80 dwellings)**, where respectively:
    a. **Savings for the tenants (cold and hot water, space heating and electricity)**

    For this building, the baseline consumptions were monitored during 2015. The recruitment process took place beginning of 2017, 62 the tenants declared to be interested in participating to the experiment, and 47 finally participated to the experiment. During the implementation of Linky smart meters, the Homerider trackers were reconnected, which allowed to follow-up the electricity consumptions.

The tenant portal was accessible through web, tablettes or smart phone, the TV interface was not used for this building further tot the problems encountered in the Tower 31.

b. Use of tenants portal

On the 47 tenants who participated to the experiment, 60% used the tenants portal at least one time in 2017. Hereafter is an analysis of how many of them connected to the portal at least one time per month.

The tenants portal and the coaching were adapted in order to solve a problem of bad communication and understanding about the space heating and ventilation equipments which were not used in an appropriate way.

c. Energy savings at building scale

Thanks to the individual space heating, it was possible to compare the real consumptions to the predicted ones. The observed difference could be caused by the insulation performance, the heating production/distribution efficiency, and the human factor.

The data coming from the inside temperature sensors implemented in each apartment have been analysed in order to understand the thermal behaviour of the building and improve the heat distribution control.

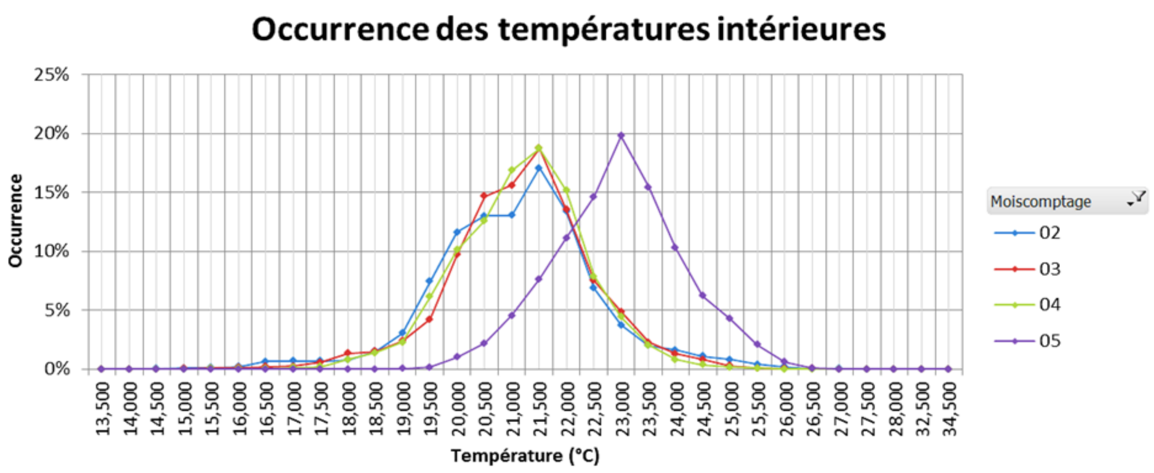


Figure 49 Occurrence of indoor temperatures from the inside temperature sensors

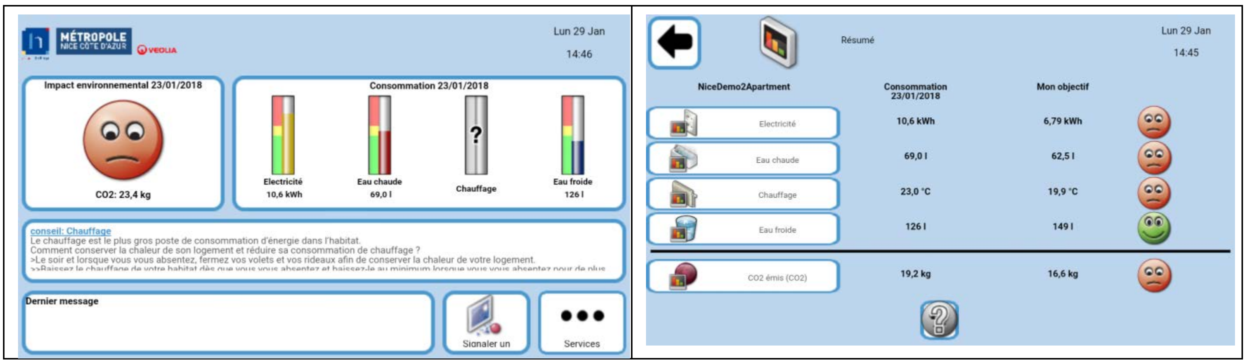


Figure 50 CUSA interface (one apartment of Alandier building)

8.1.2.8 *Key Technical Components of Pre-Pilot 3*

Table 24 Key Technical Components of Nice Cote D'Azur Pre-Pilot 3 in IS 1.2

Main Component	Technical Specifications	Area of the pre-Pilot
Monitoring devices:	The monitoring devices for the Tower 31 consist in Homerider following smart 868 MHz meters or sensors : ● 106 cold water meters with radio heads, ● 106 hot water meters with radio heads, ● 106 inside air temperature sensors, ● 106 electricity meters trackers.	Tower 31
	The monitoring devices for the Alandier building consist in Homerider following smart 868 MHz meters or sensors : ● 80 cold water meters with radio heads, ● 80 hot water meters with radio heads, ● 80 inside air temperature sensors, ● 80 electricity meters radio heads trackers, ● 80 heat meters radio heads trackers	Alandier building

Communication devices:	Several radio wave Homerider repeater were installed in order to improve the quality of the radio signal.	Repeater outside a building 

 Itron Aquadis cold water meter with its Homerider radio head	 Itron Aquadis hot water meter with its Homerider radio head
 Homerider radio head tracker on electricity meter	 Homerider radio head tracker on heat meter

8.1.2.9 Lessons Learnt by the implementation of the Solution in the Pre-Pilot 3

The main innovative element is the 3 pillars approach of the solution, in which individual coaching by the NGO is guaranteeing the appropriation by the citizens and the efficiency of the solution.

Smart metering and dedicated applications are necessary to help the end-users to link their utilities consumptions and their behaviors, but coaching is essential to reach the end-users appropriation of the solution and the savings targets. The coaching process which was implemented in the framework of the CUSA pre-pilot is including 4 main steps and it is described in the Annex.

The results will be based to the following two KPIs:

- 10% net savings on utilities bills (cold water, hot water, heating, electricity) for the tenants

  Utilities savings have been evaluated according to the IPMVP (International Performance Measurement and Verification Protocol) protocol adapted to social housing as a deliverable of ICT PSP European project (it is described in Figure 51). The steps for the calculation were:
  1. Utilities reference consumption during a baseline period
  2. Utilities savings solution implementation
  3. Savings calculation
- Creation of value through improvement of customer relationship (2 to 3 years ROI)

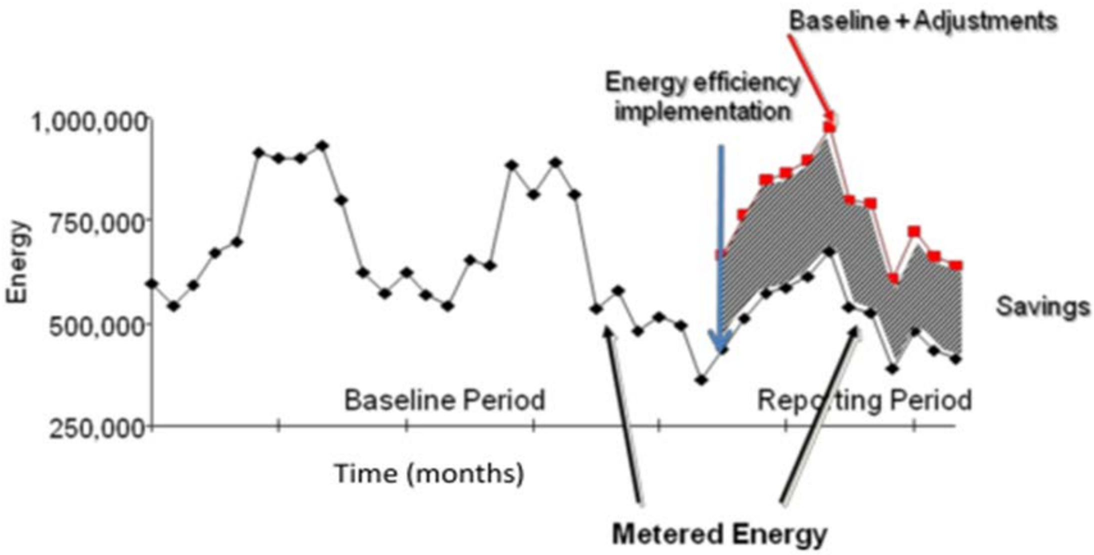


Figure 51 Utilities savings evaluation according to IPMVP

Estimated Savings for the two use cases:

1. **Tower 31:** Average net savings of 53€ per apartment (tenants' reduced budget of 213€) in 2016 and average net savings of 82€ per apartment (tenants' reduced budget of 119€) in 2017.
2. **Alandier Building:** No savings were found, which means that there were not significant consumptions gap after the implementation of the coaching process compared to the baseline.

Savings and benefits for Côte d'Azur Habitat

The main identified potential savings and benefits for the landlord were the following ones:

- Time savings and improvement of relationship with tenants through the problem report function
- Time savings and improvement of relationship with tenants through the inside temperature monitoring, in case of claims from the tenants related to the heating
- Improvement of relationship with tenants through communication and coaching about new space heating and ventilation in Alandier building
- **Reduction of insurance cost due to the water consumption real time monitoring**
- **Reduction of unpaid rents due to tenants savings**

The targeted resulting saving for the landlord is 200 euros/dwelling/year, which could bring a 2 or 3 years ROI.

In the Annex, the KPIs, where the results were based, are mentioned and the respective graphs and tables from the savings are presented.

Linked Projects:

- NiceGrid
- STEP-UP
- EU-GUGLE

8.1.3 *Gothenburg Pre-Pilot*

Pre-Pilot 1 – Use Case #1: "Stjärnhus" house

As a pre-pilot retrofitted case the "Stjärnhus" house in Gothenburg is selected. It is a multi-family building from 1968 that quite recently (finalized in 2016) was retrofitted to passive house standard and equipped with solar PVs for own production of renewable electricity.

A triple-glazed window upgrade has been implemented in that along with a heat recovery ventilation (MVHR) unit, which has been PHI certified, with 85% heat recovery efficiency.

Additional elements include, a) insulated attic, b) an installed new PHI-certified windows and sort out air tightness with an upgraded MVHR control, c) insulated façade and included balconies into thermal envelope.

8.1.3.1 Pre-Pilot Area 1 and Geographical Overview

Below a picture of the house can be seen, as well as a map showing its location in the north-eastern part of Gothenburg.

Figure 52 Location of pre-pilot area in the north-eastern part of Gothenburg

8.1.3.2 *Key Technical Components of Pre-Pilot 1*

The following Table presents a description of the different components having been integrated to form the specific Solution, along with their main technical specifications:

Table 25 Key Technical Components of Gothenburg Pre-Pilot 1 in IS 1.2

Technical component	Technical specification	Placing in building
Solar panels	Mono-crystalline silicon (mono-SI) on the roof (approx. 250 pcs) Amorphous silicon on the façade (approx.. 2000 pcs)	Façades (all) and roof
Auxiliary equipment #1: Energy control system	For solar electricity: Ferroamp Energy hub with "Solar String Optimizers" and "700 V DC bus". District heating from city grid for heating and hot water	Solar string optimizers: half in the attic and half on the ground floor (in the workshop) Energy hub: ground floor (in the workshop) District heating central: ground floor (in the workshop)
Auxiliary equipment #2: Heat recovery from ventilation	MVHR: Swegon Gold with 85% recovery. Demand-driven valve actuators: Moisture controlled exhaust air device (two per apartment), which is also controlled by presence in the bathrooms and CO2-level in the kitchen air.	MVHR: in the attic Demand control: all exhaust air units in the apartments and the other premises.

Auxiliary equipment #3: Low energy windows and front doors (to the outside)	U-value of the whole window: 0,7 W/m2K (246 psc.) U-value of the glass: 0,48 – 0,53 W/m2K U-value of the front doors: 0,66 W/m2K (5 psc.)	Windows in all apartments Doors to the outside, on the ground floor.
Other: Demand-driven lighting Renovation of façade with additional insulation	Lighting: In every room, the lighting automatically switched off 15-20 minutes after last stay in the room. Not automatically switched on by motion. Additional insulation: 25 cm Rockwool RedAir isolation on top of existing concrete element façade (U-value: 0,12 W/m2K.) 50 cm loose wool /cellulose in the attic (U-value: 0,08 W/m2K).	Lighting: the whole house, including apartments and common premises. Additional insulation: Façade and in the attic

8.1.3.3 Lessons Learnt by the implementation of the Solution in the Pre-Pilot 1

The consolidated conclusions of this pre-pilot are not yet available.

Linked Projects:

- Stroomversnelling
- rendement voor iedereen
- “Stjärnhus” Stacken
- HSB Living Lab
- FosterREG
- STEP-UP
- EU-GUGLE

Pre-Pilot 2 – Use Case #2: HSB FTX

The HSB FTX is preheating incoming ventilation to no lower than -5 degrees Celsius during winter by using geothermal energy which is collected from boreholes, in order to avoid ice formation in heat exchanger (Figure 53).

During summer HSB FTX cools the incoming ventilation for comfort.

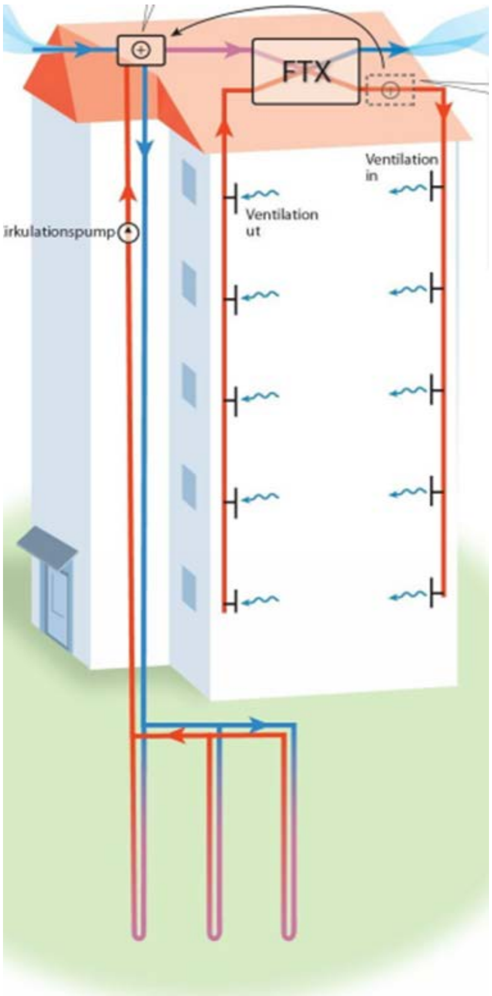


Figure 53 Schematic of the HSB FTX system

The system was installed in HSB Living Lab, a third generation Living Lab situated on the Chalmers Johanneberg Campus.

Figure 54 HSB Living Lab

8.1.3.4 Key Technical Components of Pre-Pilot 2

The following Table presents a description of the different components having been integrated to form the specific Solution, along with their main technical specifications:

Table 26 Key Technical Components of Gothenburg Pre-Pilot 2 in IS 1.2

Main Component	Technical Specification	Location
Boreholes and preheating device:	Two boreholes are being built at the site. Each of them are 200 meters deep. One preheating device is installed.	At HSB Living Lab, Gothenburg

8.1.3.5 Lessons Learnt by the implementation of the Solution in the Pre-Pilot 2

The conclusions are summarized to the followings:

- **Reasons for the method selection**

  The preheating method lowers energy costs, but most of all it reduces the power requirement for the building.

  This will lower the need and cost for extra energy normally used for avoiding ice formation in the heat exchanger during days with extreme cold.

- **Savings**

  The cost for installing the HSB FTX in a house like HSB Living Lab (4000 sqm) is 40 000 euro. This is the additional cost needed for boreholes and the preheating device.

  By using the HSB FTX system the property owner can save 4 000 eur each year.

  The reduction of energy peaks will lower climate impact such as CO2 emissions with approximately 15 tons each year.

  Energy suppliers will also save costs and CO2 emissions due to fact that during energy peaks energy is produced by fossil based energy sources.

8.2 Demonstration in the Lighthouse Cities

8.2.1 Utrecht Demonstration

8.2.1.1 Use Case and Brief technical description

Utrecht's ambition is to contribute to Near Zero Energy districts by integrating:

- A high share of locally produced and consumed renewable energy at district scale
- Energy savings at building level
- Energy savings at district level

The foreseen demonstrated solutions in Track #1 integrate high renewables penetration (district scale PV), near zero energy housing retrofit, and energy efficient smart street lighting powered by renewables and connected to the DE system with DC distribution. IRIS sets out to demonstrate how energy streams can be jointly used in such a way that a maximum of RES penetration at district-scale becomes possible (storage of locally produced electricity in 2nd life batteries, electric vehicles and busses is part of this integrated systems, which is described under transition track #2).

The applied measures under transition track #1 encompass:

1. PV panels on the roofs of the apartment buildings and the schools
2. Home Energy Management Systems (EMS) TOON
3. Energy savings as a result of refurbishing towards near energy zero building
4. Smart (hybrid) electric heat pumps for the production of heating and hot water
5. Energy savings as a result of smart AC/DC power grid in apartments
6. Smart DC street lighting at district level

Measures 1 to 4 will be integrated and deployed in 12 four-storey apartment buildings adding up to 644 apartments. Measure number 5 will be demonstrated in 4 apartment buildings. Figure 55 provides an overview of the envisioned integrated energy systems for an apartment building.

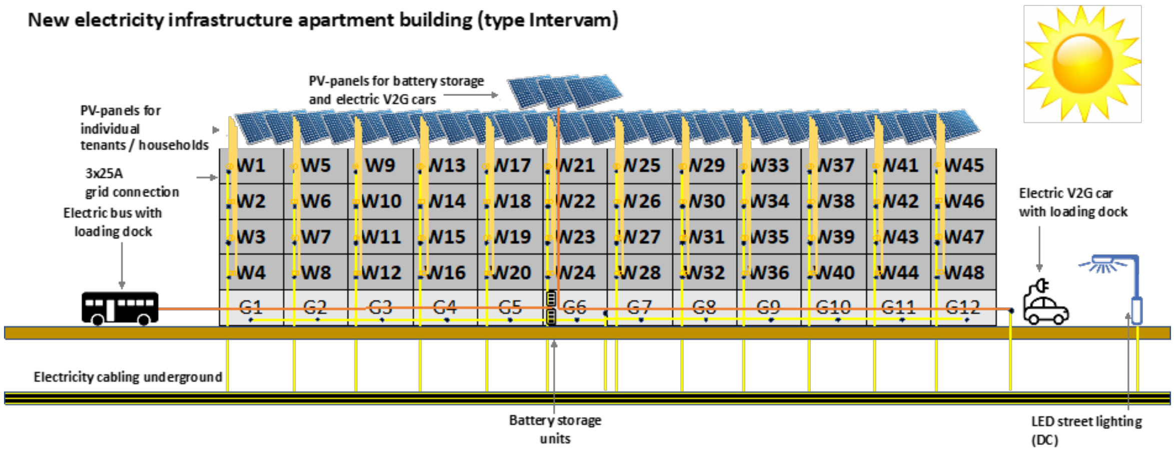


Figure 55 Overview of the envisioned energy system for an apartment building

8.2.1.2 Demonstration Area and Geographical Overview

The smart solutions will be integrated and deployed in 12 four-storey apartment buildings of social housing corporation BOEX in the district of Kanaleneiland Zuid, adding up to 644 apartments. Of these apartment buildings 8 are of the Intervam type of and 4 of the Bredero type. Next, 3 school buildings (Kaleidoscoop, Schatkamer, MBO Utrecht) will be provided with PV-systems, and integrated in the district's energy grid (Figure 56).

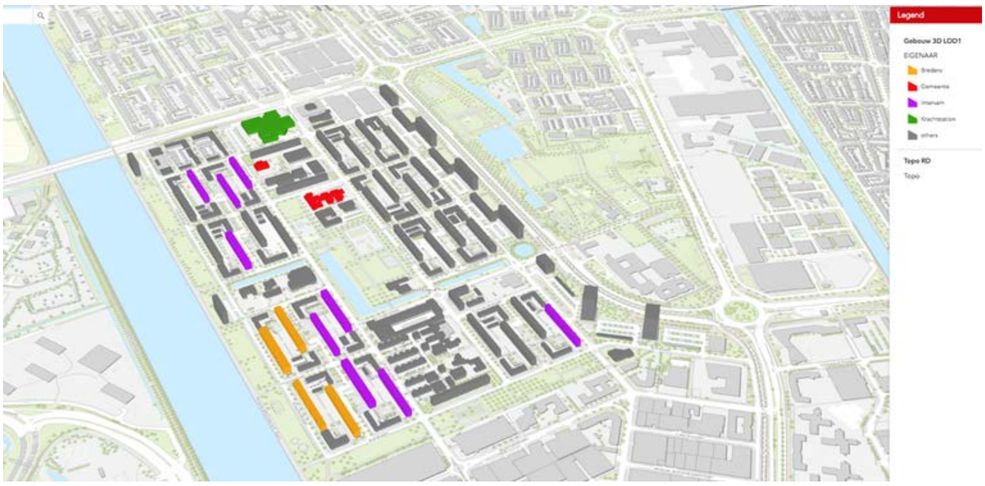


Figure 56 Map of the demonstration district Kanaleneiland Zuid with overview of apartment blocks that will be renovated, involved schools and the local innovations hub Krachtstation

The apartment buildings of Bo-Ex Kanaleneiland Zuid district are marked by high energy losses, low thermal comfort, hardly any use of RES and subsequently bad energy labels (Figure 57).

Figure 57 Current Energy labels for the apartment buildings in the demonstration district Kanaleneiland Zuid that will be renovated

The current energy infrastructure encompasses an electricity network, a districting heating network and gas infrastructure. Parts of the gas infrastructure are obsolete and either needs to be replaced or be taken out of operation (Figure 36). Of the apartment buildings that will be renovated 8 are currently heated with gas boilers and 4 are heated through the district-heating network (Figure 58).

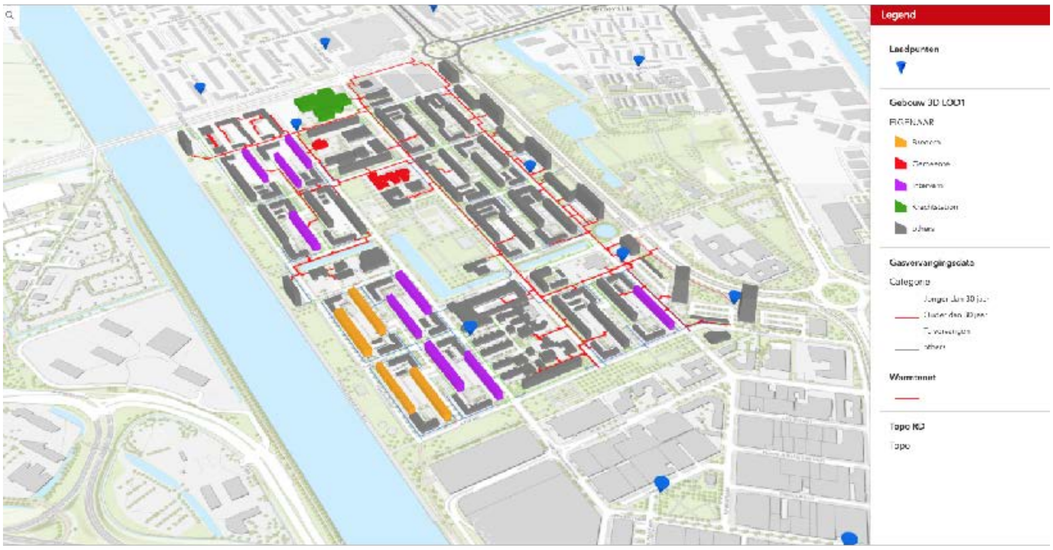


Figure 58 Current gas and district-heating infrastructure in the demonstration district Kanaleneiland Zuid

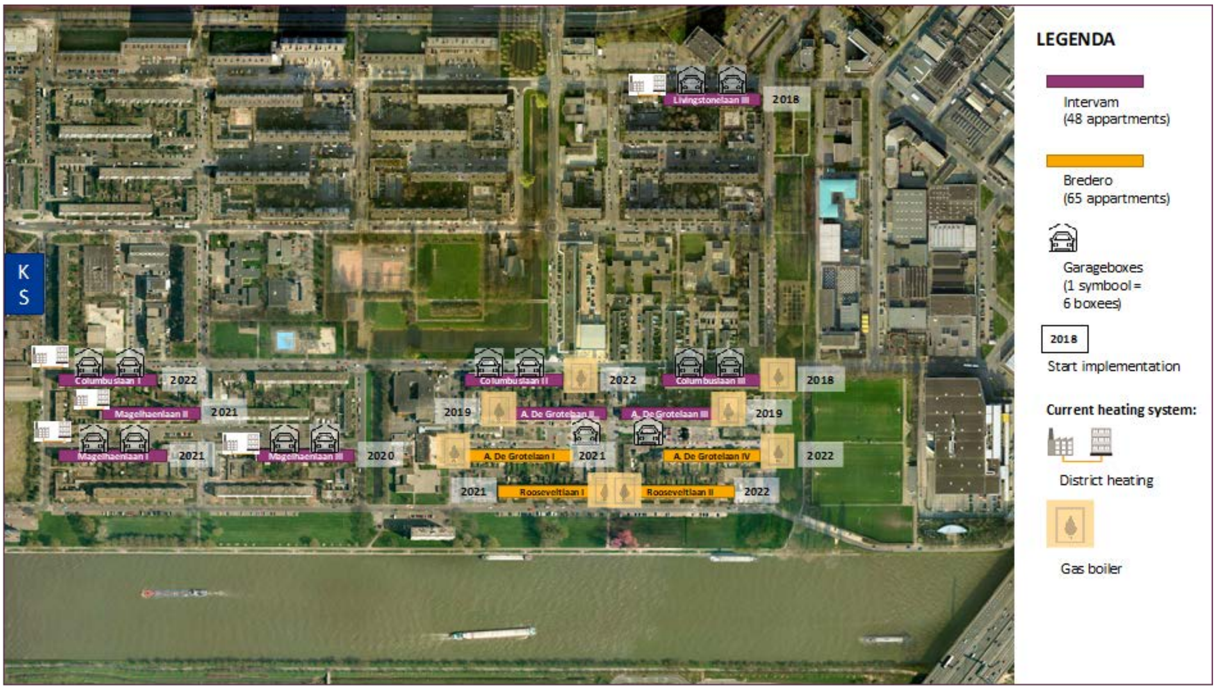


Figure 59 Overview of the apartment building that will be renovated and current energy infracture providing the heat

8.2.1.3 *Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Demonstration*

Table 27 Objectives/Needs & Opportunities of Utrecht Demonstration in IS 1.2

Opportunities	Needs/Objectives
Renewal of the energy infrastructure	The district is characterised by a variety of energy infrastructure (electricity, natural gas and district-heating). The majority of which was installed decades ago and has become obsolete. The resulting need for renewal of the energy infrastructure is an opportunity for transforming the district into a Near Zero Energy district. Parts of the gas infrastructure are obsolete and either needs to be replaced or be taken out of operation. The planned renovation of the apartment building by Bo-Ex creates the need for (i) replacing the gas infrastructure or taking it out of operation and (ii) investing in the electricity grid to accommodate large scale local renewable energy production.
Heating and cooling system	The aim is to use renewable power for heating and cooking rather than natural gas, and to create an all-renewable electric district.

Opportunities	Needs/Objectives
Local renewable production	A Near Zero Energy district not only requires a drastic reduction in energy demand but also extensive renewable production and optimal distribution of renewables within the district by means of demand side solutions and storage for grid flexibility and cost-effective use of renewables. Therefore, (1) the apartment buildings and three schools will all be covered with PV, (2) DC powered smart street lighting, which is directly connected to the PV panel, (3) AC/DC switchboxes enabling direct use of PV produced electricity for use within households.
Software equipment development	Smart management of the home energy needs through the HEMS TOON and control of available PV power.
Stable and lower housing bills in combination with higher comfort in homes	The district consists of buildings with high-energy losses and low thermal comfort. This situation imposes the upgrade of the buildings which raises the opportunity for improving the residents' quality of life and lowering their energy bills.

8.2.1.4 *Key Technical Components*

Hardware:

Table 28 Hardware Key Technical Components of Utrecht Demonstration in IS 1.2

Main Component	Technical Specifications	Demonstration Area	IRIS partner
PV solar panels Number on appartments: 8-10 per apartment plus 30 panels for the electric car *Number on schools: t.b.d.*	• PV panel on the rooftops • Type: Mono silicium back contact cel • Capacity: 350WP per panel, providing approx. 298kWh per year. Resulting in 143.040kWh per year for an apartment building. • 60 cells per panel • Dimensions: 1700 x 1016 x 40 mm • Individual string convertors (with optimizers if necessary)	12 four-storey apartment buildings *3 schools*	Bo-Ex (owner) Provider t.b.d.

Battery Storage 2nd life batteries Capacity: 125kWh per unit, 250kWh per storage Number: 4 storages	• Capacity: 96kW / 125kWh per unit, resulting in 1MWh in total • Technology: Li-Ion • 1 automation server per unit • Power conversion of approx. 96kW • Weight: max. 300kg per unit • Dimensions: max. 2,0*1,8*0,8m per unit	2-4 four storey apartment buildings	Bo-Ex (owner) Provider t.b.d.
Smart street lighting	DC electricity LED lighting	50 existing street lighting poles in/among the demonstration area	Luminext (provider) Municipality of Utrecht (owner)
AC/DC Switchbox	8 homes will be equipped with AC/DC switchboxes	8 apartments	Bo-Ex
Hot water and heating equipment	**Scenarios with regards to heating and hot tap water:** > Heating with a hybrid solution (gas central heating boiler i.c.w. heating pump) for low temperature heating and hot tap water *> Heating with centralized heating pumps of heat exchangers for low temperature heating ans hot tap water and electric cooking* *> Middle/Low Temperature district heating (70-40^{o}C) for heating i.c.w. a boiler / heating pump for low temperature heating and hot tap water and electric cooking*	12 four-storey apartment buildings	

Software:

Table 29 Software Key Technical Components of Utrecht Demonstration in IS 1.2

Main Component	Technical Specifications	Demonstration Area	IRIS partner
Smart electricity meter	450MHz unwired network	12 four-storey apartment buildings	Stedin (owner)
Eneco Toon control system	7`` display Z-wave protocol Android / iOS platform	12 four-storey apartment buildings	Eneco (provider and owner)
Communication Platform	t.b.d.	12 four-storey apartment buildings	t.b.d.
Algorithms for building energy management	t.b.d.	12 four-storey apartment buildings	t.b.d.

8.2.2 *Nice Cote D'Azur Demonstration*

8.2.2.1 Use Case and Brief technical description

The third instalment of the Urban Redevelopment Programme in Les Moulins managed by Côte d'Azur Habitat, a social housing company, is going to cover the period from 2017 to 2020.

Five degraded mid-rise and high-rise buildings are going to be refurbished (namely buildings 8, 9, 11, 13, 14) with the objective to eradicate insalubrious housing and reduce the primary energy consumption of the buildings from 180 kWh/m².year to 70 kWh/m².year.

Figure 60 Buildings concerned by the third instalment of the Urban Redevelopment Programme in Les Moulins

The use cases will focus on two high-rise buildings: Tower 13 (66 flats – 16 storeys) and Tower 14 (66 flats – 16 storeys) that were just refurbished (end of work: April 2018).

Besides traditional energy conservation measures (see next section), 3 innovative solutions will be experimented on these 2 buildings to achieve the target of Near Zero Energy Building (NEZB):

- **Use Case #1:** Implementation and test of the REPERE method, a commissioning service developed by the CSTB to assess the real energy performance and savings related to building energy refurbishment, especially in the context of multifamily apartment buildings.
- **Use Case #2:** Optimization of the energy distribution system in buildings.
- **Use Case #3:** Test of new energy awareness services, including smart metering to track water and energy consumptions (hot water, cold water, electricity, space heating, internal temperature), data collection through wireless sensors mesh (concentrators and data transmitters) for tenants to raise awareness and promote behavioral change.

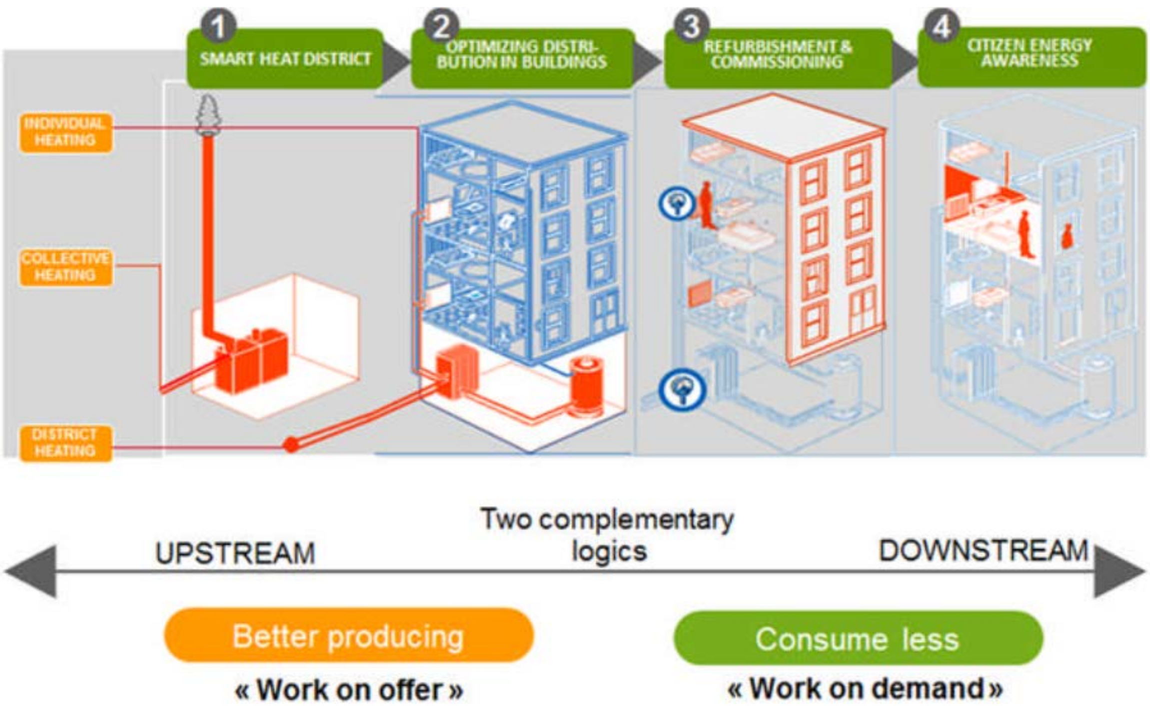


Figure 61 Use cases, a complementary approach to reach NZEB target

8.2.2.2 *Demonstration Area and Geographical Overview*

The demonstration will focus on two high-rise buildings built in 1974 and located in Les Moulins, a social housing area densely populated characterized by a majority of low-income and multicultural households.

Figure 62 Les Moulins demonstration area - Focus on refurbished buildings

These **two buildings (towers 13 and 14)** have been recently refurbished with a large panel of energy-efficient measures:

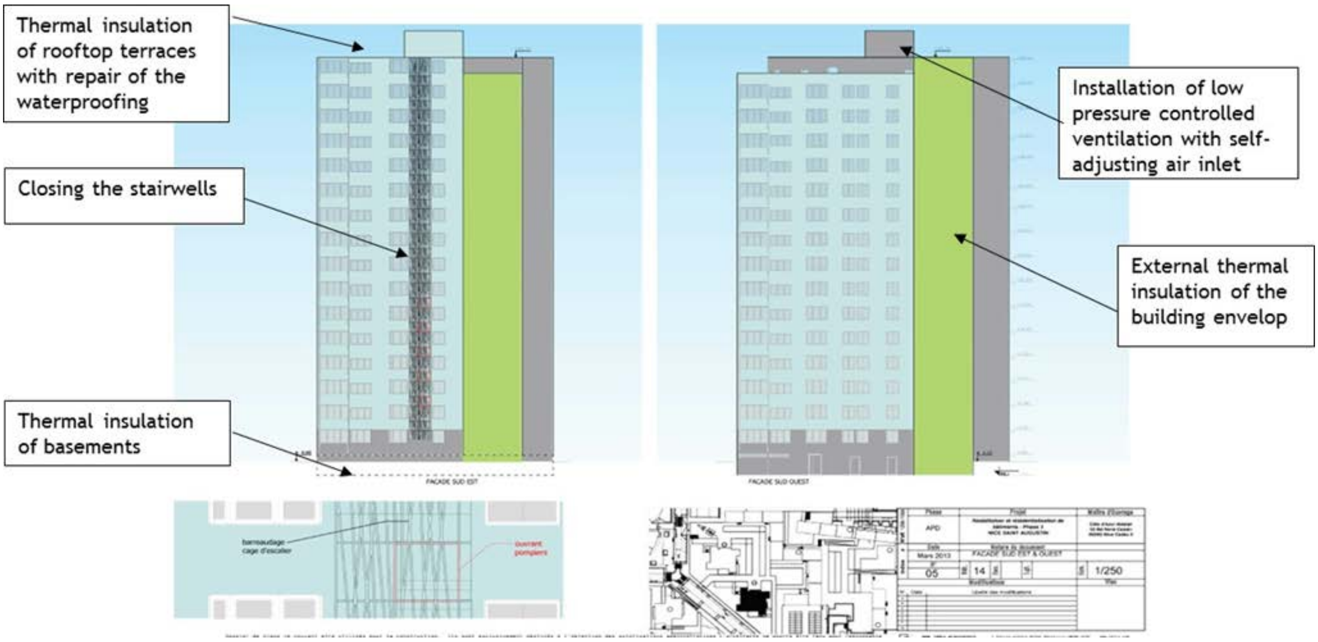


Figure 63 Refurbished buildings – Energy conservation measures

Refurbishment works started on September 2016 and are now achieved. The total amount of the work is 17 690 €/dwelling (VAT excluded) whereas this amount is 11 740 €/dwelling only for energy conservation measures.

Figure 64 Refurbished buildings – Before (left) and after (right) refurbishment

8.2.2.3 Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Demonstration

Use Case #1: Implementation and test of the REPERE service

The REPERE service is a dedicated commissioning process elaborated to check from the design to the operation that energy efficient measures have been correctly implemented in refurbished apartment buildings. This service is based on monitoring and measurement data acquisition. Measurements are performed both before and after refurbishment and used to build an energy model of the building. This model is then processed to compare the performance after refurbishment with the performance or bills before refurbishment (bills are used when measurement before refurbishment is not possible).

Only few measurements are required to apply the REPERE approach. Energy consumptions (heating, hot water and electricity), from the already in place meters, as well as some comfort variables such as temperature, hygrometry or luminosity are measured. Theses variables must be measured (usually using wireless technology) over the entire monitoring period (basically one heating season before and after retrofit works) and are stored on a server to be analysed offline.

Based on these measurements and on various meta data collected from the refurbishment project, the REPERE service consists in a complete data processing chain that allows semi-automatical energy analysis of the refurbished building and comparison with the forecasted energy savings. This data processing chain encompasses a full data management process, including the diagnosis of measurement data with error checking tests and the split of energy consumption between usage when relevant.

The **main benefits of the implementation of the REPERE commissioning service** after the refurbishment works are:

- to facilitate the identification and mitigation of any issues related to the process of building refurbishment;
- to compare the predictions in the design phase of the building's energy requirements with the real energy performance monitored;
- to tease out differences related to poor implementation or defaults from differences related to occupants 'misbehaviour':
- to propose corrective measures designed to bridge the possible gap between forecast and measured energy performance;
- to advise users to ensure proper use of building-plant system and practices through the monitoring of their energy behaviour.

At the end, the added value of this solution for the **tenants lays in more stable and lower housing bills, in combination with a higher comfort** and less draught and humidity in homes.

Use Case #2: Optimization of the energy distribution system in buildings

Use Case #3: Implementation and test of new energy awareness services

8.2.2.4 Key Technical Components

Use Case #1: Implementation and test of the REPERE service

Hardware:

Table 30 Hardware Key Technical Components of Nice Cote D'Azur Demonstration Use Case 1 in IS 1.2

Main Component	Technical Specifications	Demonstration Area	IRIS partner (owners and providers individually)
Air temperature/Humidity sensor	• Timestep : 10 min fixed or variable timestep [minimum = 5min, maximum = 1hour, variable step= 0.3°C on temperature 3% on Relative humidity] • Measure accuracy : 0.2-0.3 °C on air temperature measurement, 2-3% on relative humidity measurement • Measure resolution : 0.1 °C on air temperature measurement, 1% on relative humidity measurement • Measure range: 10°C-35°C on air temperature measurement, 0-100% on relative humidity measurement	Each apartment of Towers 13 and 14	CSTB, VEOLIA, CAH
Volumetric DHW meter	• Measure accuracy : 1L • Measure resolution : 1L • Measured variable : water volume as an index • Timestep : o Best : 1 index report per hour o Required : 1 index report per day or month	Each apartment of Towers 13 and 14	CSTB, VEOLIA, CAH
Energy consumption meter	• Index accuracy : o Best :1kWh or better o Required : 10kWh • Timestep : o best : 1 index report per hour o Required : 1 index report per day	Each DHS sub-station	CSTB, VEOLIA, CAH
Energy consumption meter (optional)	• Index accuracy : o Best :1kWh or better o Required : 10kWh • Timestep : o best : 1 index report per hour o Required : 1 index report per day	Each distribution network of Towers 13 and 14	CSTB, VEOLIA, CAH
Energy DHW meter (optional)	• Index accuracy : o Best :1kWh or better o Required : 10kWh • Timestep : o best : 1 index report per hour o Required : 1 index report per day	Each apartment of Towers 13 and 14	CSTB, VEOLIA, CAH
Data acquisition system	Wireless technology	One system per building	CSTB, VEOLIA, CAH
Building simulation tool		Les Moulins	CSTB

Data processing chain		Les Moulins	CSTB, VEOLIA, CAH

Use Case #2: Optimization of the energy distribution system in buildings

The Key Technical Components are not available yet. Information will be provided in the respective deliverable of WP6.

Use Case #3: Implementation and test of new energy awareness services

The Key Technical Components are not available yet. Information will be provided in the respective deliverable of WP6.

8.2.3 *Gothenburg Demonstration*

8.2.3.1 Use Case and Brief technical description

Use Case: Demonstration of how Building Integrated Photovoltaics (BIPV) can be used in façade and roof renovation process

In HSB Living Lab at campus Johanneberg, HSB are demonstrating construction integrated solar PVs, both roof integrated and façade mounted. The pictures below show how the solar PVs are placed on the house.

Figure 65 PV Integration on the surfaces of the house

The many sensors available in the Living Lab enable collection of a manifold of data. Electricity production is of course measured, as well as outdoor temperature, temperature on the façade and roof, solar radiation, wind velocity and many other parameters. This enables, e.g., an analysis of how different solar panels work on different types of shading. Solar panels with amorphous silicon and with monocrystalline silicon will be tested and analysed.

In addition, the temperature and the humidity content behind the solar panels are measured. This is used in order to evaluate the solar panels as construction material. The extra feature with the construction integrated panels is that only one "layer" is needed and thus the additional investment for solar panel can be lowered.

An evaluation report is under progress. Expected time for delivery is during August 2018.

The solar panels are complemented with string optimisation, inverters (DC/AC) and a battery function. The picture below shows the setting in the HSB Living Lab ground floor and the graphical interface used for visualisation.

Figure 66 The setting in HSB Living Lab ground floor and the graphical interface

8.2.3.2 Demonstration Area and Geographical Overview

HSB Living Lab is placed at Gothenburg´s demonstration area campus Johanneberg.

Figure 67 HSB Living Lab, Johanneberg district

8.2.3.3 Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Demonstration

Table 31 Objectives/Needs & Opportunities of Gothenburg Demonstration in IS 1.2

Opportunities	Needs/Objectives
RES contribution to Near Zero Energy Buildings	Investigate how construction integrated PV work as construction material. Optimise solar panel material. Observe and analyse how shading influences various types of solar panels. There is a great need/interest for PVs in Sweden. HSB have already started one renovation process in Gothenburg where we use the same technology as in the demonstrator.
Investigation of the feasibility of the innovative insulation components	Study if the new applied insulation technologies can contribute profitably to the energy efficiency of the buildings from the economic point of view. Using PVs as a façade or a roof material when renovating have a positive economical impact on the business model. To be described further when the evaluation report is finished.

8.2.3.4 *Key technical components*

Hardware:

Table 32 Hardware Key Technical Components of Gothenburg Demonstration in IS 1.2

Main Component	Technical Specifications	Demonstration Area	IRIS partner (owners and providers individually)
PV (Type, Number (#), Capacity (kW)):	10-15 kW Amorpheus kisel 9kWp and Monocrystallin Kisel 9,5kWp. Total of 18,52 kWp (kWc) Ferroamp Inverter that converts DC to AC.	HSB Living Lab	HSB, Chalmers
Storage (Type, Number (#), Capacity) if existing:	7kW, 7,2 kWh FerroAmp. Inverter is Ferroamp EnergyHub, and is controlled via Ferroamp portal.		HSB, Chalmers
BIPV technology (followed by specifications):	Please specify: 1) The arrangement and the capacity 2) The efficiency etc	HSB Living Lab	HSB Living Lab Chalmers
Anscillary Equipment Type #N (N type followed by required specifications):	The entire system is controlled via the Ferroamp system. The only Ascillary Equipment is the Humidity sensor that is a part of the façade and roof.		HSB, Chalmers

8.3 Replication Planning in the Lighthouse and Follower Cities

8.3.1 *Utrecht Replication*

8.3.1.1 *Use Case and Brief technical description*

In the Netherlands 14.000 apartments of the Intervam type were built in 1960's, of which 6.500 in Utrecht alone. In 1948-1973 13.000 apartments of the Bredero type were built as well. The social housing associations Bo-Ex, Portaal and Mitros who own the apartment blocks have recently started regenerating buildings, resulting in energy labels A/B, including a total make-over of the building and increased comfort levels. All the apartments need to be renovated in the coming years, providing opportunities to replicate demonstrated solutions specially:

- PV panels on the rooftops of the apartment buildings;
- Home Energy Management Systems (EMS) Eneco TOON;
- Energy savings resulting from refurbishment towards near energy zero building;
- Smart (hybrid) electric heat pumps for the production of heating and hot water / Low Temperature District heating for heating and hot water;
- DC switchbox pilots in 4 apartments.

8.3.1.2 *Replication Area and Geographical Overview*

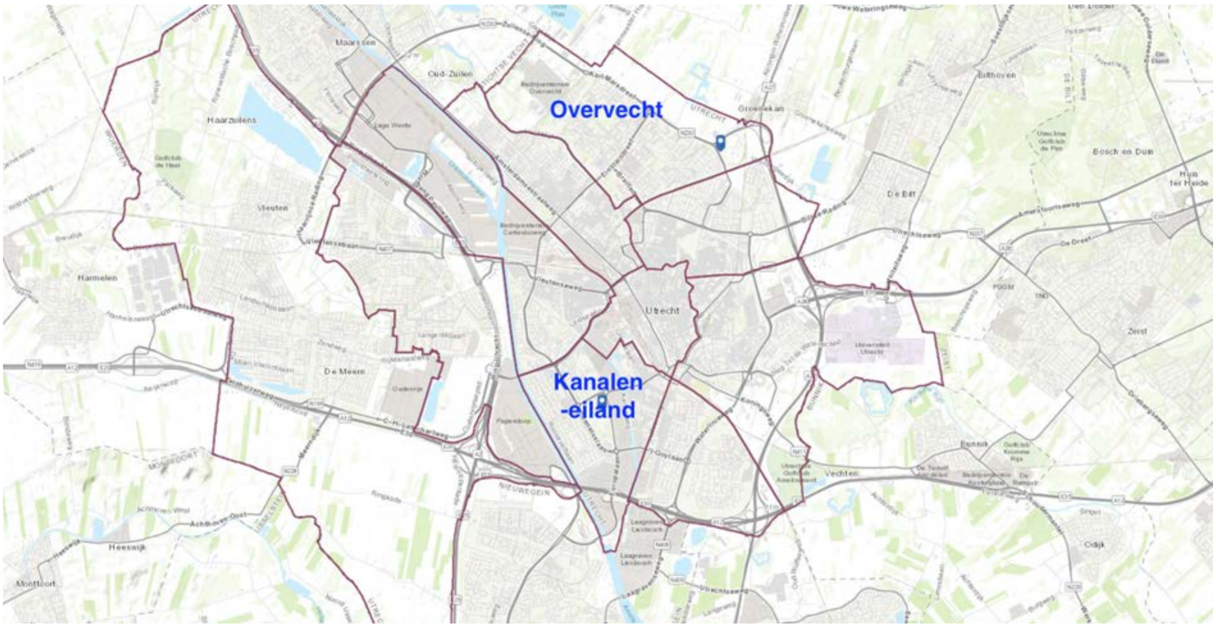


Figure 68 Overview of two replication areas in Utrecht : Kanaleneiland and Overvecht

8.3.1.3 *Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication*

Table 33 Objectives/Needs & Opportunities of Utrecht Replication in IS 1.2

Opportunities	Needs/Objectives
Renewal of the energy infrastructure	The district is characterised by a variety of energy infrastructure (electricity, natural gas and district-heating). The majority of which was installed decades ago and has become obsolete. The resulting need for renewal of the energy infrastructure is an opportunity for transforming

Opportunities	Needs/Objectives
	the district into a Near Zero Energy district.
Heating and cooling system	The aim is to use renewable power for heating and cooking rather than natural gas, and to create an all-renewable electric district.
Software equipment development	Smart management of the home energy needs through the HEMS TOON and control of available PV power.
Stable and lower housing bills in combination with higher comfort in homes	The district consists of buildings with high-energy losses and low thermal comfort. This situation imposes the upgrade of the buildings, which raises the opportunity for improving the residents' quality of life and lowering their energy bills.

8.3.2 *Nice Cote D' Azur Replication*

The proposed solutions will be replicated in the 5th instalment of the Urban Redevelopment Programme in Les Moulins. Optimization of the heating load curve will bring energy savings and generate a quick RO.

Further information will be available in the respective deliverable of WP8.

8.3.3 *Gothenburg Replication*

8.3.3.1 Use Case and Brief technical description

Components for introducing near-zero energy appartments and districts, are solar panels integrated in roof top and facade construction. These components are tested and optimised at HSB Living Lab and can later be used for renovation purposes in existing building stock.

In the Living Lab, the solar PV are connected with string optimisation, inverters (DC to AC) and a battery for energy storage and also visualisation of the dependence of electricity supply from the grid.

8.3.3.2 *Replication Area and Geographical Overview*

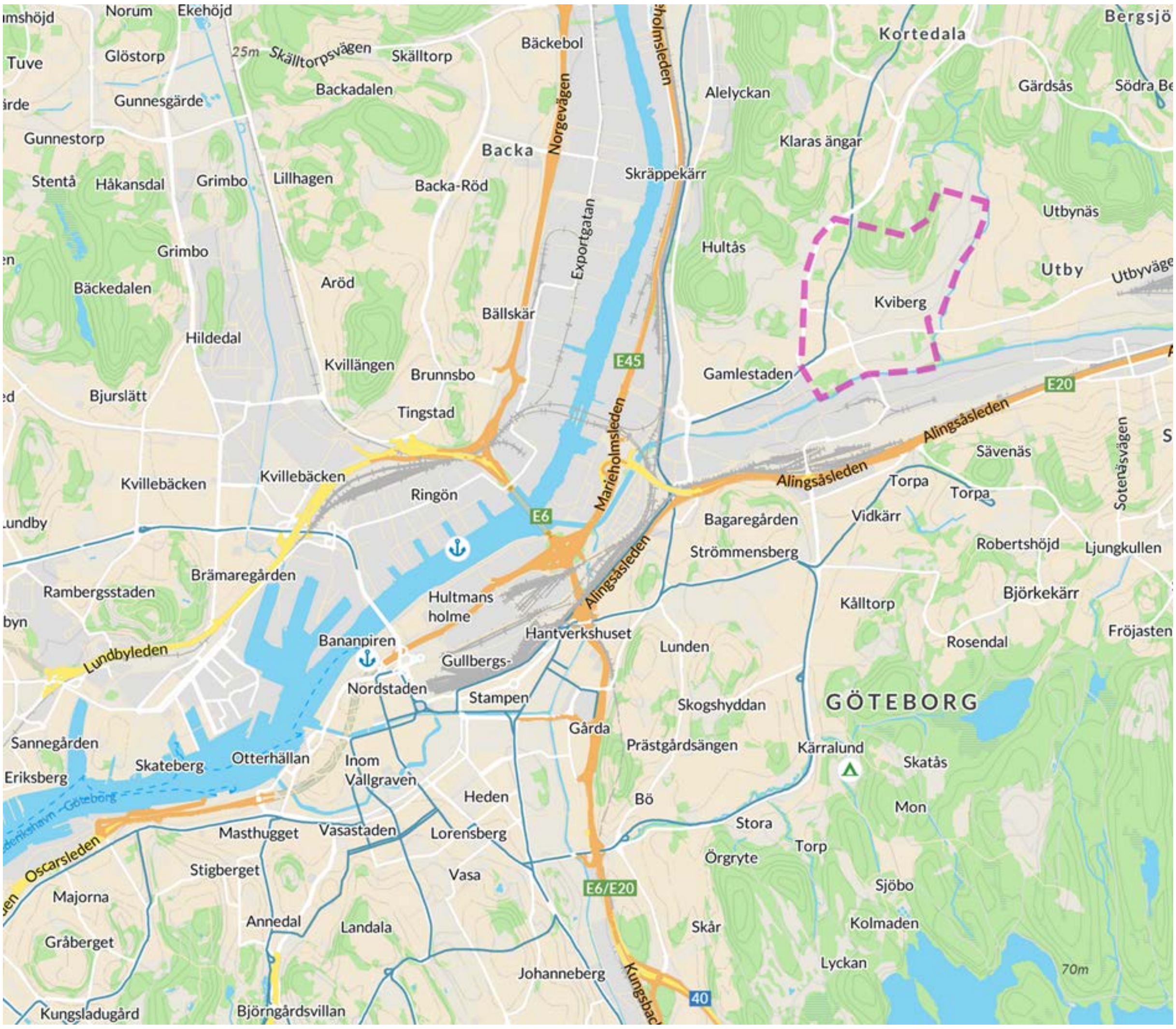


Figure 69 Location of the Kviberg district in Gothenburg

Gothenburg HSB will replicate roof construction integrated solar PV in a renovation project in Kviberg in Gothenburg. The whole renovation project consists of four multi-family houses, of which one will be retrofitted with roof construction integrated solar PV. The other three will be equipped with "standard" solar PV on the roof. All four houses will be interconnected with a DC cable to enable exchange of electricity between the four houses, in case of various electricity production and consumtion. A fifth multi-family house, in the direct proximity, might also be connected to the internal "DC-grid" in the near future, to enable a higher utilisation of the locally produced solar electricity, instead of selling it to the grid.

8.3.3.3 *Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication*

The replication of the roof construction integrated solar PVs is an important step in order to show a viable business case and a good, working example of renovation of a roof in existing building stock. A positive outcome can ensure that more property owners, tenants and housing associations dare to invest in this technology.

An environmental and economic key finding could be the added value of self-produced, renwable electricity and the lowering of the tenants/residents electricity bill, hopefully at a relatively low additional cost, see further discussion under Business Model.

Table 34 Objectives/Needs & Opportunities of Gothenburg Replication in IS 1.2

Opportunities	Needs/Objectives
RES contribution to Near Zero Energy Buildings	Investigate how PV can be added in façade renovation processes.
Investigation of the feasibility of the innovative insulation components	Study if the new applied insulation technologies can contribute profitably to the energy efficiency of the buildings from the economic point of view.
Showing a good example for further replication.	

8.3.4 *Vaasa Replication*

8.3.4.1 *Use Case and Brief technical description*

Many of the apartment buildings contracted in the City of Vaasa are built in 1960's to 1980's and are in need to retrofitting for materials and technical infrastructure. Many of those buildings are either for social or student housing. To find a cost effective methods and technologies are crucial for implementation for the solutions. Solutions should provide economic feasibility to invest on retrofitting in districts which where most old apartment buildings are located.

The main technologies used will involve (1) a high share of locally produced and consumed renewable power at district scale making PV profitable without subsidies (TRL9), (2) PV and LT for the DHN partly serving the district (TRL8->9), (3) innovative home energy management system HEMS TOON (TRL8), (4) energy savings thanks to refurbishing towards NZE 4-storey apartment buildings (TRL9), (5) smart (hybrid) gas-electric heat pumps for heating and hot water (TRL8->9), (6) energy savings thanks to smart AC/DC power grid in apartments (TRL7->8), (7) smart DC street lighting at district level (TRL7->8) and (8) commissioning process to check from the design to the operation that innovative technologies have been correctly implemented (TRL:8). Next, these solutions are integrated into one smart micro-grid at district level, a stepping stone towards a NZE district composed of existing buildings with mainly social housing apartments.

8.3.4.2 *Replication Area and Geographical Overview*

Ristinummi is located in eastern part of City of Vaasa. Distance to the City centre is about 5 kilometers. Area is the weakest socioeconomic area in Vaasa. As part of South-East district of Vaasa the center of sub-district Ristinummi is an area that consists mainly of blocks of apartment buildings built in the 70's. There are 15 blocks of apartment buildings with approximately 380 apartments which are in urgent need of renewal and consist of about 600 inhabitants. When the buildings are retrofitted their energy-efficiency should be improved near to 0-energy level with increase of the use of renewable energy.

Developing the built-up structure of Ristinummi by urban renewal and by improving energy-efficiency is also one part of solving the area's social problems. The methods used in Ristinummi can also be replicated to other parts of Vaasa. There are approximately 240 blocks of apartment buildings with 2.900 apartments built in the 70's that inhabits almost 4.400 people. The numbers grows when adding blocks of apartment buildings built after 70´s. The possibilities for replication includes about 46.000 apartments which inhabit about 65 % of the population of Vaasa.

Location of Ristinummi demonstration area

Central area of Ristinummi

Location of Onkilahti demonstration area

Student housing area in Onkilahti

Figure 70 Location of the replication area

Table 35 Potential of replication retrofitting

Buildings stock in 2016	apartments (no.)	estimated surface of apartments (m2)	Number of inhabitants (no.)
South-East Vaasa district (project area)	*4.350*	*326.000*	*6.500*
Apartment buildings build 1970's	2.900	*217.000*	4.400
Apartment buildings build 1980's	665	*50.000*	1.000
Apartment buildings build 1990,s	170	*13.000*	250
Total estimated stock VAAS	45.825	*2.500.000*	55.000

8.3.4.3 Needs and Opportunities to be served by the implementation of the Solution in the Replication

Table 36 Objectives/Needs & Opportunities of Vaasa Replication in IS 1.2

Opportunities	Needs
Renewal of the energy infrastructure	The need for renewal of the energy infrastructure is an opportunity for transforming the district into a Near Zero Energy district. Reduce the energy consumption and need for external energy for the low income districts.
Reduction of CO2 emissions	A near Zero Energy district will reduce CO2 emissions.
Increased use of renewable energy resources and local renewable production.	The aim is to increase use of renewable energy for heating. Political decision to only purchase green energy. A Near Zero Energy district not only requires a drastic reduction in energy demand but also extensive renewable production and optimal distribution of renewables within the district by means of demand side solutions and storage for grid flexibility and cost-effective use of renewables.
Use of resources optimization and primary energy requirements reduction	Developing management and control systems that can deal with the combination of small scale RES production (PV, wind, etc.) and large scale supply such as from the external grid or district heating and cooling.
Behavioural changes through energy awareness services	Monitoring of the real-life performance to assess the gap related to occupants' behaviour.

8.3.5 Alexandroupolis Replication

8.3.5.1 Use Case and Brief technical description

Municipality of Alexandroupolis targets to replicate innovative solutions demonstrated in the lighthouse cities of the project in respect to the development of near zero energy retrofitted districts. The technologies that are of main interest for Alexandroupoli include solar PVs, energy management systems for households, smart gas-electric heat pumps, smart AC/DC power grid, smart DC street lighting and smart micro-grids. Social housing of Alexandroupolis is characterised by its aged building stock that was initially developed by the Greek government and it is currently owned by low income families. Buildings of social housing are poorly insulated with increased energy demand for heating/cooling and electricity. Local conditions will introduce an important challenge in the replication process, mainly due to private ownership of social housing buildings and due to differences in typology of buildings as opposed to the demonstration buildings of the lighthouse cities. However, the knowledge on nearly zero energy retrofit districts is valuable for the city of Alexandroupolis. Feasibility studies will be executed and building companies will be challenged in the procurements policies. Retrofitting towards nearly zero energy retrofitted districts constitutes a challenge for Alexandroupolis and therefore, the feasibility of such solutions will be thoroughly examined.

8.3.5.2 *Replication Area and Geographical Overview*

The replication area is located in the western part of the city of Alexandroupolis, about 2 km away from the city centre. The area includes buildings constructed by the Greek government and subsidized to low income families that are currently the owners of these buildings. The typology of the buildings is semi-detached houses, that were constructed in the 70's. There are 80 houses with approximately 300 ihabitants, that require energy renovation. Alexandroupolis has also three other areas of similar buildings (social housing), where the solutions examined could also be replicated. Since the typology of the buildings is similar to other areas of Alexandroupolis, it is valid to state that the solutions examined can be replicable to all buildings construction before the entry into force of the Building Insulation Regulation of Greece (1980).

Figure 71 Aerial view of the replication area (google earth)

8.3.5.3 *Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication*

Table 37 Objectives/Needs & Opportunities of Alexandroupolis Replication in IS 1.2

Opportunities	Needs/Objectives
Near Zero energy performance of buildings	Reduce the energy consumption for the low income districts, not compromising comfort levels.
Behavioural changes through energy awareness services	Monitoring of the real-life performance (integrated in a digital district scale model) to assess the gap related to occupants' behavior.
Smart metering, Display monitors and apps	Towards citizens' behavioural changes there is the need to measure utilities consumptions and present it to the citizens in an easy-to-understand form.
Use of resources optimization and primary energy requirements reduction	Developing management and control systems that can deal with the combination of small scale RES production (PV, wind, etc.) and large scale supply such as from the external grid or district heating and cooling.

8.3.6 *Santa Cruz de Tenerife Replication*

8.3.6.1 Use Case and Brief technical description

The following text has already mentioned for the description of replication in IS 1.1.

Santa Cruz de Tenerife has initiated the process to transform an industrial refinery into to a new part the de city. The city aspires to grow to this area since it is limited by Anaga mountains on the East, on the North by La Laguna and on the South by the sea. This new area is about 500.000 m2 and placed at 15 minutes on foot to the city center and very well communicated with other cities. One of the most important uses for these new part of the city will be green zones and city facilities. Mobility and accessibility for citizenship will be key as well as R&D and innovation for smart and green cities.

This initiative has a long term perspective and it is on its initial steps. The IRIS goal of Santa Cruz de Tenerife is to develop its smart city strategy and define a operational zone to implement replication activities on the coming years. This new industrial area represents the most promising opportunity for the city to fully developed all lessons learnt on IRIS.

On the other hand, there are another parts of the city where to implement replication actions from the current moment. The main area for energy positive building is called Barrio de la Alegría at the East side of the city limited by Anaga mountains and by the sea. There are other replication actions which might take place scattered across the city.

Municipality of Santa Cruz targets to replicate innovative solutions demonstrated in the lighthouse cities of the project in respect to the development of near zero energy retrofitted districts. The technologies that are of main interest for Santa Cruz include solar PVs, energy management systems for households smart DC street lighting and smart micro-grids. Social housing of Santa Cruz de Tenerife is characterised by various type of building's' age. Buildings of social housing are poorly insulated. Local conditions might introduce an important challenge in the replication process, due to private ownership of some social housing buildings. That is why it has been selected social housing owned by the municipality of Santa Cruz for an easier replication.

Santa Cruz de Tenerife have decided to transform two pairs of public social housing into a low carbon buildings. This will be the foundation of the future low carbon buildings for social housing in the municipality. There will be carried out an energetic and building envelope audit in order to define a set of measures for energy saving as well as to measure PV and hot water solar.

8.3.6.2 Replication Area and Geographical Overview

The replication area is located in the eastern part of the city of Santa Cruz de Tenerife, about 10 minutes of foot to the city centre. The area includes buildings constructed by the regional and local government but mainly by private initiative. The typology of the buildings two block of apartments of 34 and 52, that were constructed in the 90 accordingly with old and no energy efficiency regulation.

Figure 72 Replication area in the eastern part of Santa Cruz de Tenerife

Figure 73 Overview of replication area

8.3.6.3 Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication

The main objective for city of Santa Cruz de Tenerife is to contribute to mitigate Climate Change by reducing use of fossil fuels and the increasingly usage of renewable resources.

Table 38 Objectives/Needs & Opportunities of Santa Cruz de Tenerife Replication in IS 1.2

Opportunities	Needs/Objectives
Near Zero energy performance of buildings	Reduce the energy consumption for private tenants of the building, and eventually for the municipality in specific cases.
Creating a replication model	This replication action can create a model that can be used for other buildings in Focsani city, other cities in Romania and also in other South-Eastern Parts of Europe

8.3.7 *Foscani Replication*

8.3.7.1 Use Case and Brief technical description

Municipality of Focsani city is interested in increasing energy efficiency and utilization of renewable energy sources for several public and administrative buildings. The replication plant includes several kindergartens, schools and the Municipality building. Energy efficiency measures can include the following: retrofitting the buildings, thermal insulation of buildings, improvements of the heating system of the buildings. The utilization of renewable energy sources for the specified buildings can include the following: utilization of PV panels for electricity generation for own consumption and for exporting into the grid, utilization of passive solar panels for heat generation for domestic warm water and for heating. Another component of the replication project includes modernization of street lighting using LED technology and possible PV panels for charging.

8.3.7.2 Replication Area and Geographical Overview

The pictures bellow shows the building of the Municipality of Focsani city and its position on the map with all boundaries. For the building of Municipality, the main objective is to install PV panels for electricity generation, but there can be also analyzed the possibilities of building thermal insulation and utilization of solar thermal panels for heat generation for heating purposes.

Figure 74 Building of Municipality of Foscani

Figure 75 Position of building within the city

Figure 76 Aerial view of the replication area

8.3.7.3 *Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication*

Table 39 Objectives/Needs & Opportunities of Foscani Replication in IS 1.2

Opportunities	Needs/Objectives
Near Zero energy performance of buildings	Reduce the energy consumption for public and administrative buildings.
Behavioural changes through energy awareness services	Monitoring of the real-life performance (integrated in a digital district scale model) to assess the gap related to occupants' behaviour.
Smart metering, Display monitors and apps	Towards citizens' behavioural changes there is the need to measure utilities consumptions and present it to the citizens in an easy-to-understand form.
Creation of value to utilities companies through improvement of customer relationship	Generally, utilities aim at creating appropriate business models combining customers' satisfaction and financial feasibility (reduced ROI).
Smart and renewable street lighting	Modernization of street lighting including utilization PV panels for charging
Creating a replication model	This replication action can create a model that can be used for other buildings in Focsani city, other cities in Romania and also in other South-Eastern Parts of Europe

8.4 Data Collection and Management

8.4.1 *Utrecht*

Data that will be collected within the demonstration area:

- Energy consumption on the households level. Data collection through the Toon. Because of Privacy legislation, permission of the tenants to obtain this data is required.
- Energy consumption and production on the apartment building level. Data collection through the district.
- Electricity production of the PV panels. Data collection through Electricity (sub)meters.
- Consumption of locally produced electricity with the PV panels. Data collection through smart meters (with the permission of the tenants).
- DC electricity consumed by households (AC/DC switchbox). Data collection through (sub) meters within in the apartment (with the permission of the tenants).
- DC electricity consumed by street lighting. Data collection through (sub)meters.

For the mentioned data of production and consumption, the amount of CO_2 savings can be calculated easily.

8.4.2 *Nice Cote D'Azur*

The Data collection of Nice Cote D'Azur is not available yet. Information will be provided in respective deliverable of WP8.

8.4.3 *Gothenburg*

In the replication area in Kviberg, HSB plans for data collection with the demonstration case HSB Living Lab as role model. Data of solar electricity production and usage, including allocation and transmission between the different house bodies. The ambition is to visualise energy flows, as in the Lab, for all tenants in the houses in question, see the illustration below.

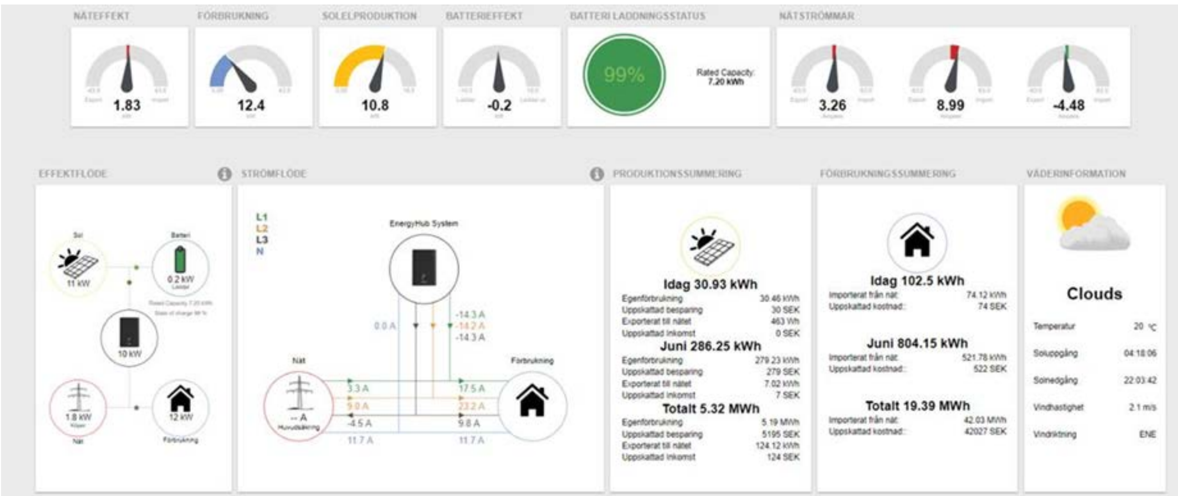


Figure 77 Graphical User Interface of Replication case

8.5 Regulatory Framework per LH/FC

8.5.1 *Utrecht*

- Social housing corporation's (through the branch-organization Aedes) in the Netherlands signed a *covenant* with the national government in which they agreed to make investments in energy saving measure in their housing stock resulting in an average label B in 2021.
- The national government provides *financial incentives* to invest in energy savings for social housing cooperation's through a subsidy scheme (called STEP Stimuleringsregeling energieprestatie huursector) with a total budget of 395 million euro. The level of the subsidy depends on the level of improvement of the energy index (EI).
- The national government introduced regulations that provide Housing Corporation's with the opportunity to invoice their tenants an *energy-performance-compensation* (Energy Prestatie Vergoeding EPV in Dutch) when they renovate towards "nearly zero-on-the-meters". In this case tenants no longer receive an energy bill but pay a fixed service fee per m2 based on the energy index realized after the renovation. The EPV provides housing cooperation's with the opportunity to recover part of the required additional investments costs to make the homes energy toward nearly zero energy. This regulation is currently practiced in several new build and renovation projects throughout the Netherlands. Experiences so far:
    - Advantages: fixed fee and low risks for tenants, insight in the energy production and consumption by tenants and housing corporations, clear and fair incentive for housing corporations to invest in energy efficiency houses.
    - Disadvantages: it's hard to explain the principles of this regulation and pro's/con's to tenants, high costs for additional metering and applications, many requirements and administrative costs to prove that a compensation (EPV) is allowed, less appropriate for users with excessive energy usages.
- Households that produce electricity with PV panels are given the opportunity to balance their consumption and own production (The so-called *balancing regulation*). This means that the energy supplier deducts the produced electricity from the consumption of the customer. As a result, the customer receives the same price (including taxes and transport costs) for the returned energy as he pays for the energy he purchases from the energy supplier at a different time. Due to the relatively high level of energy taxes in the Netherlands this provides an attractive financial incentive for household resulting in average pay back times for PV panels of 7 years. The current government plans to revise this regulation because: (i) they believe that the current scheme is unfair because no energy taxes are paid for the returned energy, resulting in lower tax revenues for the national government that need to be compensated by increasing other taxes, (2) current scheme is too generous regarding provided financial incentives, and (2.) it provides no incentives to consume the locally produced electricity also locally (behind the meter).

8.5.2 *Nice Cote D'Azur*

The Regularory Framework of Nice Cote D'Azur is not available yet. Information will be provided in the respective deliverable of WP6.

8.5.3 *Gothenburg*

New construction element and methods must be approved by the National Authority, in Sweden the National Board of Housing, Building and Planning is responsible for this. Since both roof construction integrated PVs and façade construction integrated PVs are quite new technology, there might still be regulatory decisions to await before a larger roll-out of optimised technology can be realised.

8.5.4 *Vaasa*

Nationwide regulatory framework for both new and old buildings structures and energy performance applies. Cities have regulatory authorities who are responsible to supervise adequate energy certifications or energy studies whenever building permit is granted. Regulatory framework for new buildings is based on primary energy and on average shares of RES in national level. For old buildings bigger renovations requiring building permit have to fulfil same requirements as there would be for new buildings if they are economically, technically and functionally feasible. Although better energy efficiency has to be reached.

As for metering, smart meters (AMR) have to be on apartment level in electricity. Water is also individually measured but data collection is voluntary. Heat is measured typically with smart meters (AMR) at the building level. All meterings have to fill standards. Electrical meterings will be more easily available to 3rd parties via “Datahub”-project, but in most cases data is already available to them.A short description of the on-status

Decision making will differ in social/student housing companies and privately owned apartment buildings. Social or student housing company is owned by one entity which can make decision but in privately owned apartment buildings decision making could be more complicated.

For this specific Solution, regulations relevant to the operation of electricity grid and the role of the DSOs should be highlighted.

8.5.5 *Alexandroupolis*

There is no regulatory framework for the development of near zero energy districts currently in Greece. The law of energy performance of buildings (4122/2013) and the regulations of energy performance also apply to this solution. Municipality of Alexandroupolis has the authority to issue all the new construction licenses for new or refurbished buildings and is responsible for approving the energy performance studies that require to fulfill the national regulations. In case of refurbishment of buildings, the law applies only if the energy saving measures are technically and economically feasible. RES technologies are obligatory for covering at least 60% of domestic hot water demand.

8.5.6 *Foscani*

The Romanian regulatory framework is aligned to the EU legislation. All EU Directives and normative Acts have been transposed or shall be transposed in the future into Romanian legislation.

The Romanian Energy Strategy for the period 2007-2020 has as main objective meeting the energy needs both today and in the medium and long term, at a lower price, adequate to a modern market economy and a civilized standard of living, in conditions of quality, food safety, respecting the principles of sustainable development. So, the increasing of energy efficiency and the utilization of renewable energy sources is in complete accordance with European and national legal framework. Romania has set as goal achieving a primary energy savings of 10 million toe in 2020, which is a reduction in projected primary energy consumption (52.99 million toe) using the PRIMES 2007 model, for the realistic scenario of 19 %.

In accordance with the Law no. 121/2014 the Municipality of Focsani city has to implement the following:

- to develop energy efficiency improvement programs that include short-term and midterm 3 to 6-year measures;
- to appoint an energy manager certified according to the legislation in force, or to conclude an energy management contract with an authorized entity, attested by the law, or with a legal entity providing energy services approved under the law.

The Romanian legislation that sets the framework for this area includes the following:

- Law no. 121/2014 on Energy Efficiency with subsequent amendments and completions (Law no. 160/2016);
- Law no. 220/2008 establishing the system for the promotion of energy production from renewable energy sources, republished, with the subsequent modifications and completions;
- Law no. 325/2006 of the public service of heat supply;
- Law no. 51/2006 of the community services of public utilities;
- Law no. 372/2005 on the energy performance of buildings with subsequent amendments and completions;
- Government Decision no. 122/2015 for the approval of the National Energy Efficiency Action Plan;
- Government Decision no. 529/2013 for the approval of Romania's National Strategy on Climate Change, 2013-2020;
- Government Decision no. 1460/12.11.2008 for the approval of the National Strategy for Sustainable Development - Horizons 2013-2020-2030;
- Government Decision no. 1069/05.09.2007 - Energy Strategy of Romania for 2007-2020;
- Government Decision no. 163/2004 National Strategy in the field of Energy Efficiency;
- Government Decision no.1535 / 2003 on the Strategy for the Utilization of Renewable Energy Sources;
- Ordinance 22/2008 on Energy Efficiency and Promotion of the Use of Renewable Energy Sources by Final Users.

8.5.7 *Santa Cruz de Tenerife*

The Regulatory Framework for Santa Cruz de Tenerife is not available yet. Information will be provided in the respective deliverable of WP8.

8.6 Bounds and Drivers per LH/FC

8.6.1 *Utrecht*

1) Technical: Insulations measures that will be applied to reduce energy demand of the apartment building are well knows and have been frequently applied. This also applies for the PV panels that will be placed on the roofs. Experience with hybrid heat pumps is still limited, which means that performance needs to be closely monitored.
2) Legal: Currently there is uncertainty with households regarding financial incentives for electricity production with solar panels. The scheme will change but it's not yet clear how this will affect financial return for investment in solar panels. The current systems of energy-performance-compensation, to provide building owners with an incentive to renovate towards "nearly zero-on-the-meters", is complicated and therefore difficult to explain to tenants.
3) Social: In order for the renovation to take place 70% of the tenants need to agree with the renovation plans. This requires careful communication with the tenants and good communication to clarify pros en cons of various measures.
4) Financial: Potential driver for the renovation is the fact that it provides tenants with the opportunity to lower their expenses for housing. This is very relevant as this is a neighbourhood with a high share of low-income households. This is, however, also a potential barrier as tenants are seeking guarantees on presented benefits before they are willing to accept the renovation.

Environmental: The implemented measures provide the opportunity to achieve a substantial reduction in CO_2 emissions, and to improve the indoor climate of the homes.

8.6.2 *Nice Cote D'Azur*

The Bounds and Drivers of Nice Cote D'Azur are not available yet. Information will be provided in the respective deliverable in WP6.

8.6.3 *Gothenburg*

HSB:

• Technical: Insulations measures that will be applied to reduce energy demand of the apartment building are well known and have been frequently applied. This also applies for the PV panels that will be placed on the roofs. Experience with hybrid heat pumps is still limited, which means that performance needs to be closely monitored.

• Legal: Currently there is uncertainty with households regarding financial incentives for electricity production with solar panels. The scheme will change but it's not yet clear how this will affect financial return for investment in solar panels. The current systems of energy-performance-compensation, to provide building owners with an incentive to renovate towards "nearly zero-on-the-meters", is complicated and therefore difficult to explain to tenants.

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• Environmental: The implemented measures provide the opportunity to achieve a substantial reduction in CO2 emissions, and to improve the indoor climate of the homes.

8.6.4 *Vaasa*

Many of the buildings are owned by local housing company, Pikipruukki Oy, which is owned by the City of Vaasa. Also student housing association (VOAS) has large housing stock that would require retrofitting. Retrofitting will require decision from the Pikipruukki or VOAS and most likely external funding sources (state, EU) have to be in place for the replication activity.

The socio-economic issues, employment, integration etc. should be improved together with technical improvements to the buildings.

Energy poverty needs to take into account. Poor families do not have funds to invest on retrofitting or pay extra cost for retrofitting (possible increase in rent does not compensate decrease in utility bills.

City need to get on the track on retrofitting buildings, Old housing stock is large and impacts to emission and energy consumption are higher than with new buildings. In Vaasa challenges with retrofitting are high when building standards have been higher already than in central of south Europe (double windows, insulation etc,.

Construction companies could benefit by adopting innovative technologies and improving their opportunities in the market.

8.6.5 *Alexandroupolis*

1) Technical: The technologies to be applied, such as thermal insulation, PV panels, etc are considered as state-of-the-art. Novel technologies such as hybrid heat pumps may present a technical barrier. The need to develop nearly zero energy retrofitted districts will act as a driver for development of technical solutions required.
2) Legal: Currently there is uncertainty with households regarding financial incentives for electricity production with solar panels. The scheme will change but it's not yet clear how this will affect financial return for investment in solar panels. The current systems of energy-performance-compensation, to provide building owners with an incentive to renovate towards "nearly zero-on-the-meters", is complicated and therefore difficult to explain to tenants.
3) Social: Private ownership of the replication constitutes a significant barrier for the potential implementation of such project. 100% agreement needs to be agreed that requires careful communication with the tenants and good communication to clarify pros en cons of various measures.
4) Financial: Potential driver for the renovation is the fact that it provides tenants with the opportunity to lower their expenses for housing. This is very relevant as this is a neighbourhood of low-income households. This is, however, also a potential barrier as tenants are seeking guarantees on presented benefits before they are willing to accept the renovation.
5) Environmental: The implemented measures provide the opportunity to achieve a substantial reduction in CO_2 emissions, and to improve the indoor climate of the homes.

8.6.6 *Foscani*

1. Technical Bounds & Drivers: One bound can be Due to different specific issues for any analyzed case/building the utilization of a certain technology cannot be possible. A driver in this case can the fact that in Romania these solutions have not been implemented before on a large scale, so today there can be used the best available technologies on the market.
2. Legal: There are still Bounds regarding legal framework, especially with lack of some secondary legislation. On the other hand, Romanian legal framework should completely align to EU legislation, which can be considered as a Driver for the future project development.
3. Social: There are still a need for increasing the awareness of population regarding the energy efficiency concept and utilization of renewable energy sources.

4. Financial: On the local/national level there is a bound regarding the available financing from the Government. On the other hand, there is available financing through different EU funded programs.
5. Environmental: All energy efficiency measures and utilization of renewable energy sources can surely lead to reducing pollutant emissions and thus reducing environmental impact.

8.6.7 *Santa Cruz de Tenerife*

1. Technical: Technologies related to PV, solar heated domestic hot water are already mature (TR9). There is an PV heating domestic water system that need to be further study to reduce heat loss in tube transportation.
2. Legal: Currently there is still some uncertainty with households regarding financial incentives for electricity production with solar panels.
3. Social: Renovation plans in social housing are complicated because it normaly requires some social economic input to these initiatives. And depending the state of the situation regarding building stake holding the possibilities will vary. This requires careful communication with the tenants and good communication to clarify pros en cons of various measures.
4. Financial: Potential driver for the renovation is the fact that it provides tenants with the opportunity to lower their expenses for housing. This is very relevant as this is a neighbourhood with a high share of low-income households. This is, however, also a potential barrier as tenants are seeking guarantees on presented benefits before they are willing to accept the renovation.
5. Environmental: The implemented measures provide the opportunity to achieve To be defined

8.7 Business models

8.7.1 *Utrecht*

- The housing cooperation Bo-Ex will develop a novel business model to overcome the split incentive for the additional investment required to deliver nearly zero energy buildings. Split incentives occur when those responsible for paying energy bills (the tenants) are not the same entity as those making the capital investment decisions (the building owner). In this model, the benefits associated with the resulting energy savings accrue to the tenant.
- A business model will be created for 600 households, with their own set of PV-panels (collectively placed on the building roofs by Bo-Ex), to exchange solar power. This business model should motivate the households to participate in the IRIS project.

8.7.2 *Nice Cote D'Azur*

The Business models of Nice Cote D'Azur are not available yet. Information will be available in the respective deliverable of WP6.

8.7.3 *Gothenburg*

The roof integrated solar PVs, with marginally higher cost than standard roof construction material, enables access to renewable electricity at a low extra cost.

8.7.4 *Vaasa*

New business models, need to be profitable in certain period in terms of money in the future, social impacts or sustainability to attract investors.
New innovations with private energy/construction companies, Pikipruukki, VOAS to make benefits to city and social housing.

8.7.5 *Alexandroupolis*

The business model development for the replication activity of Alexandroupolis constitute an important challenge due to private ownership of the buildings. A novel business model is required for the implementation of the replication activity that will include financing mechanisms for private ownership. Low-income owners is also an obstacle to overcome in terms of financing and energy poverty has to be taken into consideration.

8.7.6 *Foscani*

Smart Near Zero Energy Buildings: The implementation of different energy efficiency measures and utilization of renewable energy sources in different public and administrative buildings can become a business model for replication in other similar buildings (kindergartens, schools, administrative buildings) in other Romanian Cities or elsewhere in the region.

8.7.7 *Santa Cruz de Tenerife*

New business models are necessary for making smart cities investments profitable.

There are some which will arise without foreseen it, but other need to be addressed in order to have a sense of reaching a possible future.

Positive Energy Buildings are likely the easiest way to create direct added value when investing, since energy is scarce.

New mobility business models associated to e-biking, car pooling, car sharing, and other solutions might take advantage of the struggles of the city on mobility.

9. Annex for IRIS Solution IS-1.3: Symbiotic Waste Heat Networks

9.1 Pre-pilot Areas description and Available Infrastructure

9.1.1 *Nice Cote D'Azur Pre-Pilot*

Nice Eco Valley district operates a municipal sewage sludge plant which, after dehydrating the sewage sludge, produces high energy content biogenic fuels for the production of heat and electricity. On top of that, during the sewage sludge post-treatment step, additional waste heat is produced, covering part of the heat needs of Nice residents.

9.1.1.1 Pre-Pilot Area and Geographical Overview

The pre-pilot is located on the north-east part of Nice, close to the Ariane district.

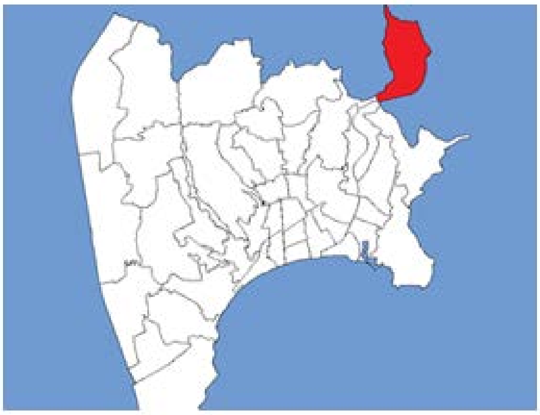

Figure 78 Location of the pre-pilot area

Waste materials such as sewage sludge and biomass mixtures are turned into biogenic fuel used for the production of heat and electricity. The first step consists in operating a sewage sludge drying unit (120ton a day) in which sewage sludge dehydration of 36% is achieved by special combination of hydraulic press and filter to keep water out.

Figure 79 Sewage sludge dehydration

The second step consists in using the cogeneration heat produced from the household waste incineration plant to dry sewage sludge up to 95%.

Figure 80 Household waste incineration plant

The last step is the elaboration of biogenic fuel by a combination of dehydrated sludge and moist sludge. The biogenic fuel is finally burnt together with other waste materials in the household waste incineration plant (54ton/hours). The calorific power of the biogenic fuel is close to 2800 kCal/kg and the global thermal efficiency of the whole process is about 60%.

3 domestic heat networks totaling an installed capacity of 95 MW and serving a population of 11,000 equivalent housing and some industrial buildings are connected to the household waste incineration plant enabling to value the produced heat (110000 MWh per year) and electricity (36000 MWh per year).

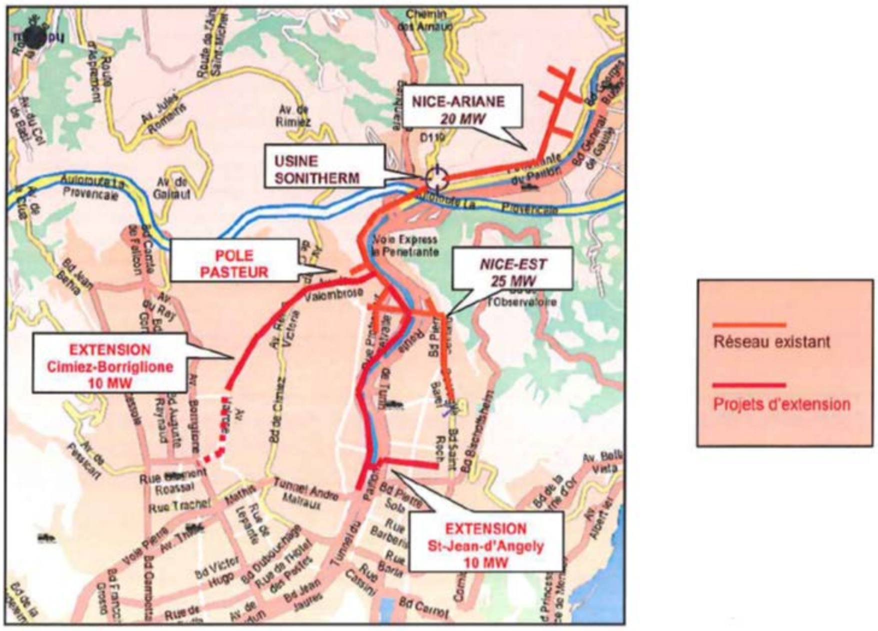

Figure 81 Domestic heating networks – Existing and planned

9.1.1.2 Key Technical Components

Table 40 Key Technical Components of Nice Cote D'Azur Pre-Pilot in IS 1.3

Main Component	Technical Specifications	Area of the pre-Pilot
Sewage sludge drying plant	A sewage sludge drying plant before incineration with a capacity of 100 tons a day	
Household waste incineration plant	4 furnace boilers with a capacity of 54 tons per hour of household waste and 135 tons of superheated steam per hour	
Heating network	3 domestic heat networks totalling an installed capacity of 95 MW and serving a population of 11,000 equivalent housing and some industrial buildings	

9.1.1.3 Lessons Learnt by the implementation of the Solution in the Pre-Pilot

The thermal efficiency of the global process is about 60% which is rather good. Complementary solutions to improve the thermal efficiency of the whole process (up to 70%) can be tested in order to cover a higher share of household energy needs with this solution. For example, heat recovery during the sewage sludge drying process (step 1) can be enhanced considering that the residual water collected during this drying process has a flow rate between 3100 m3/hours and 4100 m3/hours with an annual mean temperature of 22°C which corresponds to a heat recovery potential of 18 MW per year. However, this solution based on the incineration of municipal waste is expensive and involves the generation of climate-relevant emissions such as CO_2, N_2O, NO_x and NH_3 which is not environmentally friendly. Therefore, this solution can not be advised for replication in lighthouse and follower cities at district level.

Produced heat will be supplied to buildings with a new heat network. The network construction started in 2017. The new heat network should rise up to 7,5MW within 2019-2023 period according to IRIS master plan, and reach 21MW after 2023.

9.1.2 Gothenburg Pre-Pilot

9.1.2.1 Pre-pilot 1 – Use Case1: Gasendal Biogas Upgrade Plant in Arendal

Biogas is produced in Gothenburg in the city sewage water treatment plant from municipal sewage via digestion (60 000 MWh/year).

Gasendal is located in Arendal, Gothenburg, and is an upgrading plant for biogas. The biogas is produced by sewage sludge in the Gryaab sewage treatment plant, and is then sent to Gasendal for purification to produce natural gas quality. The plant was commissioned in 2007.

Table 41 Installation Specifications of Gasendal Biogas Upgrade Plant in Arendal

Installation Specifications	
Facility Type:	Upgrade
Upgrade Technique:	LP COOAB
Energy Production:	60 GWh/year
Capacity:	1,600 m3/year
Location:	Arendal, Gothenburg

Biogas is upgraded to natural gas and injected to the NG grid and sold manly as vehicle fuel (cars, buses, trucks). Waste heat is recovered by two oil refineries connected to the DHN. Heat is also recovered from the city sewage water treatment plant and the Renova waste incineration plant.

The raw gas consists of methane (about 60%), carbon dioxide (about 40%), some moisture and small amounts hydrogen sulfide. The raw gas is upgraded to compressed methane gas, corresponding to the quality that is required to feed the gas into the natural gas network. The upgrade takes place in a process where carbon dioxide, hydrogen sulphide and moisture are separated, and the methane content of the gas is concentrated. This is done by means of an amine that binds the carbon dioxide chemically. The absorbent is regenerated in a reverse chemical reaction with heat supply, where carbon dioxide (biogenic) returns to the gas phase and goes to air along with a very small proportion of methane. The process is shown schematically in Figure 82 below and is described in more detail in the accompanying text. When heating the process, heat is supplied from one natural gas fired boiler of 1.2 MW.

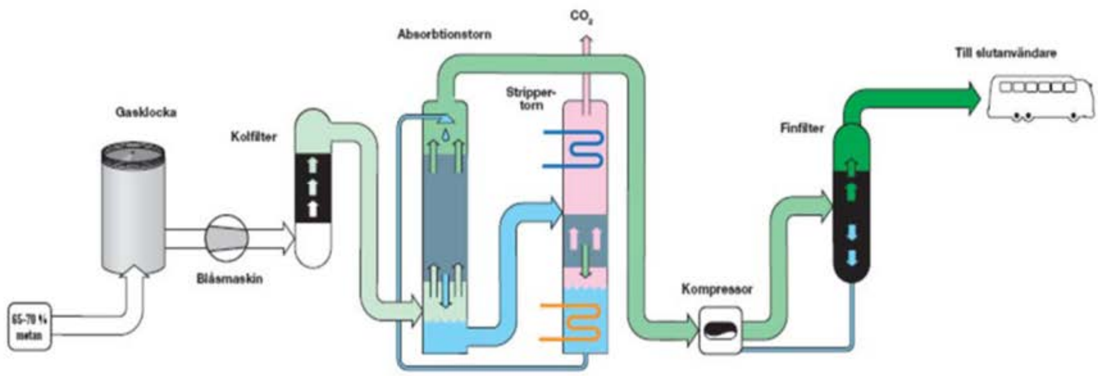

Figure 82 Schematic of the biogas process

The main environmental impact of the biogas plant is positive, mainly because the biogas produced replaces fossil fuels and its air emissions. Biogas as fuel contributes to reduced emissions to air, as it replaces gasoline and / or diesel as fuel.

9.1.2.2 *Pre-Pilot 1 Area and Geographical Overview*

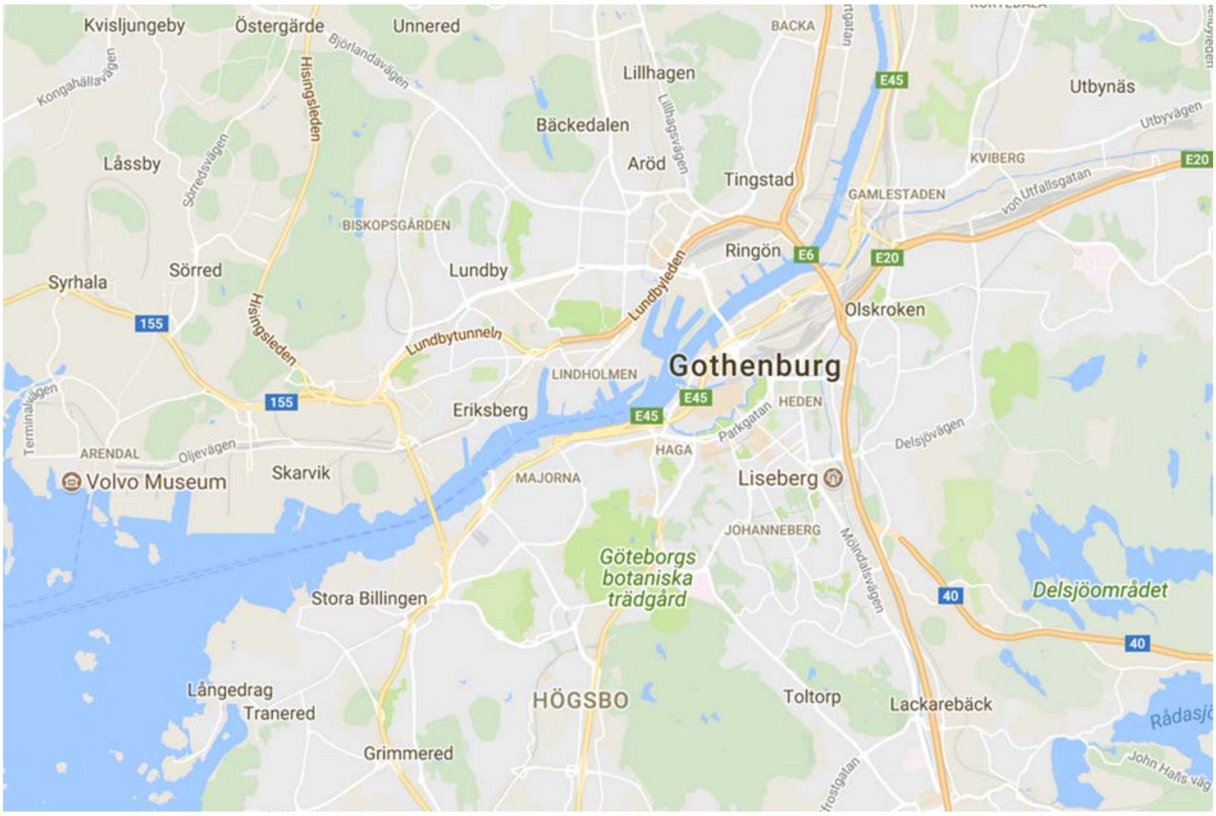

Figure 83 Gasendal Biogas Upgrade Plant in Arendal Area

9.1.2.3 *Key Technical Components of Pre-Pilot 1*

Table 42 Key Technical Components of Gothenburg Pre-Pilot 1 in IS 1.3

Main Component	Technical Specifications	Area of the pre-Pilot
Biogas upgrade plant	Upgrade Technique: LP COOAB Energy production: 60 GWh / year Capacity: 1,600 m3 / h Incoming raw gas 11 861 kNm3,74 GWh Upgraded biogas incl. propane delivered to the natural gas network 7 548 kNm 3,85 GWh Propane consumption 797 tonnes	
Emissions	1. Nitroxides (NOx) 1.2tonnes 2. Carbon dioxide (CO2) in total 10 158 tonnes of which fossil CO2 of which biogen CO2 1 383 tonnes 3. 8 682 tonnes of Methane converted to CO2 (equivalents 94 tonnes)	
Waste heat recovery injected to the DHN:	Waste heat from the sewage plant, the gasification plant and the Renova waste incineration plant	

9.1.2.4 *Lessons Learnt by the implementation of the Solution in the Pre-Pilot 1*

Gasendal's biogas production is considered to be a very successful project when looking back at 10 years of operation. The process uses an amine process to purge the biogas from CO2. Production is stable and safe. The plant is now reaching the limit of its production capacity.

In the early years there were some teething problems that have now been eliminated. The choice of recovery technology was made because the higher methane content of 99% methane is needed for delivery to the natural gas grid.

Today, similar upgrade units are packaged in container solutions that provide a very compact facility but hard to service and to gain access to the equipment, whereas the Gasendal facility is in a refurbished property that makes it easy to access the equipment and serve the compressors.

Production has increased over time with increased availability of raw gas from Gryaab, as well as production improvements and better availability at Gasendal. From the start we have next to doubled the delivery capacity.

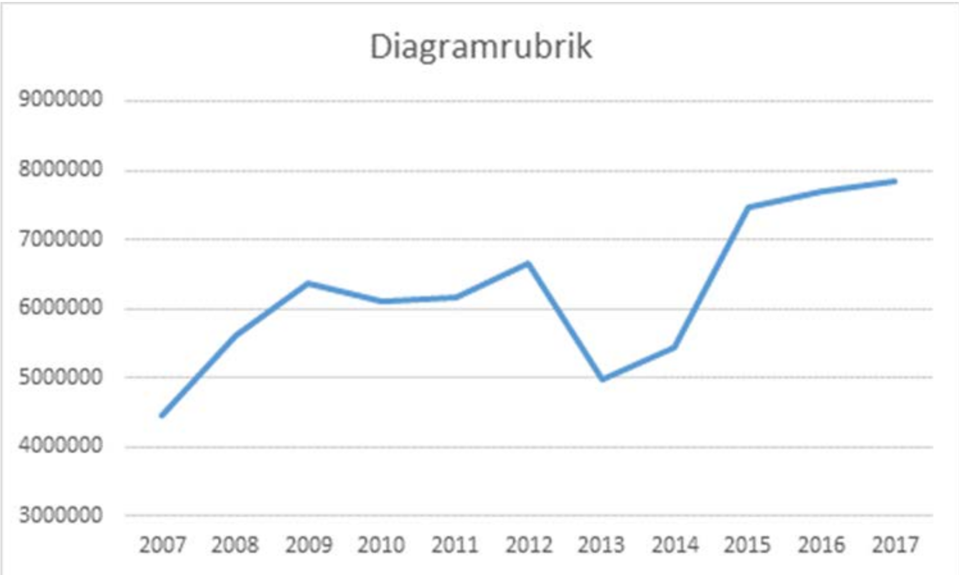

Figure 84 Gasendal annual delivery volume (tonnes)

9.1.2.5 *Pre-pilot 2 – Use Case #2 (New): District Heating for Moored Ferry*

In this Pre-Pilot, a connection of the city DH system to one of Stena Line's ferries has been made. This removes the need for the ferry to use diesel for heating while moored, thus reducing emissions and improving air quality.

Stena Danica (Ship of Stena Line's ferries)

The Göteborg Energi district heating system stretches for 1200 km and covers about 90% of the city's apartment blocks. 30% of the district heating origins from waste CHP plant Sävenäs. The ferry carries up to 2274 passengers and 480 passenger cars, and docks in Gothenburg Port two times per day.

The overall objective with the pilot or demonstrator project is to limit emissions: both regulated emissions such as SO2, particulate emissions and NOx, as well as CO2 and noise from ships when docked at quay in Gothenburg. Efforts targeting the main emission sources heating of buildings, power generation and road traffic have been successful. Emissions from ships at quay can be reduced if heating and power generation is switched from the ships marine gas oil (MGO) fueled engines to more sustainable energy sources. The option to connect ships to the power grid is available in Gothenburg Port. Though the need for heating and hot tap water on board remains. This pilot project shows the possibility to further reduce emissions from ships at quay in the central part of the city.

The project was evaluated after the first full year of operation. The adaption of the ferry connection to district heating includes installation of a heat exchanger in a container on the quay, flexible pipes to the ferry's four heat exchangers. It was assumed that the demand for district heating would mainly occur during the cold season. However, the environmental advantages to heat the ship's main engines when at quay has led to a demand for district heating also during the summer. The ferry's consumption of district heating during 2015 was estimated to 800 MWh.

The pilot project is regarded as a successful project to improve environmental performance, even if it is not increasing profitability for the shipping company. From the Gothenburg city perspective the project is a good example to show the possibilities to improve the environment by reducing both global and local emissions through a wider system perspective, including several sectors. Reduced noise from ships at quay enables housing development in port areas. The expected reduction of CO2 emissions is estimated to more than 200 tons per year with district heating instead of marine gas oil for the ship generators and heaters at quay in Gothenburg.In this demonstrator, Stena Danica ship is connected to the district heating network through:

- The adaptation of ship to receive district heating (connections, heat exchangers etc.);
- The installation and connection of a flexible connection at quay, for the supply of district heating hot water.

Technical Requirements

- Ships at quay for stops long enough to allow the connection ship-district heating network (at least five hours are required)
- Ships equipped to be connected to DHN
- The amount of heat supplied to the ship is enough to allow the ship to switch off the on-board oil-fired boilers

The overall objective with this demonstrator is to limit emissions (both regulated emissions such as sulphur, particulates and nitrogen oxides, and carbon dioxide) from ships when they are at quay in Gothenburg. When virtually all other emission sources (heating of buildings, traffic, etc.) are decreasing their emission levels, ships at quay become one of the worst emission sources in town.

Traditionally, when a ship is at quay, it still needs to run electrical generators and heating equipment, normally consuming bunker oils. In Gothenburg there are already possibilities to connect ships at quay to the electrical grid, but heating equipment on board still need to be used. When applying district heating from town to heat the ship, no emitting machines on board ships would need to be used at quay. The ships will be connected to the district heating system through a mobile tube when they are at quay.

On the ferry steam is used for the heating system. The steam is produced by an oil furnace, and the heat from flue gases. Steam system is designed to 7 bar and 170 °C. These heating systems have different power and temperature requirements.

On the ferry there are two hot water circuits for heating: "Pre-treatment" system and "Reheating" system. In the "Reheating" system, air is heated to the desired temperature in the AC units. Two steam condensers are used in the current situation to heat the system.

Pretreatment "system is part of the air conditioning system that has as a main objective to cool the air and condense water out. In the winter, the heat is transported through the circuit used for heating the air. For this purpose one-used in the current situation exchanger heated by either steam from the boiler or hot water from the engine cooling.

The pressure drop and water velocities in the secondary network shall be held within the re-commanding limits required lines with DN125 from the DHC to the quayside. From the quay and on to the connection point in engine selected DN100.

Finance

1) CO2 emissions in this project will be reduced by 172 tonnes or 63% per ship and year when the ship is in port. Bunker oil is replaced by district heating with the emission factor 101 g CO2/ kwh. As the ship's engines will be turned off and kept warm by district heating, the environment around the harbour will improve and the sulphur emissions will decrease.
2) District heating to a ship in harbour will also affect the noise for those who live near the port, and this is a notable accomplishment for Stena. The project has furthermore proven to be a less expensive heating solution for Stena Line, and the return on investment is expected to be less than three years. The total investment cost is approximately E 390 000.

Impact

The overall demonstrator's performance is summarized in the following table according to 5 evaluation criterions. It can be noticed that the assignment of all the scores is directly linked to the values calculated for the Key Performance Indicators, except for socio-economic benefits where a qualitative assessment is carried out based on this cluster's indicators and on separate interviews.

Table 43 Overall impact of Gothenburg Pre-Pilot 1 in IS 1.3

Overall Impact	Low/Fair/Medium/High/Extreme				
Size [MWh/y]	1-100	100-1000	1000-5000	5000-10000	>10000
Primary Energy Savings	0-10%	10-20%	20-40%	40-60%	>60%
GHG Emissions Reduction	0-10%	10-30%	30-60%	60-90%	>90%
Pollutant Emissions Reduction	0-10%	10-30%	30-60%	60-90%	>90%
Socio-Economic Benefits	Low	Fair	Medium	High	Extreme

9.1.2.6 *Lessons Learnt by the implementation of the Solution in the Pre-Pilot 2*

Demonstrator development

What was learned from this project was to include the quay in the feasibility study. The quay where the ship is moored was not in the right condition for construction and needed renovation before the district heating installations could begin. Repairing the quay delayed the project for several months. The initial feasibility study included technical information, but there were gaps in the data to be able to deduce how much installed power the ship would need. To remedy this, extensive measuring on board the ship while at sea were made during the winter to determine the power load. The initial feasibility study concluded that 740 kW installed power was needed; power to the ship was approximately 2 MW. With the addition of pre-heating the ship's motors to 70 degrees, the resulting requirement was 1,2 MW of power. In the event that Stena might move the ships to a new mooring location, Göteborg Energi and Stena needed to find a solution to be prepared for that. The heat exchangers and control equipment are placed in a container, so that if the mooring location for the ships will relocate, the installation can be moved to the new mooring location. This may also happen in other cities and could be something important to consider. In this project we have used some part of lessons learnt from a test project concerning heating streets. This project uses a special control system of temperature and flow, and this system was used on the ship.

Demonstrator performance monitoring

In December 2014 the "District heating to ships" demonstrator was started up and it is currently in operation. In January 2015, performance monitoring system was activated to measure the delivered heat enabling the estimations of performance indicators. Monthly heat delivered [kWh] to STENA ship is presented in figure below together with key performance indicators assessed against the baseline situation that is on the sameship, using standard oil fired boilers for heating purposes at quay. ***Positive effects have been highlighted with regards to different dimensions (energy, economic, environmental and social), but the most important impact is related to citizens' quality of life since demonstrator start up has drastically reduced GHG and acoustic emissions in the area next to the harbour.***

Table 44 Monitoring results of Gothenburg Pre-Pilot 2 in IS 1.3

Results	
Key performance indicator:	Value
Oil use reduction:	200kg diesel/hour
Reduced CO2 emissions:	400t CO2/year
Payback:	<2 years

Table 45 Replication Potential of Gothenburg Pre-Pilot

Replicability	**Low**	**Medium**	**High**
Authorizative easiness		x	
Adaptability to different climate conditions			x
Technology easy-to-implement (No needs of specific technical requirements)			x
Easy-to-implement (No needs of specific technical requirements)			x
Easy-to-operate (No needs of specific technical requirements)			x
Opportunity of integrating waste energy sources			x
CAPEX needed for the deployment of the solution		x	

9.2 Demonstration in the Lighthouse Cities

9.2.1 *Nice Cote D'Azur Demonstration*

9.2.1.1 Use Case and Brief technical description

The demonstration is located in Nice France in the Grand Arenas development district.

The demonstration leans on a waste heat recovery system that is conceived as a low temperature district heating network. This will be sourcing waste heat energy at the outflow batch of the Haliotis waste water treatment plant (WWTP) (Summer: 25-30°C / Winter: 13-8°C) located on the west side of the airport of Nice and owned by the city of Nice.

The water is then distributed to the buildings substations which will be equipped with reversible heat pumps to provide the needed heating, cooling and sanitary hot water to the end users (4,0 MW // 2, 9 GWh heating, 2,5 MW // 3,5 GWh SHW, 5,1 MW // 4,5 GWh cooling). In certain Plots among the district, thanks to different or complementary energy profiles, a heat pump will be able to take cool from one building (evaporator side of heat pump) and then transfer it at higher temperature to another building (condensing side of heat pump), this is the so called “thermo-frigo pump” mode and increases the recuperation energy and efficiency of the heat pumps.

Based on such system, the demonstration of an innovative district scale “Local Energy Management Dashboard” will be put in place. The dashboard will provide real time or near to real time information of the energy and environmental performance of the system to the community by mapping all energy fluxes related to the district.

It is expected that it will thus enable to raise awareness within the local community, and of end users, about the deployed energy solutions, its role and impact within the local energy mix, raise the active involvement in energy usage and also achieve, thanks to the monitoring, a positive feedback on the overall operation of the system.

Thanks to IRIS, the dashboard will be enhanced in its functionalities concerning its capabilities of monitoring the energy fluxes, calculate the instantaneous energy availability and the potential optimal demand-supply balance and the information quality made accessible to the end user or provided via push notifications.

The dashboard will be interfaced with different systems and sources of information. While technical specifications are not done yet, it is foreseeable that the dashboard will have to ensure following connections: remote control system of the district heating/cooling network operator (Dalkia), the CIP from the public authority (NCA), the LEM (EDF) and potential user information from engaging customers. Other information sources might be considered. The user interface will be a web based platform and made compatible and accessible from different portable devices and screen (computers, screens, mobile phones, etc).

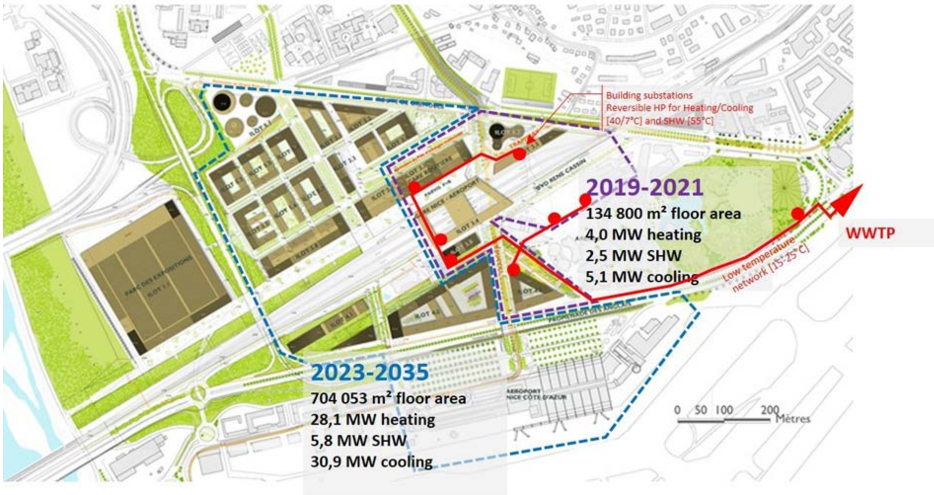

Figure 85 Simplified scheme of the planned low temperature district heating/cooling network and the two main construction phases of the area. To note, buildings are not existing yet and just partially under construction.

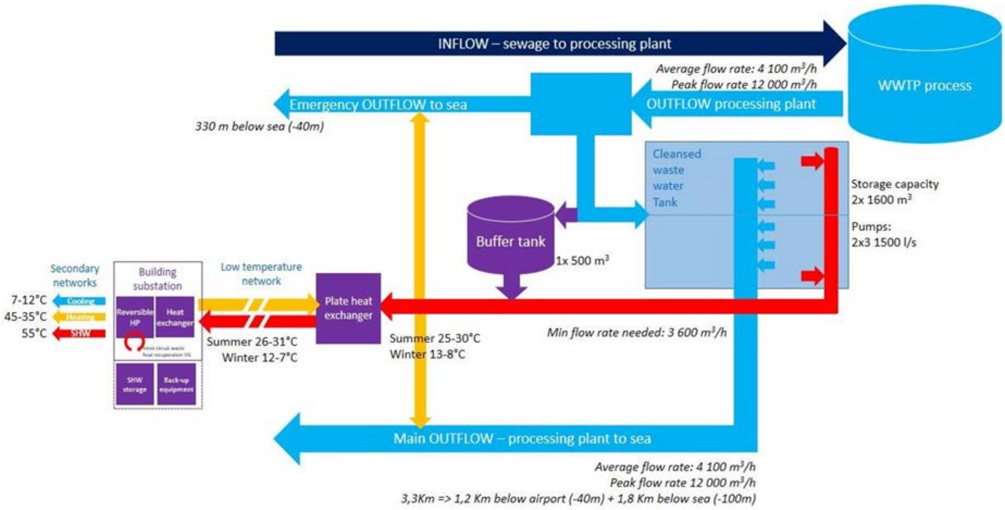

Figure 86 Schematic representation of the low temperature district heating/cooling solution to be implemented. Focus is set on the heat source side of the WWTP

Figure 87 Mock-up image of the user Interface of the dashboard

9.2.1.2 Demonstration Area and Geographical Overview

Within the West territory of the Metropolitan area of Nice, a big urban undertaking is on the way. The state and the local authorities, after a shared diagnosis on the status and potential of the western territory of Nice, decided to design together a new territorial project. At the initiative of the mayor of Nice, Christian Estrosi, the state has put a lot of resources at stake: it has made the area one of the “Operations of National Interest” (OIN) of France, with sustainable development as a guideline. The perimeter of this undertaking is the so called “Nice Eco Valley”. He entrusted the “Public Establishment for Development (EPA) of the Plaine du Var” with the implementation of this ambitious project. Ambitious because global: while proposing a new model of planning and urban planning, economics and ecology have to be combined. It also aims, for the 30 years to come, to modify in depth the economic structure of the metropolis, the modes of displacement and habitat.

The new international business district of the Côte d'Azur will correspond to the “Grand Arénas”.

The Grand Arénas represents a highly strategic sector, at the gateway to the city of Nice and in the immediate vicinity of Nice Côte d'Azur international airport. Its articulation with the international airport and the future multimodal exchange hub of Nice-Airport gives it exceptional accessibility and rapid connections with the whole of the Eco-Valley and the metropolitan area.

To the existing tertiary site of 10 hectares at complementary 49 hectares will be added, corresponding to potentially 750 000 m² of new floorspace. Within the Eco-Valley, the goal of the Grand Arénas is to create a lively, innovative and eco-friendly neighborhood, as the two driving principles of the new international business centers are urban diversity and eco-exemplarity. In addition to the offices and other facilities, a diversified housing offer is ensured (social mix), accompanied by services, shops, hotels or public facilities. The first development phase will be realized by 2021, achieving up to 140 000 m² of new mixed developments

To achieve this large-scale project, several actors come into play alongside the EPA Plaine du Var: the City of Nice, the Nice Côte d'Azur Metropolis, the airports of the Côte d'Azur, the French State , the Alpes-Maritimes General Council, the Provence-Alpes-Côte d'Azur region, RFF and the SNCF among others. Private investors will then intervene on projects they will carry.

Figure 88 contextualisation of the Nice Grand Arenas project (bottom image) compared to iconic historic centre of Nice and its port (top image)

(source Google Maps and © EPA / Mateoarquitectura)

Figure 89 Localisation of the development district and its contextualization towards the other demo site of IRIS, Nice Meridia. On the bottom right, the Nice Airport. (Source: EPA plaine du Var)

Figure 90 Plan of the Nice Grand Arenas project (Source: EPA plaine du Var)

Figure 91 North to south bird eye view of the project (Source: EPA plaine du Var)

Figure 92 West to east bird eye view of the project (Source: EPA plaine du Var)

9.2.1.3 *Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Demonstration*

In general terms, the district heating and cooling solution proposed is an undertaking which has already proven its environmental, economic and societal benefits in other contexts and are well understood and endorsed by the related public and business community. However, this type of solutions still stay at the very early stage of the adoption curve and thus, have still to proof repeatedly their upper value before becoming mainstream. The realization of the technical solution will prove once more, the feasibility and interest of public authorities to promote such solutions in their overall urbanization strategy and to ensure to integrate them from the early planning stages. Not only, at the other side of the value chain, local actors and thus the future clients, will have to be persuaded on the fact that the heating and cooling provision service, can be achieved at the same quality, at lower or equal costs than traditional production means, and this with at a higher environmental benefit.

It will put light also the availability of so called “waste heat sources”, which yet are too often forgotten or overlooked when it comes to distributed or local energy systems in cities and districts, might. Waste heat sources are usually not widely considered, first because of an overall missing awareness of the decision makers, as their potential is too poorly analyzed. Secondly, there is a reluctance of private actors to carry financial risks, as the uncertainty of the quality and durability of the heat source increases investment risks and also the contractual terms that have to be put in place are more complex than with traditional DH/CN. Thanks to this project carried on by EDF’s subsidiary Dalkia, the feasibility and interest to promote the valorization of waste heat energy sources will be proved and hopefully provide a reference in other developments across the region or nation.

Nevertheless, the local specificities make the implementation not straightforward. Different obstacles and barriers have to be overcome, related to local regulations, commercial and contractual terms and acceptability of customers. Being a private led undertaking, despite being endorsed by the public authority, the financial risk of the operation is beard by the private system operator.

Thanks the dashboard which will be demonstrated within the IRIS project, it will be put light on the overall energy balance and efficiency of a district, and empower citizens and businesses with a mean to better understand, acknowledge and interact with the energy system that surrounds them in their daily life.

The dashboard is seen as an opportunity to develop a new approach towards the local communities which live and/or work in new eco-districts, in promoting new and renewable energy systems. It is expected to gain through this demonstration, a better insight into the interest and awareness of citizens in the matter of energy in districts, their sensibility and interest in making a difference in terms of impact in the local energy system and identify new means to channel such type of solutions to an existing or potential pool of customers.

Table 46 Objectives/Needs & Opportunities of Nice Cote D’Azur Demonstration in IS 1.3

Opportunities	Needs/Objectives
Waste heat recovery – overall environmental and economic benefit	Supply heating and cooling through a low temperature (15°-25°C) district heating and cooling network, enables to make use of freely available heat source in urban areas. The system will enable to have an overall higher energy efficiency and this at lower carbon and pollutants emissions, compared to classic solutions, based on fuels or fossil fuels for heating and on electricity only for cooling. Being the network development a privately led undertaking, it will

	demonstrate that heating and cooling provision from non-conventional energy sources and with low carbon technologies, can be achieved at no increased costs for end users and compete with less performing technologies. This solution will enable to contribute to the development objectives of the city of Nice in terms of emission reduction, energy efficiency increase and renewable integration. Furthermore, the system will contribute to the innovation and sustainability aims of the Nice Eco Valley and represent a demonstrator for further spread and adoption of such solution not only locally, but nationwide.
Dashboard – Customer focused monitoring	By making the dashboard accessible to the different user of the district, awareness rising about low carbon district technologies is aimed. It is thus expected that energy solidarity is promoted and achieved among local communities. This awareness rising should lead to an overall positive societal impact in the district's residential and commuting communities and rising the acceptability of local and distributed renewable based resources or even promote their adoption within bottom-up lead activities. Thanks to such dashboard, it is expected to achieve a better understanding of the acceptability of such a service, better identify the needs and interests of certain local communities and more efficient ways to channel the information to the end users.
Dashboard – software development	Thanks to the acquisition of different monitoring data sources, the mapping of the main energy fluxes among the district should be achieved. This will enable to identify the overall efficiency of the district's energy system, enabling to quantify the supply-demand balance and the contribution of local source energy to the overall district's needs. Furthermore, the integration of the platform with exogenous information (like meteorological forecasts) and more advanced algorithms, should enable to have a more accurate forecast of the energy needs and the optimal supply demand balance that could be achieved in the network.

9.2.1.4 *Key Technical Components*

As mentioned above, the district energy system itself is a privately led undertaking (Dalkia, 100% subsidiary of EDF) and not financed by the IRIS project. Nevertheless, below the shared information about the technical specifications of the system as available to the present date.

Hardware:

Table 47 Hardware Key Technical Components of Nice Cote D'Azur Demonstration in IS 1.3

Waste heat recovery from WWTP	
City	Nice, FR
Main stakeholders and roles	MNCA > owner of the infrastructure (WWTP and DHN)
	Daklia (100% subsidiary company of EDF) > DHN operator (BOT contract)
	Optimal Solution (100% subsidiary company of Dalkia) > EPCM
	WWTP operator
Main characteristics	
Waste heat source	Cleansed waste water from WWTP
Fluid type	Water
Key technology	Electric heat pump
Waste heat temperature	Summer : 25-30°C
	Winter : 13-8°C
Waste heat available	Source power winter : 4, 1 MW Source power summer : 5,4 MW
Thermal demand	i. 4,0 MW // 2, 9 GWh heating ii. 2,5 MW // 3,5 GWh SHW iii. 5,1 MW // 4,5 GWh cooling
Useful heat demand temperature	Cooling : 7°C Heating: 45°C SHW :55°C
Useful heat expected power	Sized to demand

Software:

Software components related to the district system operation (and related ICT infrastructure) are not developed under the IRIS project.

The technical specifications of the Dashboard and related software needs and algorithm development are underway and not finalised yet. Therefore possible software (in-house or sourced) solutions are not named and specified. The Dashboard developments under IRIS should base on a first platform at about TRL 5.

Table 48 Software Key Technical Components of Nice Cote D'Azur Demonstration in IS 1.3

Main Component	Technical Specifications	Demonstration Area	IRIS partner (owners and providers individually)
DESC (Dalkia Energy Servings Center) > e-monitoring platform	The DESC is the regional e-monitoring facility of all installations belonging to Dalkia. The exchanger building (source) and substations (delivery point) are remotely monitored by the DESC (electricity consumption, temperatures and mass flow among in and outlet interfaces in the system). The final technical planning of the metering and ICT solution is not set yet, so no solution provider has not been identified. It might be foreseen that the SCADAs/automates of the different system components might be able to be adjusted remotely via the DESC. Operation software should enable a fully automatized operation of the system	Nice Grand Arenas	MNCA (owner) Haliotis WWTP operator Network operator : Dalkia (100% subsidiary of EDF)

	.This is realized through Dalkia's own in-house software components.		
Dashboard (for real-time monitoring of the district's energy balance):	The Dashboard software solution will be developed within EDF premises. It will consist in an internet accessible interface. The software solution will consist of following components: • remote connector with: o the DESC to ensure the repatriation of the DH/C system's related data. o The CIP to integrate complementary information on the district (for e.g.: weather data, traffic information, geodata concerning built environment, others) o The LEM to provide information on flexibility activations o Other data platforms, as for e.g. energy market data for CO2 content estimation, weather forecast provider, etc.) • User Interface: o Synthetic overview of metering and performance data (from monitoring or modelling) o Visualization of geotagged data on the district (energy production and consumption points, possibly with time series information) o Access to media for the "awareness rising" concerning the district's embedded systems o Other services which will ameliorate the use of the application as for e.g. a social media service for the application's users (chat box, up and download of media, etc.). • Embedded algorithms for: o Data management o Data visualisation o Algorithms for indicators calculation o Usage analytics o Production forecast (local assets) o Demand forecast (district level) o Optimization of supply-demand balance.	Nice Grand Arenas	EDF

Available Algorithms and a short description of them:	Energy demand forecast software (EDF in house development) > It is based on learning algorithms (neural networks, GAM, random forests) and learns from past consumptions and past weather information to forecast the load thanks to recent consumptions and weather forecasts Energy production forecast software (EDF in house development) > based on a similar mixed approach solution as above. Optimisation software (EDF in house developments) > Software core is based on Mixed Integer Linear Programming (MILP) – solution compatible with most solvers (proprietary and open source) and running on different operating systems. The optimization software interface is a planning software for production systems. The optimisation under constrain is done for a customizable Criterion - "single optimization function". The optimization is based on a technical system modelling, and adapted to multi-energy systems.	Nice Grand Arenas	EDF

9.2.2 *Gothenburg Demonstration*

Not applicable

9.3 Replication Planning in the Lighthouse and Follower Cities

9.3.1 *Utrecht Replication*

Local project partner Eneco is currently examining the feasibility to utilize the heat produced at the waste water treatment plant in the adjacent area of Overvecht in Utrecht, after first pumping its temperature up to 70°C. (See map of the location of the area in the section on replication for solution 1.2)

9.3.2 *Nice Cote D'Azur Replication*

9.3.2.1 Replication Area and Geographical Overview

If the dashboard implementation will result to be a viable product, it could be foreseen to extend its implementation to the second phased developments of the Grand Arenas urbanization project or within the wider territory of Nice Eco Valley. Precondition for the replication potential of the dashboard development, is the development/extension of renewable energy based district heating/cooling networks.

Within IRIS, only part of the first phase of the urbanization project will achieve the realization. If no delays will incur in the construction project, by 2023, about 135 000 m² will be realized. As replication area, the Grand Arenas in its second phase, will represent about 700 000 m² of new mixed use developments. The area will embrace housing, business and commercial buildings and potentially, an expo area among other developments. Being still at the master planning stage, no concrete action or energy related program has been defined. Nevertheless, supposing the renewable based district energy solutions of the Grand Arenas and Nice Meridia districts proof their feasibility and acceptance by the local society and the public authority alike, it could be foreseen that at least part of the new development area will see the development of a similar infrastructure (for e.g. waste heat recuperation, sea water or geothermal sources). Clearly the Dashboard could be replicated on top of such undertakings and thus, enable the replication of this IRIS solution.

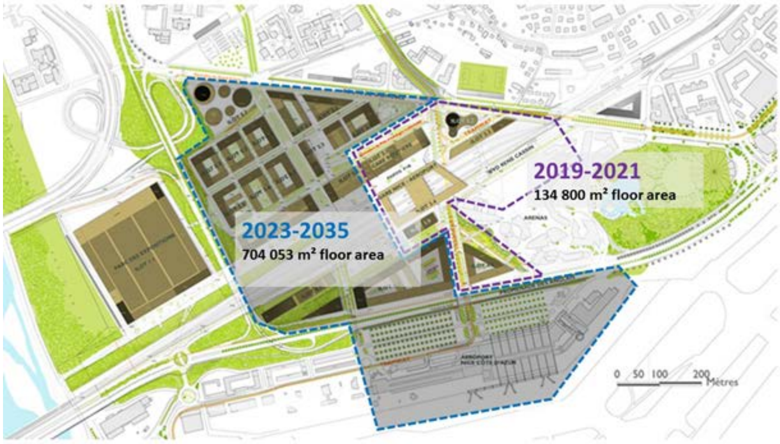

Figure 93 Second phase development of the Grand Arénas district

As a further replication area, the greater Eco Valley area can be targeted. The project has to be seen in a long-term perspective, aiming at a strong territorial mutation and revitalization. Its development will see distinct and subsequent urbanization phases and related construction programs. Yet, the projects to come are not defined, but the whole area will be developed under the same objective of sustainable development, driven by innovation and green technologies. This perimeter represents a potential pool of 3 000 000 m² of new constructions and developments. A Spill Over effect could be expected, fostering an adoption of the solutions which have proven their upper value in the first demonstration projects. The energy mix will be a leitmotif for the new districts, making the adoption of a Dashboard very likely.

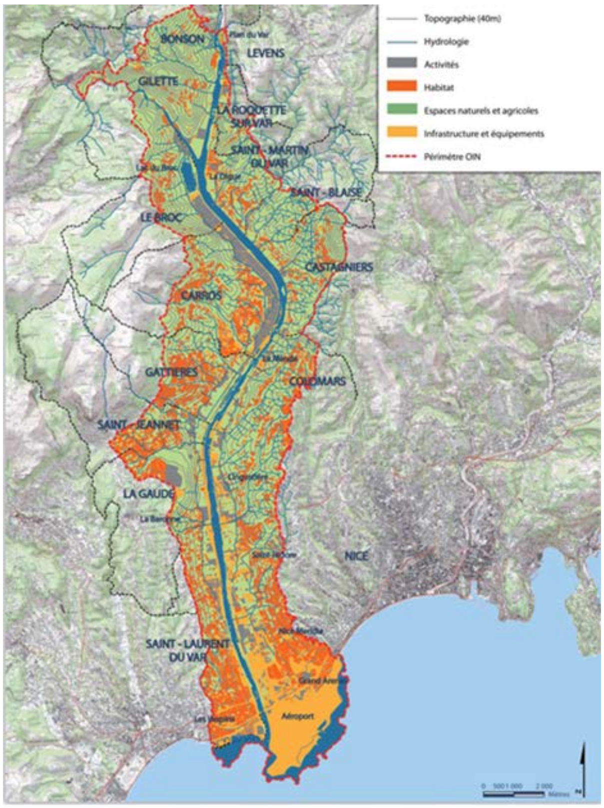

Figure 94 Perimeter of the Nice Eco Valley project: a territory with potentially up to 3 000 000 m² of new constructions

9.3.2.2 Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication

Table 49 Objectives/Needs & Opportunities of Nice Cote D'Azur Replication in IS 1.3

Opportunities	Needs/Objectives
Environmental objectives and energy mix	The low temperature district heating/cooling network, independently from which low temperature renewable source, should become part of the overall energy mix strategy of the territory. It provides an upper value for construction programs through a high quality energy service provision to citizens, long term energy pricing visibility and transparency, while serving to the city administration to achieve their set ambitious environmental targets: renewable energy share in the overall energy mix, renewables in the heating/cooling sector, CO2 and air pollution reduction.
Dashboard – public acceptance	To promote energy solidarity within society and communities, is at the very heart of the Dashboard development. The Dashboard aims to contribute in developing social inclusion at the local scale by linking local communities (commuters, workers, residents). While doing this, it will enable the users to acknowledge the quality and kind of development that exist, or are taking place, in their urban area. By rising awareness on such sustainable energy solutions, acceptance and adoption should be enhanced and helping in

	speeding up the development of such systems.
Transparency between citizens and public infrastructures	Providing accessibility to monitoring data to consumers and the wider public alike, the positive impact that renewable district energy solutions provide should be put into the foreground and thus become a knowledgeable process for the wider public. It will enable to private and public actors to provide a mean to communicate in a transparent manner their performance in terms of energy and environmental engagement.

9.3.3 *Gothenburg Replication*

Information will be available in WP7.

9.3.4 *Vaasa Replication*

Novel elements as those of a) smart collection of waste streams (TRL8) and b) use of produced biogas as an energy carrier for mobile services (TRL9), will be added in the context of currently operating sewage sludge or waste gasification plants.

Vaasa is interested in, since there are two power plants (one combined heat/electricity and one based on waste) where extra heat could be used or put in a heat storage. There are also several industrial units that produces extra heat that is not utilized currently.

Vaasa has already implemented 12 biogas buses that utilize biogas produced from local biowaste from local waste incinerator/gasification plant. Additional biogas is now sold at the gasification plant but it is foreseen to establish a biogas fueling station inside the City area. The Geographical area of City of Vaasa also includes large agricultural area (Vähäkyrö district) which could have potential to produce biogas from agricultural side product.

9.3.4.1 Replication Area and Geographical Overview

Stormossen is the area of the current biogas production from the waste and sludge, as well as future circular economy center. Stormossen is co-owned by City of Vaasa and Mustasaari, which is the neighbour municipality of Vaasa.

Vähäkyrö situated about 30 km from Vaasa city centre is a former municipality that was integrated with the city of Vaasa 2013. It is a rural area with agricultural as well as entrepreneurial activities. A large percentage of people living in the area work in the Vaasa city area. Vähäkyrö has waste water- and waste treatment plants, as well as production of agricultural biomass. This area has a lot of potential for future sustainable heat and electricity production. Vähäkyrö has district heat network in the Vähäkyrö centre, using almost solely biomass.

At the moment about 25 % of household biowaste is used in incinerator plant. Vaasa aims to increase use of biowaste for gas production by activating better separation of different waste streams.

Figure 95 Preliminary concept of biogas/LNG solution

9.3.4.2 *Needs and Opportunities to be served by the implementation of the Solution in the Replication*

Table 50 Objectives/Needs & Opportunities of Vaasa Replication in IS 1.3

Opportunities	Needs
Waste heat recovery	Serve neighbourhood needs through a low temperature (15o-25oC) DHN.
Real-time monitoring of processes and outcomes	Promote energy solidarity within society and communities.
Utilization of waste streams	Increase in use of biogas. (household, industrial and agricultural waste)

9.3.4.3 *Alexandroupolis*

Alexandroupolis is currently developing the studies for the development an important energy project that utilises waste heat. Alexandroupolis is the first European municipality that will be crossed by the Trans Adriatic Pipeline (TAP), which opens up the Southern Gas Corridor and supports the achievement of the European energy policy objectives. Alexandroupolis has agreed with TAP AG to utilise the waste heat of the compression station for district heating of residential buildings, industries and greenhouses. Although it considered as unique waste heat application, the knowledge gained and lessons learned from the demonstration activities of the lighthouse cities will support the development of the DHN from TAP's compression station waste heat.

9.3.4.4 Replication Area and Geographical Overview

The compression station of TAP is currently being constructed near village "Kipoi" several kilometres away from the city of Alexandroupolis, close to the boarders with Turkey. The district heating network that utilises the waste heat from the natural gas compression station is shown in the picture below. Alexandroupolis is aiming to district heat approximately 4.000 households with the development of more than 140 km of network. The main replication area is "Ferres", where the majority of consumers are located.

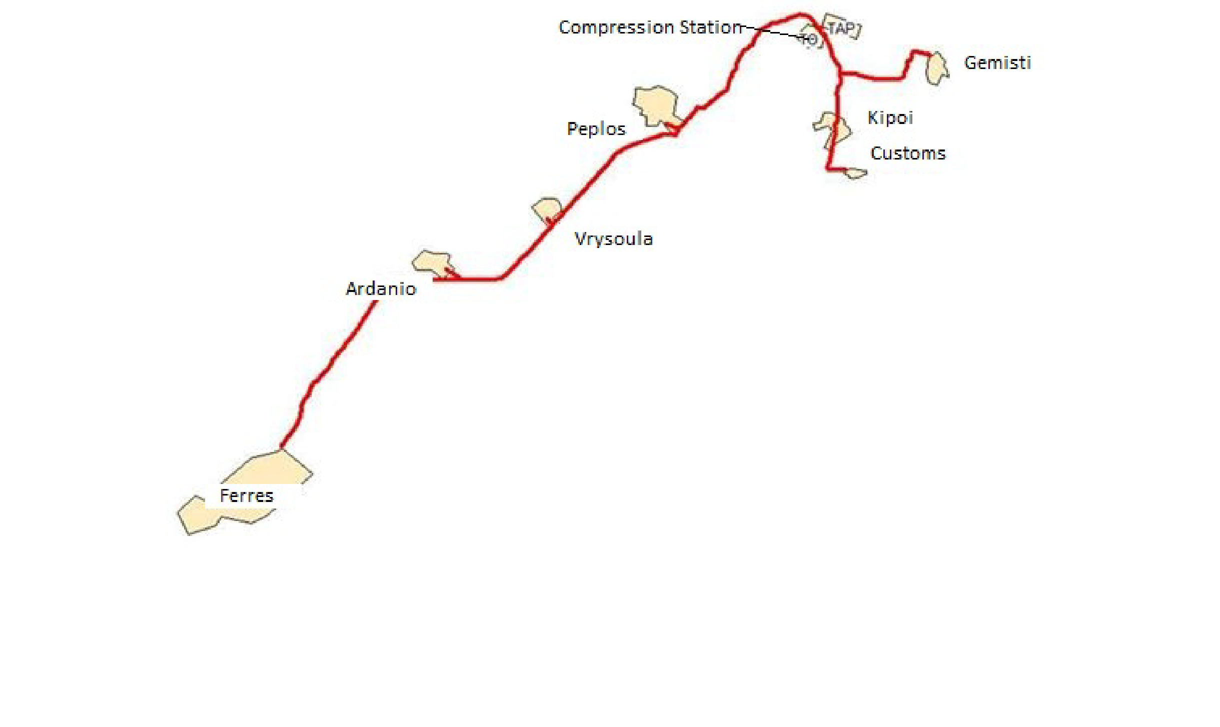

Figure 96 District heating network that utilises waste heat from NG compression station

9.3.4.5 *Objectives, Needs and Opportunities to be served by the implementation of the Solution in the Replication*

Table 51 Objectives/Needs & Opportunities of Alexandroupolis Replication in IS 1.3

Opportunities	Needs/Objectives
Waste heat recovery – Energy Savings	To cover the heating needs of the district. Reduction of use of mineral natural resources.
Reduction in GHG emissions	According to its SEAP, the city wants to reduce residents' consumption-based greenhouse gas emissions concerning climate impact.
Business, Economic and Social Contribution	Create opportunities for small industries and greenhouse owners to lower energy costs and increase their economic viability Reduction of residents' bills concerning the heating and improvement of life quality.

9.3.5 *Foscani Replication*

The Municipality of Focsani is implementing a project for development of a landfill. The position of the landfill is within a substantial distance from the city, which makes inefficient the use of wastes for energy generation and supply to the Municipality of Focsani.

9.4 Data Collection and Management

9.4.1 *Nice Cote D'Azur*

At Month-7, the data collection and management is being defined as part of WP4 "City Innovation Plateform", and more specially the D4.1, D4.2, which final version is under review with both CERTH and UTR.

During CPB in Goteborg (March 2018), a working session dedicated to WP4 was held, with the following conclusions:

"After a general introduction of the City innovation platform architecture three sprints were done based on different "use cases", addressing economy, mobility and energy challenges.

The use cases were developed in design sprints which resulted in a better understanding of the specification of the data required from the digital services needed and of the role and benefits of the city innovation platform

The sprint method was highly appreciated by the participants. It is a motivating way to get input with people from different backgrounds. "

A "T6.6 preparatory workshop" dedicated to the set-up of the CIP will be held in May/June (doodle running) with Nice Ecosystem partners.

The "use case" approach enables to address and anticipate the different transition tracks issues and challenges, whilst anticipating and covering potential technical constraints."

Even though data collection lies at the very heart of the Dashboard solution, its technical and functional specifications have not been defined at this time.

What can be supposed at the moment, is that the following data and data series might be used:

- Geographic data and geo-tagged data
- Energy consumption data (heating, cooling, electricity)
- Energy imports (Grid)
- Local renewable energy production (PV, district heating/cooling network)
- Weather data / metrological data
- Air quality data
- Road and public transport data

By means of modelling and other algorithms, more datasets and indicators will be generated, as energy performance, CO2 emissions or renewable energy share. Furthermore, by means of forecast, additional data series will be generated, as for e.g. production and demand load curves.

The data granularity should provide at least hourly updates of the information flow, in order to enable to the users to have information which could impact their short-term decision making process.

Similarly, it has to be ensured the data are made available in the long term, enabling to have a monitoring of the past events to identify long term trends and processes, enabling (passively or actively) end users to acknowledge seasonal or long terms trends which could influence their decision making.

The mentioned data are, partly, both in the private and public domain. Thus, part of the data, will be stored in the servers hosting the Dashboard within EDF premises, while others will only be accessible through dedicated or ad-hoc connectors and interfaces, so be hosted at the owner's premises.

9.5 Regulatory Framework per LH/FC

9.5.1 *Utrecht*

The majority of the district heating networks in the Netherlands are operated by private companies. They own and operate the district heating network, supply heat to the end users and often also operate the production facilities that provide the heat for the district heating network. District heating operators that supply heat to "protected consumers" are regulated under the Dutch Heat Act. The Act protects these consumers who are unable to switch suppliers (about 90% of the customers) amongst others against being charged too high prices. The fact that the network is operated by private companies and regulated tariffs has a significant impact on the feasibility of the business case for district heating operators.

9.5.2 *Nice Cote D'Azur*

The "energy transition for green growth act" (national law 17/08/2015 - dedicated website: http://www.gouvernement.fr/en/energy-transition) leads French local authorities to define a local "Territorial Energy and Climat Plan", with different level of objectifs and expectations according to the size of the local authorities.

The Metropole of Nice Cote d'Azur, totalizing more than 500.000 inhabitants,has therefore its local action plan (http://planclimat.nice.fr/public/accueil.html).

The symbiotic waste heat network aims at contributing to the objectives set by NCA.Also, ADEME (French Agency for Environment and Energy Management - http://www.ademe.fr/en) is an industrial and commercial public institution placed under the joint supervision of Ministry of Ecology and Sustainable Planning and Development and the Ministry of Higher Education and Research.

ADEME aims to be the point of reference and privileged partner for the general public, companies and local authorities, acting as the State's tool to generalise the best practices designed to protect the environment and energy saving.

ADEME is involved in the following sectors: air pollution, noise, waste, energy (energy management and renewable energies), environmental management, polluted sites and soils, transports. Within the framework of public policies defined by the government, the Agency's mission is to stimulate, animate, coordinate, facilitate and perform operations aiming at the environment protection and energy management.

Also, ADEME regularly launches call for proposals to foster innovation projects.

9.5.3 *Gothenburg*

Information will be available in WP7.

9.5.4 *Vaasa*

In use of waste heat there are no regulatory issues. If investment is economically feasible it can be collected and used in own premises. It is also possible to make contract with local district heating company to sell extra heat to network.

On household waste the City is regulating collection and use of household waste. Any change need to be decided by the City. On industrial and agricultural waste, companies producing the waste are themselves responsible to organise collection of waste.

9.5.5 *Alexandroupolis*

There is no regulatory framework for waste heat utilisation.

9.6 Technology Bounds and Drivers per LH/FC

9.6.1 *Utrecht*

Information will be available in WP5.

9.6.2 *Nice Cote D'Azur*

1) The "energy transition for green growth act" (national law 17/08/2015 - dedicated website: http://www.gouvernement.fr/en/energy-transition) leads French local authorities to define a local "Territorial Energy and Climat Plan", with different level of objectifs and expectations according to the size of the local authorities.

2) The Metropole of Nice Cote d'Azur, with more than 500.000 inhabitants, has therefore its local action plan (http://planclimat.nice.fr/public/accueil.html).

The symbiotic waste heat network aims at contributing to the objectives set by NCA.

3) Nice's Agenda 21

http://www.nicecotedazur.org/environnement/agenda-21

9.6.3 *Gothenburg*

Information will be available in WP7.

9.6.4 *Vaasa*

At the moment Wärtsilä´s excess heat is already used, in other industrial locations do not have that much excess heat it could be fitted on current DHN. More effective systems of low temperature solutions should be developed.

Vaasa is involved in network of Finnish Sustainable Communities that focus on developing circular economy within the city. At the moment most of the waste is used for energy production in waste incinerator plant and household bio-waste in gasification plant (Stormossen). Progress on circular economy could change waste stream and reduce waste used for energy production. This will have impact on biomass availability and should be considered in planning future processes, e.g. incorporated in Vähäkyrö district.

Local industries and agricultural producers would have possibility to saving on energy costs or new income streams if waste can be utilized to biogas or other materials.

9.6.5 *Alexandroupolis*

Technical. The development of extensive district heating network can be considered as a technical barrier. However, there is significant experience of DHN from the lighthouse cities and other cities in Europe that will be used for the development of the project.

Social. The success of such high cost project is also based on the increased number of consumers. There, the acceptance of the project from the citizens of the area is crucial and can potential be a barrier.

Financial. The budget of the waste heat utilization project to be examined is estimated more than 30 m€. Therefore, funding of such project is considered as a barrier. However, preliminary studies show that the thermal energy provided to the consumers will be significantly cheaper.

Environmental. The implementation of waste heat DHN provide the opportunity to achieve a substantial reduction in CO_2 emissions.

9.7 Business models

9.7.1 *Utrecht*

Information will be available in WP5.

9.7.2 *Nice Cote D'Azur*

Excess Heat Sales (GOT) - Small scale producers (or prosumers) distributes excess heat to the DHN. Utility company or consumer connected to the grid buys the heat, value decided by hourly based marginal production cost and grid aspects in the DHN. Managed by a local energy trading system.

Dashboard solution (NCA)
Yet no clear business model is defined: in the followings a first draft is provided.

- **Key partners**
  - City administration and agencies
  - DH/CN operator
  - DSO
  - Local businesses
  - Dashboard provider
  - Other associations
- **Key activities**
  - Monitoring of data and information provision in real time (at least hourly) and provide forecasts or access to past data series
  - Ensure quality of forecasts and validity of provided information and services
  - Ensure appealing and interactive visualization and representation means - quality and stability of application – service quality
  - Provide push informations to individual users or the wider local community with alerts/coaching to reduce their overall environmental footprint
  - Maintenance and extension of application > improvement of customer experience
  - Others
- **Key resources**
  - Data scientists
  - Energy engineers
  - Economic engineers
  - Social scientists
  - Designers
  - Software developers
  - Developers/commercials
- **Value proposition**
  - Simple and easy access to environmental information on local district and other added value information (actual or forecasted) (past, current, future)
  - Energy/Green assets valorization through accessibility of information and design means (as geolocalisation, other graphical means)
  - Local social platform/chatbox for citizens inclusion/animation of a local community
  - Transparent citizen and environmental engagement through developed indicators and collected information and its communication channels – enabling user's feedback
  - Easy/preferential access to local services (transports, events, shopping or retails)
  - Coaching for behavioral change in energy or environmental impacting activities (energy consumption, life style, mobility)
- **Customer relationships**
  - Push information from dashboard to users

  - Screening on usage of interfaces and services
  - Satisfaction questionnaires or on-site exchange with customers
  - FAQ and Comments functionalities
- **Channels**
  - Third party web sites (company's or clients web sites, city platform)
  - Public spaces as squares, transport, bus stops, etc. (QR codes, posters)
  - Commercial activity on site
  - Media distribution in local commerce/shops
- **Customer segment**
  - B2B2C
  - B2G2B/C
  - B2C/B2B
- **Cost structure**
  - To be defined – No available information
- **Revenue Stream**
  - To be defined – No available information

9.7.3 *Gothenburg*

Excess Heat Sales (GOT) - Small scale producers (or prosumers) distributes excess heat to the DHN. Utility company or consumer connected to the grid buys the heat, value decided by hourly based marginal production cost and grid aspects in the DHN. Managed by a local energy trading system.

9.7.4 *Vaasa*

Excess Heat Sales: Small scale producers (or prosumers) distributes excess heat to the DHN. Utility company or consumer connected to the grid buys the heat, value decided by hourly based marginal production cost and grid aspects in the DHN. Managed by a local energy trading system.

Biogas production: Industrial and agricultural bio-waste in small scale producers distributes excess biogas for market. City should develop business model for household waste to improve sustainability and reduce operation costs.

For normal district heat system business model is in place already and in principal same business models works in small local area network. For biowaste new business models are needed. At the moment systems only encourage use of bioenergy in for own purposes.

9.7.5 *Alexandroupolis*

Excess Heat Sales (GOT) - Small scale producers (or prosumers) distributes excess heat to the DHN. Utility company or consumer connected to the grid buys the heat, value decided by hourly based marginal production cost and grid aspects in the DHN. Managed by a local energy trading system.