THERMOS

Baseline Replication Assessment Report – Pilot Cities

20.03.2018

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723636. The sole responsibility for any errors or omissions made lies with the editor. The content does not necessarily reflect the opinion of the European Commission. The European Commission is also not responsible for any use that may be made of the information contained therein.

Lead Deliverable Authors:

Ignacio Prieto - Creara

Paolo Michele Sonvilla - Creara

Marta Chillida Munguet - Ayuntamiento de Granollers

James Wilson - Islington Council

Marta Kęsik - URZĄD M.ST. WARSZAWY

Valdis Rieksts-Riekstins - Zemgale Regional Energy Agency

Thomas Wenzel – Deutsche Energie-Agentur GMBH

João Dinis – Municipio de Cascais

Simon Wyke – Greater London Authority

Maria-Elena Seeman, Nicolaie Moldovan – Alba Iulia Municipality

Reviewers:

Ignacio Prieto - Creara

Paolo M. Sonvilla - Creara

Michele Zuin - ICLEI

Annette Lamley - CSE

Contents

1 Introduction

The Baseline Replication Assessment Report aims to map-out and assess the national and local framework conditions for a successful adoption of the THERMOS model.

This document constitutes the final issue of the Baseline Replication Assessment Report and focuses on the four Pilot Cities of the THERMOS project: Granollers, Islington, Jelgava and Warsaw, and the 4 Replication Cities: Alba Iulia, Berlin, Cascais and the Greater London Authority.

Throughout this document the most relevant characteristics and features that should be considered for the adoption of the THERMOS tool are analysed. The analysis covers the following elements in each of the four Pilot Cities studied:

- **Heating and Cooling in the local context**: this section contains an analysis of the local energy system (energy mix, key performance indicators on power and thermal supply and demand), the key energy policy and legislation, the adoption of Renewable Energy Sources (RES) in the city and the existing energy objectives and plans, among others;
- **Stakeholder Identification and Engagement**: the main local and national stakeholders that should be engaged for a successful adoption of the tools developed throughout THERMOS are listed in this section, together with the roles that they can hold towards the THERMOS model replication and the strategies to be followed for their engagement;
- **Towards THERMOS Uptake**: in this section the principal barriers that could prevent the adoption of the THERMOS tool and the solutions to overcome them are examined;
- **THERMOS Case Study**: finally, the document focuses the analysis on a single opportunity in a city district or quarter where the THERMOS tool will initially be applied.

This report is therefore meant to establish a baseline and serve both as a guide and a set of practical examples on the information that should be gathered and the stakeholders that should be engaged for a successful replication and adoption of the THERMOS tool.

2 Granollers

2.1 Introduction

Granollers City Council is the local administration of the Granollers municipality. The city is 14.89km^2 in size and has over 60,000 inhabitants (60,174 inhabitants in 2016) who live in 26,000 family dwellings. It is one of the medium sized cities comprising the second metropolitan crown and is located approximately 30 kilometres from Barcelona, surrounded by an extensive road communications network.

Image: Granollers Mercat EPE

The oldest traces of life found in Granollers date back to 4,000 years ago. The *Porxada*, built in 1587 as a corn exchange place, is the city's most symbolic building, and has been declared as being of national interest.

The city has a continuous urban area with other municipalities that represent all together more than 100,000 inhabitants and attract many citizens of the *Vallès Oriental* region for commercial purposes and services.

From an orographic perspective, Granollers is settled in a valley, a depression limited on the west with the pre-coastal mountain range, the *Montseny* on the north and the coast mountain range on the east. The climatic characteristics of the geographic depressions make the city and its surrounding area vulnerable to air pollution, especially in winter, when the climate

conditions are too stable. Furthermore, the last 20 years have seen an increase in the proportion of dry years, with an average rainfall of 600 l/m per year.

The following links provide a quick overview of the city and its main landscapes:

Granollers images

Short video of the city

2.2 Heating and Cooling in the local context

2.2.1 Local energy system

2.2.1.1 Introduction

Around 47% of the total energy consumption in Granollers in 2012 corresponded to the industrial sector, with 7 industrial parks spanning more than 600 different industrial activities. There is a specific public body, *Granollers Mercat*, which promotes and supports the industrial parks in the city. Industrial consumption went down to 42% in 2014:

Figure 1: Granollers energy consumption by sector (2014)

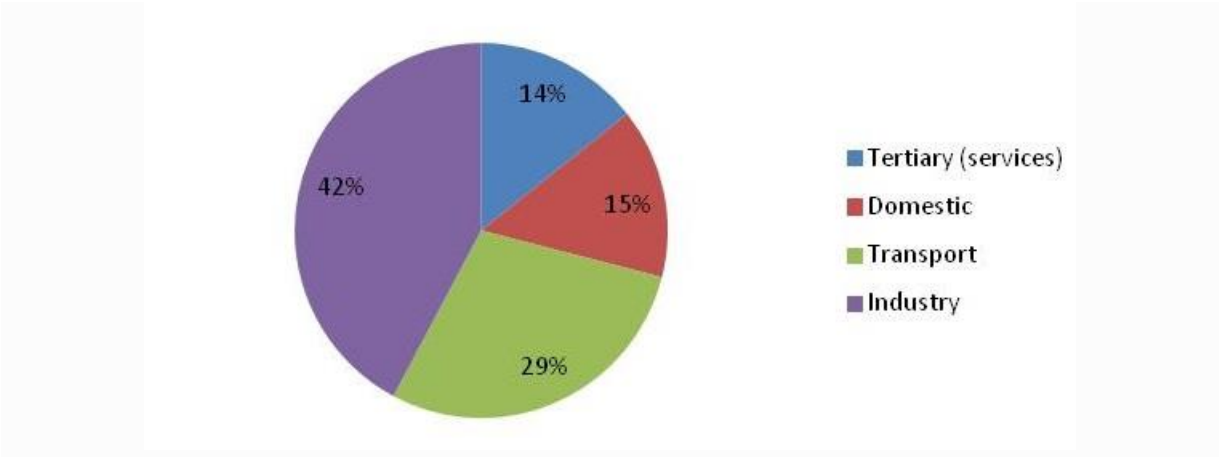
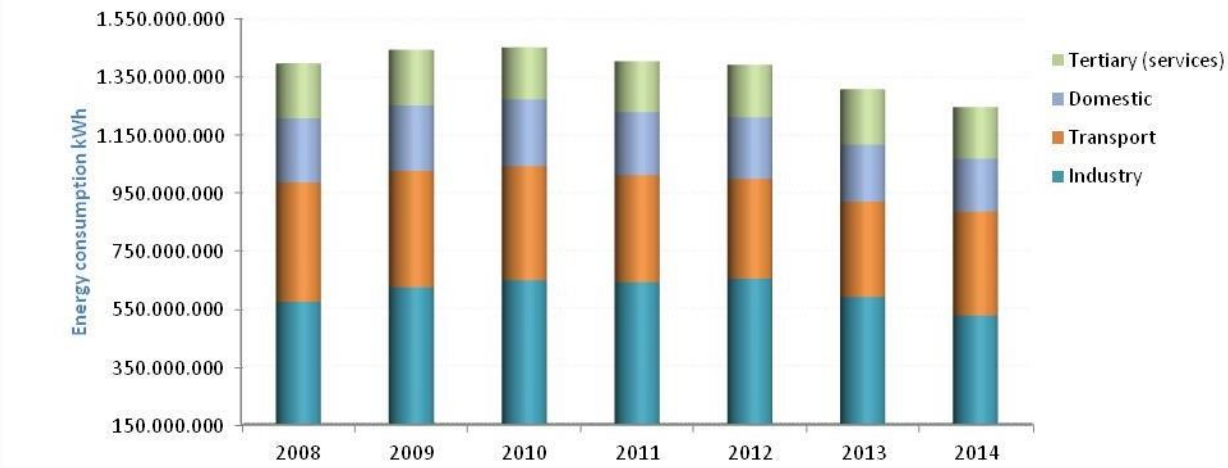


Figure 2: Evolution of the energy consumption in Granollers by sector (2009-2014)



As shown in the figure above, the energy consumption in Granollers has been dropping (kWh per year) in all sectors from 2010

	Variation 2010-2014
Tertiary (services)	-8%
Domestic	-23%
Transport	-12%
Industry	-18%
Total	-16%

The decrease in energy consumption is probably due to the economic crisis that started in 2008, as well as the efficiency measures that the different sectors might have adopted to save money and energy.

The economic activity indicators in the following table show a decrease of 13% in the number of companies between the year 2008 and 2014 which is most likely the cause of the decrease in energy consumption from industry.

Economic activity indicators	2008	2009	2010	2011	2012	2013	2014	2015
Wage earners	24.834	23.206	22.926	21.994	21.139	20.698	21.770	23.654
Wage earners / Active workers	78,41%	74,76%	75,03%	73,02%	71,78%	71,12%	74,39%	80,68%
Self employed and free lance	4.286	4.064	3.949	3.819	3.743	3.717	3.817	3.868
Self employed and free lance/ Wage earners	17,26%	17,51%	17,22%	17,36%	17,71%	17,96%	17,53%	16,35%
Companies	2.658	2.512	2.468	2.437	2.362	2.308	2.322	2.389
Wage earners / Companies	9,3	9,2	9,3	9	8,9	9	9,4	9,9
Technology sectors / Wage earners	36,95%	38,33%	37,73%	36,96%	36,91%	37,96%	37,81%	39,66%
GDP per capita (thousand euros)	n.a.	n.a.	n.a.	35,4	34,9	n.a.	n.a.	n.a.
Income tax per capita (taxable base in euros)	22.012	21.582	21.353	21.216	20.534	20.484	n.a.	n.a.

Domestic sector

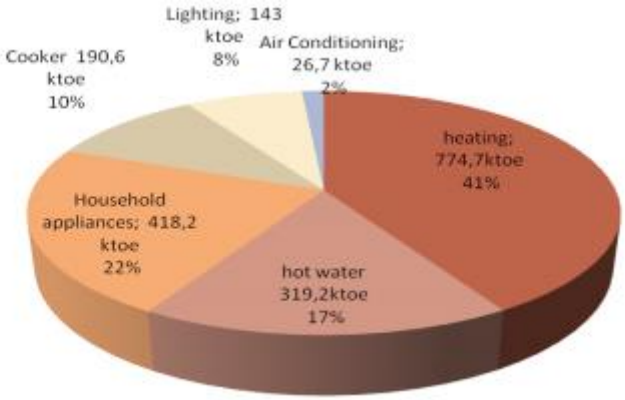
The energy consumption in the domestic sector has been defined from available studies and statistical reports developed at national and regional level.

IDAE (*Instituto para la Diversificación y Ahorro de la Energía*), in the framework of the SECH-SPAHOUSEC project (Development of detailed Statistics on Energy Consumption in Households) led by Eurostat, published a report named 'Analysis of energy consumption in the Spanish residential sector'. This document details the energy consumption demand of different residential sectors, depending on the type of building and the geographical location.

Focusing on the Catalonia region, in the framework of the MARIE project, a detailed benchmarking analysis of residential heat demand has been performed and an annual heating demand ratio (kwh/m^2/year) has been calculated.

The same document includes the breakdown of residential energy consumption by end use in Catalonia:

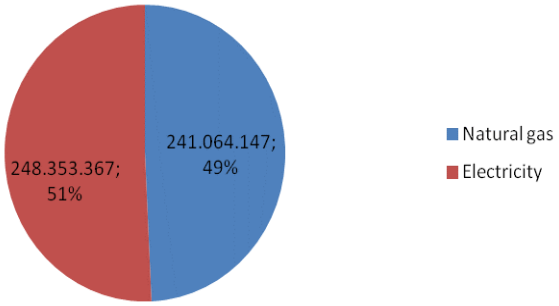
Figure 3: Domestic energy consumption distribution by uses (2007)



Industrial sector

The main energy sources in Granollers are electricity and natural gas. The following figure shows the industrial energy consumption by energy source in 2016:

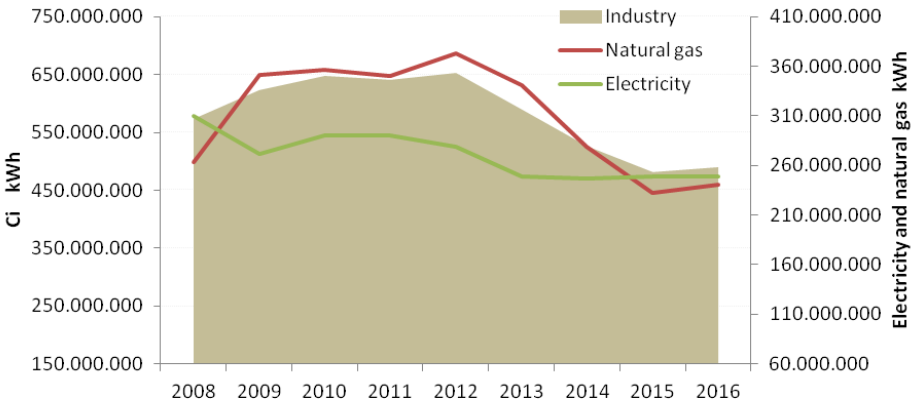
Figure 4: Industrial energy consumption by energy source in 2016



As already mentioned, about 42% of the energy consumption in Granollers (2014) is consumed by the industrial sector, in seven industrial parks with more than 600 different industrial activities. The industrial energy demand is therefore an important issue to work on for the local sustainable development.

With the aim of developing sustainability indicators at the local level and monitoring Local Agenda 21 objectives, the energy consumption of different social sectors has been analysed based on real performance data provided by energy utilities. The following figures show the evolution of the industrial energy consumption in the last 8 years, and the importance of natural gas and electricity as the main energy sources.

Figure 5: Evolution of the energy consumption in the industrial sector (2008-2016)



Because of the nature of industrial activities, it is not possible to define a general industrial heat demand profile: it strongly depends on the sector, and it is necessary to introduce specific profiles for each activity.

The study "Evaluation of suitability of solar thermal systems in the industrial sector", as part of the PER 2011-2020 (Spanish Renewable energy plan), defines a heat demand ratio for each CNAE (national classification of economic activities). However, CNAE's classification categories do not often completely fit real industrial processes, and several industries can fit several categories at the same time.

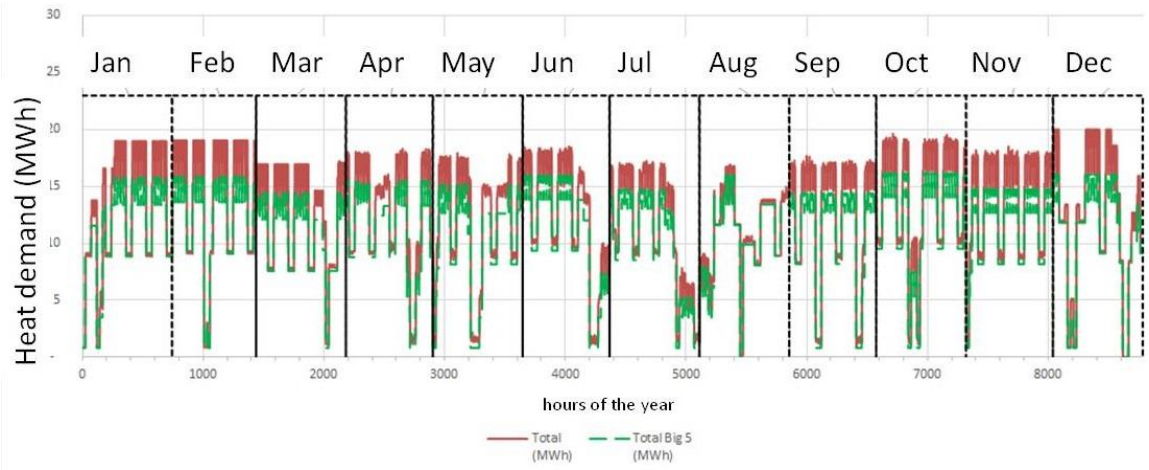
Two main industrial areas have been identified for action: the *Congost* and *Jordi Camp* industrial parks. A range of solutions including solar thermal energy, PV energy, heat exchange between industries, the district heating network, and a cogeneration plant providing steam and hot water is being investigated for both areas.

The calculation of the heat demand of the industrial activities placed in *Congost* and *Jordi Camp* is based on:

- Monitored values: A continuous monitoring of demand has been registered for 9 of the most important industries placed in the selected industrial areas. Only the 12 heat generation systems (steam and hot water boilers) that could be replaced by a heating network have been monitored.
- Surveys and interviews: for some industries, already monitored, additional data has been obtained through specific surveys or interviews.
- Statistical approach: For the rest of activities, the total heat demand has been estimated from the built surface of the industry, the heat demand ratio from IDAE and CNAE's company classification. The yearly value has been then transposed by considering the calendar and the common working time.

The heat demand of the buildings is not being considered because of its reduced size as compared with the heat demand from industrial processes. The following chart reflects the heat demand of the companies with detailed demand profile (monitored or not).

Figure 6: Total heat demand of Congost and Jordi Camp industrial parks



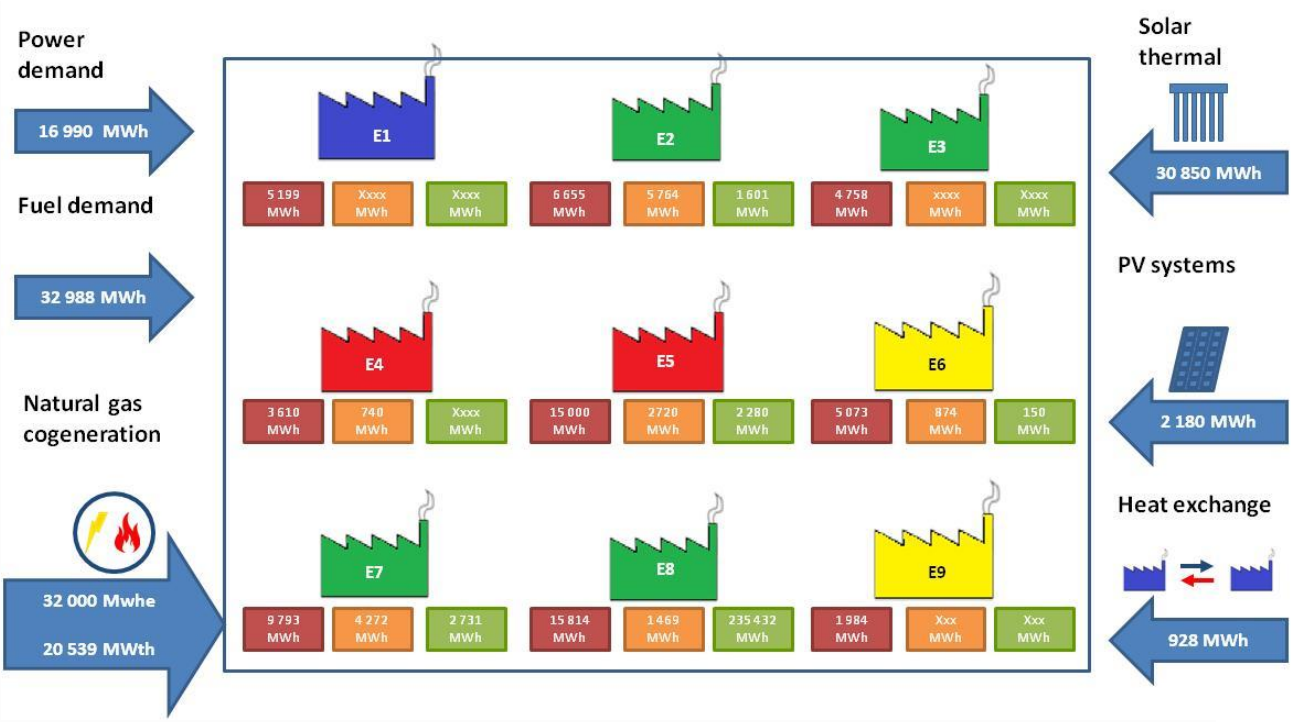
Granollers Mercat started to study the industrial energy demand in 2013 and *IREC* (Energy Research Institute of Catalonia) elaborated the EcoCongost study, which constituted a diagnosis and a definition of alternatives to reduce the energy consumption in the *Congost* and *Jordi Camp* industrial parks.

The EcoCongost project aims to create a singular industrial zone that can improve industries' competitiveness by lowering their energy costs and their environmental impact through the sharing of a high-efficiency cogeneration facility and a district heating network in an area with a concentrated demand for heat. The main objective of the project is to improve the energy use in the industrial area, using renewable sources and surplus heat among different industrial companies and the two biogas production plants available in Granollers (sewage and bio-waste treatment plant).

The study analyses different alternatives in order to reduce the consumption from non-renewable energy sources, as the introduction of solar thermal and PV systems, heat exchange between companies, heat network and centralized energy plant.

The following figure reflects the potential results derived from the installation of all the proposed solutions:

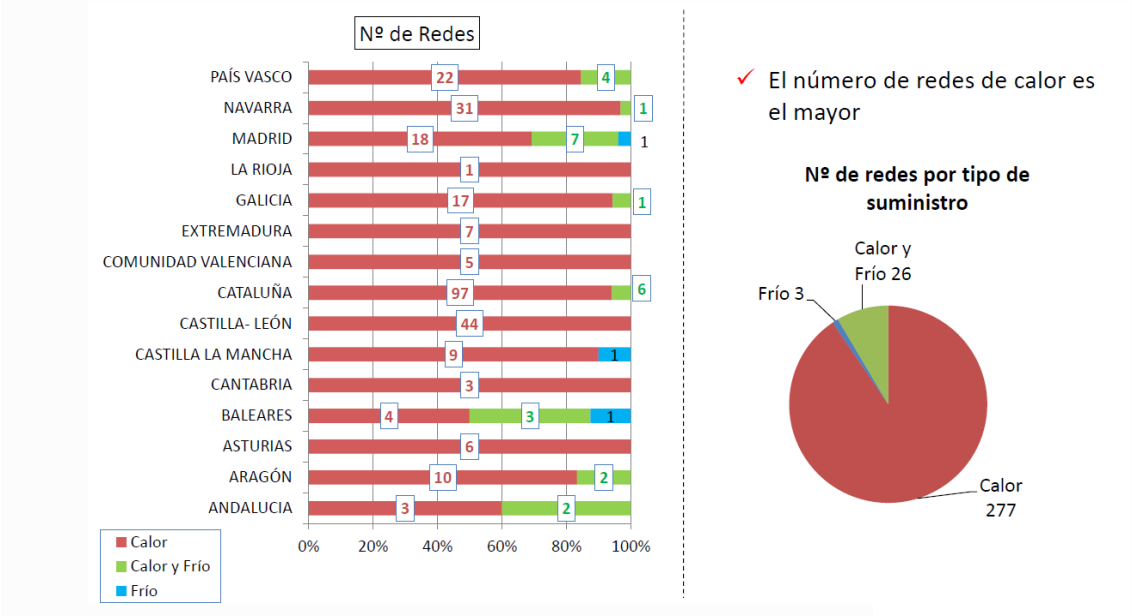
Figure 7: Potential from the installation of the solutions proposed in the EcoCongost project



District heating and cooling

An inventory of district heating and cooling (DHC) networks, compiled by *ADHAC* and *IDEA* in 2016, identifies 306 DHC networks in Spain: 277 provide exclusively heating, 26 of them provide both heating and cooling and 3 networks cover solely cooling needs. Users of DHCs are mostly commercial (69%), although the domestic (23%) and industrial (8%) sectors have presence as well. 28 district heating systems in Spain use only biomass, 14 natural gas, and 2 only electricity. There is still wide room for the development of DHC networks in the way of reaching current figures in northern Europe. Furthermore, at this moment there is not a widespread use of DHC within the industrial sector.

Figure 8: Number and type of existing DHC networks in Spain



Source: ADHAC

Catalonia has three main DHC networks close to Granollers: DISTRICLIMA and ECOENERGIES (DHC) at the north and south of Barcelona, respectively, and TUB Verd in Mataró. But none of those networks has been developed exclusively for the industrial sector. There is another district heating and cooling network nearby, powered by a polygeneration plant and located in the science and technology park of *Cerdanyola del Vallès*, named PARC DE L'ALBA.

ECOENERGIES (DHC) works with hot water (not steam) and *DISTRICLIMA* and *PARC DE L'ALBA* have several economic activities as users, which are mostly from the tertiary sector (services).

As mentioned before, the EcoCongost project is mainly focused on industries and their heat process. It aims to replace the existing heat production systems in industries with a district heating network. Regarding building heating systems used in industrial facilities, a large variety of systems exists. Depending on the type of building (offices and production halls) and the existing heating system, the heating network could be easily connected.

During the last two years Granollers has been working with local industries to analyse the technical, social, legal and economic barriers and the viability of an industrial symbiosis in terms of energy recovery and waste management. From summer 2017 onwards, Granollers and about 20 of the larger local industrial companies will be involved in an energy monitoring campaign. This will enable the city to define the network, the generation plants, and economic figures of the project.

The main objective in the near future is to develop a heating network to cover industrial heat demand in the industrial areas of the city. The network will be heated by biogas (provided by a sewage plant and a wastewater treatment plant), heat recovery from industrial processes and

other renewable energy sources. In a foreseeable long-term future, it will be possible to extend the network to the residential and commercial city centre or other industrial areas.

The biggest challenge is to guarantee the heat distribution in industrial areas by using biogas, heat recovery and other distributed renewable energy systems as the main energy sources. The large number of actors involved in the project increases its sustainability, but also requires a special effort on coordination.

District heating makes it easier to reduce CO_2 emissions thanks to the possibility of implementing local generation using local renewable resources and more energy efficient systems.

At the same time, the case of EcoCongost, focused on the industrial parks, supports the reduction of the energy consumption and/or the energy intensity of the companies located in the industrial areas. This reduction will help increase businesses' competitiveness, which will impact local unemployment and will attract new companies to these industrial areas.

2.2.1.2 Thermal energy supply and demand

Key performance indicator	
Number of generation units and generation capacity	The Register of Electrical Energy Production Facilities under Special Regime is an instrument created for an adequate monitoring of the electricity production in a special regime, both of cogeneration and of renewable energy and waste. Apart from this, there are some available data on renewable generation capacity, which can be found in the table below
Solar thermal energy generation (MWh/ year)	4,300m^2 of solar collectors for low temperature solar heating, 4,000m^2 corresponding to residential buildings and 300m^2 to municipal facilities. 1,056.4 kW of total installed PV capacity in 25 different systems
Heat pump energy generation (MWh/ year)	Available information exists only in two municipal buildings, with a total thermal capacity installed of about 500 kW
Biomass energy generation (MWh/ year)	No local data available
Waste heat potential (MWh/ year)	Not monitored. Two thermal boiler companies have been consulted. The first one has a thermal oil boiler with approximately 300°C flue gas emissions to the atmosphere which consumes 8,000 MWh/year of natural gas. The aim is to recover the waste heat of flue gases until 130°C with an efficient heat exchanger and to obtain 90-95°C hot water.

	The second company has a natural gas-fired thermal oil boiler with 250°C flue gas emissions to the atmosphere. In the scope of the project, this waste heat also will be utilized by flue gas heat exchanger which will decrease the flue gas temperature to 130°C and will supply the hot water network with 90-95°C hot water.
Buildings' energy consumption in the residential sector (MWh/ year)	Not available.
Buildings' energy consumption in the commercial sector (MWh/ year)	Not monitored. Several studies from IDAE define small size commercial business as: 200-600kWh/m^2 Large commercial centres: 300kWh/m^2 The IDAE's document 'Evaluation of solar heating and cooling in Spanish buildings', has defined several ratios of heating, cooling and hot water demand based on building surface and geographic location.
Buildings' energy consumption in the industrial sector (MWh/ year)	All the *Congost* and *Jordi Camp* activities that could be connected to the district heating network consume 145,464.82 MWh/year (in terms of steam or hot water consumption). Thermal energy consumed by direct gas burning or thermal oil boilers is not being considered.

As for generation units, available data is not extensive. A first approach to estimate solar thermal systems installed under the solar ordinance that Granollers approved in 2003 was made in 2010, according to the project presented for the "Urban planning & construction" licenses. However, the review of other systems has not been extensive. The following table summarizes the information available:

Solar thermal systems	4,300m^2 of solar collectors for low temperature solar heating, 4,000m^2 corresponding to residential buildings and 300m^2 to municipal facilities
PV systems	1,056.4 kW of total installed PV capacity in 25 different systems
Geothermal systems	Two municipal buildings with a total thermal capacity installed of about 500 kW
Cogeneration systems	5,936 kW of electrical energy capacity, 1,752 kW of them corresponding to biogas and the majority, 4,184 kW, to natural gas

From 2003 to 2007 there were about 3,000m^2 of solar thermal systems installed in households (dwelling buildings). In 2010 a report reviewing the status of other 62 solar thermal systems (the total area installed then, in residential buildings, was about 4,000m^2), 10 PV installations and one geothermal system (currently, there are two municipal buildings using geothermal systems: *Can Muntanyola*, which installed the system in 2012, and the building of The Centre for Peace, *Can Jonch* 2008) was conducted.

There are 25 PV solar systems with a total electricity generation capacity of 1,056.14 kW. There are two cogeneration plants that use biogas coming from the municipal anaerobic digestion bio-waste plant and the wastewater treatment plan as fuel. The generation capacity registered for both plants is 1,752 kW (1,252 kW and 500 kW, respectively). Furthermore, there are three additional cogeneration plants producing energy from natural gas with a generation capacity of 4,184 kW.

2.2.2 Key Heating and Cooling policy and legislation

There are few key pieces of legislation regarding the thermal energy system in Granollers. This situation relates to the unstable energy policy in Spain, which has led to regulatory risk in recent times. However, despite the lack of specific normative for DHC and of consideration of DHC in urban planning, some background exists in Catalonia: several experiences (103 DHC networks; some of them with renewables) have been already developed and are in operation. The main policies and references to DHC in current legislation are listed below:

- Assessment of national heating and cooling potentials referred to in Article 14 of Directive 2012/27/EC: Promotion of efficiency in heating and cooling
- DHC is mentioned as an efficient technology in building regulations
- Safety of water distribution installations in progress, to be regulated in the coming months
- Solar ordinance (municipal legal regulation approved in 2003) to regulate the incorporation of systems to capture and use solar energy at low temperature for the production of hot water (low temperature) in the buildings of Granollers.
- A modification of the Urban Law is currently in progress. In Barcelona, urban planning laws (*Pla director urbanístic de les àrees residencials estratègiques de l'àmbit del Barcelonès*) are being reviewed to take into account DHC networks.
- On electric distribution: there is a new law in progress which intends to modify some articles of the current Law 24/2013 on the electricity sector in Spain. One of those proposed modifications relates to the recognition of a new network model such as micro-grids, managed by an 'electric aggregator'
- Granollers is one of the signatory cities of the Covenant of Mayors, and has developed a Sustainable Energy Action Plan setting objectives to be reached by 2020
- The Granollers City Council is currently assigned to the Framework Agreement of the Government Plan for the supply of electricity, which will force bidders to

guarantee that a minimum of 30% of the electricity supplied comes from renewable sources or high efficiency cogeneration sources

- The new 'Clean Energy for all Europeans' presented by the European Commission in 2016 included a revised renewable energy Directive that puts more focus on renewable heating and cooling and district heating and cooling networks

2.2.3 Heating and Cooling within urban development and renovation programmes

2.2.3.1 Heating and Cooling Objectives

Sustainable energy policies in the city of Granollers have evolved to form a clear commitment in the last ten years. In 2008, the city was one of the 200 Covenant of Mayors signatory cities in Europe, and approved its SEAP (Sustainable Energy Action Plan) one year later, in 2009, setting the plan to achieve the 20-20-20 European objectives in 2020. Furthermore, Granollers has taken part in several European projects such as Green Partnerships, which aims to support local administrations to overcome existing obstacles and effectively implement a set of measures on the way to energy efficient cities and regions.

The main strategic energy targets in Granollers, to reduce CO_2 emissions, are established in the Sustainable Energy Action Plan (SEAP): the objective to be achieved by 2020 through increased energy efficiency and the development of renewable energy sources is to reduce GHG emissions (tCO_2) by 20%. Furthermore, the mitigation and adaptation strategy integrated into relevant existing plans foresees a 40% reduction in the emission of greenhouse gases by 2030.

The city signed up the Mayors adaptation strategy in 2014 and approved a comprehensive local mitigation and adaptation strategy integrated into relevant existing plans in December 2016. The adaptation strategy pursues the city resilience to the inevitable impacts on climate change in the coming years.

In addition, as mentioned before, Granollers started working in 2015 on an ambitious and innovative project with a few references in Spain, the EcoCongost. The EcoCongost project aims to create a singular industrial zone that can improve industries' competitiveness by lowering their energy costs and their environmental impact through the sharing of a high-efficiency cogeneration facility and a district heating network in a concentrated area of heat demand. The main objective of the project is to improve the energy use in the industrial area, using renewable sources and surplus heat among different industrial companies and the two biogas production plants available in Granollers (sewage and bio-waste treatment plant). EcoCongost will help Granollers advance into the low carbon and resource efficient city that local energy policies aim to reach. The industry sector, mostly located along the river in two main industrial areas (the *Congost* and *Jordi Camp* parks), consumes more than 40% of the energy in the city (in 2012 the industrial consumption reached 47% and in 2014 went down to 42%).

The industrial sector will also play a key role in the energy transition towards lower carbon systems which lead to local reductions in the emission of greenhouse gases. Less energy wastage and lower fossil fuel imports will strengthen local economy. The main targets in the industrial sector are:

- to design and build a thermal energy network, planning it from a long-term point of view and to periodically expand the network according to energy and cost efficiency, present demand and feasible present energy recovery or production and future scenarios (reaching the urban city centre)
- to provide steam and hot water distribution in the industrial area, where a high energy demand exists
- to lower energy costs for economic activities
- to use local energy sources such as biogas from the composting and the waste water treatment plants located in the city, industrial waste heat and solar and/or biomass energy production systems
- to provide local users with stability in their energy bill prices for long-term budget planning
- to reduce the use of fossil energy consumption and GHG emissions from Granollers industries
- to reduce energy dependency at a local level
- to design and build storage for heat recovering
- to open new energy paths for the economic and sustainable energy development of the city, in order to attract new businesses to be settled and avoid industrial relocation in local industrial parks through the sharing of high-efficiency cogeneration and district heating fuelled by renewable local sources in an area of concentrated demand for heat
- to build a brand of Granollers with regards to industrial areas and sustainability and to generate a symbiotic environment to use local resources

Finally, Granollers has different strategic energy targets to reduce CO_2 emissions at European level.

European policies

EcoCongost has incorporated the heating and cooling European policies. The EU policies and measures to achieve the Energy 2020 goals and the Energy 2020 strategy are ambitious and will continue to deliver beyond 2020, helping to reduce emissions by about 40% by 2050.

Renewable objectives

The current 2020 framework sets a EU 20% target for renewable energy consumption which relies on legally binding national targets until 2020. In October 2014, the European Council

agreed the 2030 framework, which sets out a new target of at least 27% for the share of renewable energy consumed in the EU in 2030.

Energy efficiency

The European Union legal framework was constructed around an energy efficiency target of 20% for 2020, which will be reset with a 30% target in mind.

In the roadmap for moving to a competitive low carbon economy 2050 (COM/2011/0112 final) the Commission analysed the implications of EU's commitment to reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050 in the context of necessary reductions by developed countries. The built environment provides low-cost and short-term opportunities to reduce emissions, first and foremost through improvement of the energy performance of buildings. As in the transport sector, shifting energy consumption towards low carbon electricity (including heat pumps and storage heaters) and renewable energy (e.g. solar heating, biogas, biomass), also provided through district heating systems, would help to protect consumers against rising fossil fuel prices and bring significant health benefits.

The Roadmap to Resource Efficient Europe 2050 (COM/2011/0571 final) presents the dual challenge of stimulating the growth needed to provide jobs and well-being to its citizens, and of ensuring that the quality of this growth leads to a sustainable future. To tackle these challenges and turn them into opportunities our economy will require a fundamental transformation within a generation – in energy, industry, agriculture, fisheries and transport systems, and in producer and consumer behaviour.

In the Roadmap for Energy 2050 (COM/2011/0885 final) the Commission explores the challenges posed by delivering the EU's decarbonisation objective while at the same time ensuring security of energy supply and competitiveness. Among the ten structural changes for energy system transformation, there are four directly related to heating and cooling within urban development and renovation programmes:

- Higher capital expenditure and lower fuel costs
- Energy savings throughout the system are crucial
- Renewables rise substantially
- Decentralisation and centralised systems increasingly interact

2.2.3.2 Energy Efficiency Opportunities

There are some existing strategies and plans that provide an adequate framework for the uptake of some of the identified energy efficiency opportunities:

- Improvement of industries' competitiveness by lowering their energy costs and their environmental impact through sharing a high-efficiency cogeneration and a district heating network in a concentrated demand area for heat
- Having two waste treatment facilities in Granollers: the sewage and waste treatment plants, both producers of renewable energy, biogas
- Existing strategies to promote renewable energy sources, like the Catalonian Strategy for the biomass technology
- Action Plan for Energy Efficiency in Industry in Catalonia, working with a specific group of polygons to determine the level of industrial performances that favour energy efficiency
- The installation of a heat network will enable the city to recover industrial waste heat useful for all the industrial park, and not only to neighbour factories as in the direct exchange cases
- The heat network will enable the implementation of political measures to promote energy efficiency in the production processes, considering special tariffs, the temperature exchange, the timing of energy demand, etc

2.2.3.3 Renewable Energy Adoption and Potential

As outlined in previous sections, Granollers has developed some renewable generation facilities over the last few years and has the potential to further extend renewable energy adoption:

Part of the biogas produced in the waste water treatment plant and in the composting plant of domestic organic waste is currently used to produce electricity and heat with cogeneration. There is biogas and heat surplus. The composting plant is also considering the use of industrial organic waste in order to increase the biogas production. This project will materialize circularity concepts given that an industry will provide organic waste to the composting plant and will receive steam through the heat network. The biogas will cover 40% of the industrial heat demand.

As the biogas identified is not enough to cover the expected demand, available biomass from the nearest forestry zones has been identified. The first calculations defined an annual biomass demand of around 25,000Tn/year. The forest owners' associations (*Associació de Propietaris del Montnegre i el Corredor*) are currently defining the maximum yearly extraction potential at 9,000Tn/year. CREAF (Ecology and forestry application research centre) developed studies aimed at defining the biomass potential of different forestry zones around Catalunya.

There are several public buildings which use solar systems to produce hot water (about 300m^2 of solar panels) and two buildings with geothermal heat pumps (one, *Can Jonch*, with a thermal capacity of 206 kW and with a 36,585 kWh annual production, and the other one, *Can Muntanyola* with a higher thermal capacity 224 kW and an estimated annual production of 40.000 kWh).

A study to evaluate the potential of solar energy production in industrial buildings, and the urbanized and non-urbanized areas is currently being conducted by the *Institut Cartogràfic i Geològic de Catalunya (ICGC)*. Their duties are related to the fields of geodesy and cartography, to the spatial data infrastructure of Catalonia and to the activities of promoting and carrying out the actions related to the awareness, survey and information about the soil and subsoil, as regulated by Law 16/2005, of December 27th, on geographic information and the *Institut Cartogràfic de Catalunya*, and by Law 19/2005, of December 27th, on the *Institut Geològic de Catalunya*. The study aims to help the industries placed in Granollers' industrial area install solar thermal systems and inject the waste heat produced into the heat network.

There are two DHC networks currently in project progress in Granollers municipal public buildings. The first network, located in the north of the city, will supply thermal energy to five public facilities: *CEIP Salvador Espriu, EMT, EM Salvador Llobet Cultural Centre and IES Antoni Cumella*. Estimated emissions savings amount to 86.59 CO_2 tons (considering the energy consumption of the future network coverage and 86% of the current natural gas consumption). The network is currently under drafting specifications and executive project for tender by Barcelona Provincial Council (*Diputació de Barcelona*). The second network will be located in the south of the city and will supply thermal energy to seven public facilities: *Roca Umbert (Printing, La Troca, CTUG i Bar) Espai Cangur, CEIP Ferrer i Guardia, CEIP Joan Solans, Pistes Municipals d'atletisme, Pavelló Municipal d'Esports (El Parquet), Pavelló Municipal El Tub*. Emissions savings are estimated at 130.17 tons CO_2 equivalent / year, considering the energy consumption of the future network coverage and 86% of natural gas consumption in 2014. The Barcelona Provincial Council is currently looking for support for drafting the executive project.

2.2.3.4 Transport and infrastructure

The layout of Granollers, which encourages its inhabitants to travel by foot, still leads to significant GHG emissions every day. The rate of motorization in Granollers stands at 637 vehicles/ 1,000 inhabitants, below the regional (698) and Catalan (661) average. In 2014 there were 28,103 registered cars, 1.5% less than in 2006, continuing with the declining trend experienced since 2007.

	%	**Total trips per day**	%	Internal mobility	%	External mobility
Bike +walking	52%	130,784	80%	112,993	16%	17,791
Public transport	12%	29,783	2%	3,099	24%	26,684
Private vehicle	36%	91,107	18%	24,936	60%	66,171
Total trips per day		**251,674**		**141,028**		**110,646**

The sum of residential and visitor mobility made a total of 251,674 daily trips in 2014, which represents an increase of 12% from 2006.

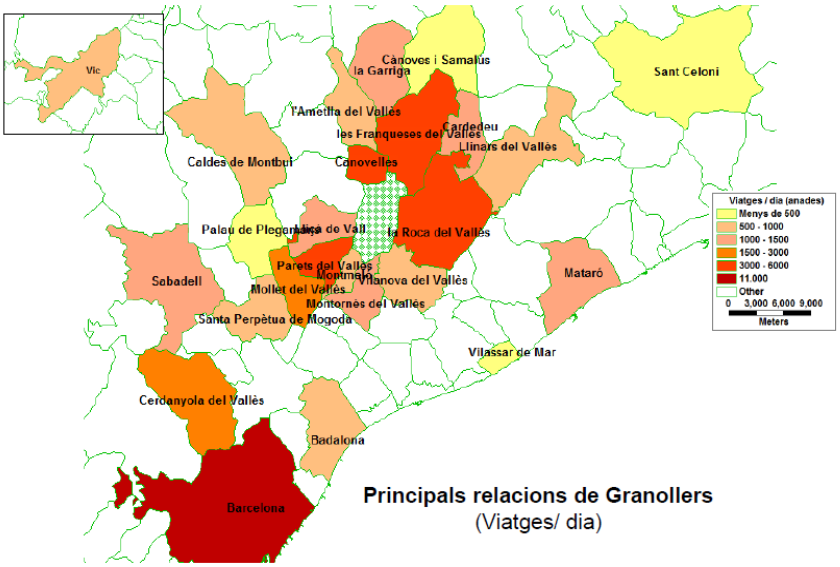
According to the data from the new Granollers Urban Mobility Plan, around 80% of internal travel within the city of Granollers is carried out on foot or bike, 18% in private vehicles and 2% in public transport.

The size of the urban hub of the compact city (3.5 km long by 1 km wide) means that a person without mobility difficulties may do most travel by walking. In fact, this is the most common mode of transport used inside the urban centre of Granollers.

Granollers is highly suitable for the use of bicycles as most of its urban centre is flat and the climate is good. But there is still very little use of them since there is a need to acquire more security both in terms of the itineraries and parking. For this reason, steps are being progressively taken to make the city more bicycle friendly: extension of pedestrian areas; creation of pacified transit 30 kph zones, signposting with safer itineraries, and, in the short-term, safe parking for bicycles, in closed spaces, inside one of the mobility generator centres.

There are 9 bus lines and a bus central station where different companies operate intercity ("*Bus Granollers SL*", "*SA Sagalés*", "*Coaches Barba SL*", "*Sarfa SA*", "*Barcelona Bus SL*"). Furthermore, since 2015 an express bus to Sabadell, Mataró and Barcelona is in place. The presence of major roads such as the AP-7 and C-17 give a daily traffic through the municipality of around 150,000 vehicles, representing a prominent focus of GHG emissions and noise. The AP7 has six lanes and 80,889 vehicles circulate per day (2015), while the C-17 has four lanes and 61,883 vehicles per day (2014). There is a new high capacity infrastructure planned to be used as *Ronda Vallès* is expanding the capacity of road C35. However, the supply of public transport is significant, with three railway stations having suburban and regional services.

Figure 9: Main communications with Granollers



The journeys in private vehicles have decreased by 4.2% for total trips and 31% for domestic travel as compared to 2006.

The last years have seen an increase in the use of public transport for external mobility by the Renfe train and intercity buses, but domestic demand, for internal trips in the city, has decreased from 2006.

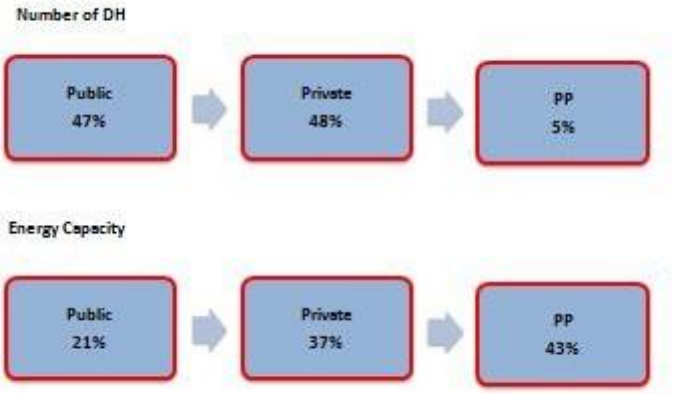
The main mobility flow occurs between Granollers and Barcelona (dark red in the above map) with more than 11,000 one way daily trips. All communications with more than 3,000 trips (bright red in the above figure) are connected by railway with Granollers, except for *Canovelles* (the downtown urban areas of these two cities are continuous, as if they were a unique municipality) and *La Roca del Vallès* (city which has one of its neighbourhoods attached to Granollers, *La Torreta*).

The current mobility plan of the city was approved in 2009 and currently a new Urban Mobility Plan has been elaborated and is planned to be approved by June 2017. It is expected that air pollution episodes can be recurrent and more intense in the future due to climate change. Granollers' concentration of nitrogen oxides and particulate matter in the air will exceed the values set by current legislation. Today, 52% of the population works outside the town of Granollers and 60% of Granollers jobs are occupied by people from outside the municipality.

2.2.4 Financing Opportunities and Instruments

Big heating and cooling networks in Spain are mostly private-public co-financed. This financing mechanisms has been the one used in networks that represent 43% of the energy capacity installed in DHC networks in the country.

Figure 10: Existing DHC networks in Spain by financing mechanism



At local level, municipalities have so far waited for grants that could help co-finance the required investment to build the network. The department of Economic Promotion of the *Diputació* of Barcelona, a public regional authority, has promoted financing schemes for the DH network in Granollers through granting the study of the industrial demand that could be included in the district heating planning. The local authority of Granollers has estimated a maximum yearly amount of 200,000 EUR to be provided once the project is approved (public investment with support of European Funds).

The European Structural and Investment Funds (ERDF, Cohesion Funds) and European funding programs (LIFE, UIA) offer opportunities for local climate and energy actions, such as the development of an efficient district heating network like the industrial one that Granollers aims to build.

District heating networks for municipal buildings are much easier to develop and therefore multiple cases in the country can be identified. For industrial systems, however, the examples are not widely spread. Depending on the Operational Programme of the ESI Funds, there are the Financial Instruments (FIs) to transform EU resources into financial products such as loans, guarantees, equity and other risk-bearing mechanisms. The main objective is to leave the current grant-dependency to allow projects to find a more sustainable and innovative financing mechanism. The national body, the Managing Authority (MA), uses ESIF allocations and place them in FIs through a Fund of Funds or a financial intermediary from which eligible projects can be financed.

Another European Project Development Assistance Facilities (ELENA EIB, ELENA KfW, JASPERS) are also addressed to local authorities will be explored in Granollers for the industrial district heating and cooling network planned.

Other financial instruments to be considered to attract private and public capital into climate financing are the European Fund for Strategic Investments (EFSI), the EIB Municipal Framework Loans, the DEEP GREEN initiative (Debt for Energy Efficiency Projects), Private Finance for Energy Efficiency (PF4EE) instruments or the European Energy Efficiency Fund (EEF).

In Spain, several economic public funds support the renovation and retrofitting of existing buildings (residential and hotel use), including DHC networks, and promote the installation of biomass, geothermal and solar thermal energy systems.

Although there are alternative finance schemes in other countries such as Green Municipal Bonds, Cooperatives, crowd funding, revolving loan funds and/or soft loans, all those finance schemes have not been used in Spain as far as we know. The Energy Performance Contracting (EPC) is one of the few contractual arrangements between an Energy Service Company (ESCO) and a beneficiary about energy efficiency improvements or renewable installations, that has been used as alternative finance scheme.

The European project ENERINVEST aims to develop a web-based platform to provide financing alternatives to different kind of energy projects. The project will provide a tool that will help define what is the best financing method for a specific project.

2.3 Stakeholder identification and engagement

2.3.1 Local Stakeholders

2.3.1.1 Ajuntament de Granollers

Granollers, with a total population of 60,174 inhabitants (2016), is the capital of the '*Comarca del Vallès Oriental*' region and is located 20 km to the north from Barcelona. Granollers, and their neighbour cities, has an important industrial activity thanks to the good location and the good communication and transport alternatives. In that sense, Granollers is the second city of Catalonia in terms of active population working on industrial sector and the fourth of Spain.

Link: http://www.granollers.cat/

2.3.1.2 Institut Català d'Energia

The Catalan Energy Institute is the public regional body responsible for developing the Catalan energy policy and to work for the implementation of those policies. The institute is specially focused on energy efficiency and the development of renewable energy sources.

The institute has two main areas:

Energy management, which is mainly focused on ongoing projects and the application of actual policies, and energy plan, aimed at the development of plans and policies, among others.

2.3.1.3 Oficina Tècnica de Canvi Climàtic i Sostenibilitat - Diputació de Barcelona

The Climate change and sustainability office of the Barcelona province Government (Diputació de Barcelona) offers technical and economic support to local authorities in order to apply sustainability policies and to promote actions in terms of climate change adaptation.

The department is mainly focused on energy management, the accomplishment of the targets on energy and climate set in the Covenant of Mayors, municipal waste management, water management, design and management support of municipal green areas and climate change adaptation.

Link: http://www.diba.cat/en/web/mediambient/canviclimisost

2.3.1.4 Àrea de Territori i Sostenibilitat - Directorate General for Environmental Policy

The Territory and Sustainability department of the Catalan government includes several working areas relating to environmental issues and climate change within the geographic area of Catalonia.

The functions of the department are urbanism policies and planning, soil policies, building and building planning and quality control, building renovation in neighbourhoods and historical city centres, public infrastructures, roads, railroads, ports and airports, transports, environmental quality policies and climate change, water, waste, and the law development.

Link: http://territori.gencat.cat/es/inici/

2.3.1.5 Consorci per a la gestió de residus del Vallès Oriental

The Consortium for Waste Management of the '*Vallès Oriental*' region is composed of the County Council and 39 municipalities in the region. The work of the consortium is mainly aimed at creating, managing and delivering unified services and activities of common interest regarding waste in the region.

The consortium has a basic infrastructure such as a waste dumps regional network, a transfer plant, another plant for anaerobic digestion and composting municipal policies supporting selective collection. The plant is generating organic compost and biogas. This biogas is mainly used in cogeneration motors providing power and thermal energy for heating digesters.

Link: http://www.cresidusvo.info/conres/portada/index.php

2.3.1.6 Institut Català del Sòl

The Catalan Land Management Institute (*Institut Català del Sòl*) is the land management entity of the Catalan Government. The institute has competences in terms of town planning and management of public land or housing.

One of the working areas of the institute is the promotion of new residential or industrial land areas, and social housing promotion. In addition, the institute has been focusing on the renewal and regeneration of urban areas recently.

Link: http://incasol.gencat.cat/ca/

2.3.1.7 Granollers Mercat

Granollers Mercat is the economic promotion department of the Granollers municipality. The activities of the department are mainly focused on supporting local commerce and economic activities located in Granollers and promoting job creation in the city.

One of the areas *Granollers Mercat* is working towards is industrial parks, in terms of their management and specific projects related with innovation, energy efficiency or industrial symbiosis.

Link: http://www.canmuntanyola.cat/

2.3.1.8 ICGC

The Cartographic and Geologic Catalan Institute (*Institut Cartogràfic i Geològic de Catalunya*) is a public body of the Catalan Government, with competences of geodesy, cartography and the spatial data infrastructure of Catalonia, and also the competences of promoting and carrying out the actions related to the awareness, survey and information about the soil and subsoil.

Link: http://www.icgc.cat/en/

2.3.1.9 Estabanell Energia

Estabanell Energia is a local power utility located in Granollers that operates in all the stages of the power sector: generation, distributions and commercialization.

Estabanell Energia manages several micro-hydropower plants located on Ter riverside, from *Osona* and *Ripolles* counties. In these areas, the company also owns and manages the power distribution network.

Finally, the commercial activity of the company is based on selling green energy to the residential, commercial and industrial sectors.

Link: https://www.estabanell.cat/

2.3.2 National stakeholders

2.3.2.1 ADHAC

ADHAC (*Asociación de Empresas de Redes de Calor y Frío)* is the Spanish district heating and cooling association.

ADHAC aims to promote the installation of heating and cooling networks in Spain and to act as a representative of those agents interested in the development of the market. ADHAC carries out studies on the status of DHC in Spain, as the one referred to in previous sections.

Link: http://www.adhac.es/

2.3.2.2 IDAE

IDAE (Institute for the Diversification and Saving of Energy) was established in 1984 as a state-owned business entity that reports to the Ministry of Industry, Energy and Tourism through the State Secretary for Energy. IDAE is the responsible authority within the Ministry for the Renewable Energy Plans (the present one 2011-2020) and for the Energy Saving and Efficiency

Strategy 2011-2020, and is in charge of developing and submitting to the Secretariat General for Energy of the Ministry of Industry, Energy and Tourism the follow-up reports and revisions, and proposals of all the necessary actions and applicable technical solutions during the Plan's temporary limit to achieve its targets.

Link: http://www.idae.es/

2.3.3 Existing stakeholder participation processes

This year the local authority stand at the local commercial fair, *Fira de l'Ascensió 2017*, analysed circular economy and industrial symbiosis in the framework of a new project, '*Granollers enters into symbiosis*', that aims to transform industrial areas and to start projects on industrial symbiosis to reduce the use of materials, waste, water and energy.

Wall panels with information on industrial waste origins, quantities, types and current management, and some information on symbiosis in terms of equipments and the EcoCongost energy project were designed.

The local commercial fair was held last May and provided information on THERMOS and its progress, as shown in the images of the stand below. THERMOS could benefit from these local and regional fairs in order to increase the uptake and replication of the tool.

2.3.4 THERMOS Local Liaison Group

The key stakeholders for the replication of the THERMOS model in Granollers comprise actors from the agencies and companies already listed and are included in the Local Liaison Group of Granollers, which is composed of:

1. Environmental councillor - *Ajuntament de Granollers*

2. Head of the economic municipal service - *Ajuntament de Granollers*
3. Head of municipal services and mobility - *Ajuntament de Granollers*
4. Head of the environmental control and licenses of economic activities - *Ajuntament de Granollers*
5. Technological Services Director - *Ajuntament de Granollers*
6. Head of the Territory and municipal Services - *Ajuntament de Granollers*
7. Head of the Catalan energy planning - *Institut Català d'Energia*
8. Head of the support section to the local energetic management. Climate Change and sustainability office - *Diputació de Barcelona.*
9. General manager - *Consorci per a la gestió de residus del Vallès Oriental*
10. GIS representative - *Institut Català del sòl*
11. Projects coordinator - *Institut Català del sòl*
12. General manager - *Granollers Mercat*
13. Head of the unit of local projects - *ICGC*
14. CEO - *Estabanell Energia*

2.3.4.1 Stakeholder roles towards THERMOS model replication

The key stakeholders listed above will hold several roles towards the replication of the THERMOS tool. The following list, which follows the numeration of the previous section, provide an overview of the function that they can hold in supporting the THERMOS model:

1. Political commitment
2. Financial information a feasibility
3. Feasibility and costs estimates
4. Local industrial knowledge
5. Municipal GIS development and data improvement
6. Urban planning knowledge
7. Regional energy planning
8. Replication aspects and dissemination to the rest of cities in the Barcelona province
9. Energy availability from biogas in the short and long-term
10. Integration of the tool regional planning maps
11. Implementation of the tool for regional urban planning development
12. Communication and collaboration with local industries
13. GIS expertise
14. Energy distribution expertise

2.3.5 Stakeholder Engagement strategies

The Local Liaison Group will help gather the required information for the building of the tool and will be used to raise awareness across Spain and facilitate the replication and exploitation of the tool within the country. The specific strategies for engagement will be defined through

the development of the project and will also build on the existing stakeholder participation processes such as the fairs already described.

2.4 Towards THERMOS Uptake

2.4.1 Barriers

The are some existing barriers within the local framework of the energy system that may prevent the uptake of the THERMOS tool.

From a broad perspective, the unstable energy policy in Spain has led to regulatory risks that prevent key market players from taking action in the installation of DHC networks. The lack of specific normative for DHC and of specific consideration of DHC in the urban planning legislation has also been hindering the market deployment. A need to develop local, regional and national legislation supporting thermal optimization can be identified. At a local level, there is a need to develop tax instruments that support DHC networks and the installation of renewable heating and cooling systems as well. The local authority is also facing a dichotomy between the number of users committed to use the network and the imposition of a mandatory use, which would alter users' free choice. In this sense, the lack of price stability is making networks less attractive for consumers and industries.

In addition, there are some local problems that may prevent the uptake of the THERMOS tool by the City Council:

Problems of enough underground space due to existing pipes, which can be categorized in four levels:
-Level 1: immovable pipes, sewer >=600 mm of diameter, high-pressure gas pipeline and pipeline of high voltage electricity.
-Level 2: tubes to be moved with difficulty, water and sewage from 300 to 600 mm in diameter.
-Level 3: medium pressure gas pipe and medium voltage electricity.
-Level 4: other tubes such as electricity, fibre optics.

There is a need to model and estimate costs of:
-Detecting key crossings of networks and different solutions to cross them
-Classification Sections and type of each section.
-Replacement of flooring, according to the service database ITEC (Information Technology Institute).
-New vegetation.
-Assigning streets coefficients depending on the difficulty of pavement replacement costs of existing networks and the width of the streets.

Problems in the management of information include:

-Difficulty in receiving updates of existing infrastructure by suppliers. There is an annual information delivery by suppliers.
-Data sources are usually different, with diverse formats and contents, and required distinct load procedures.

Confidentiality of data

Service companies expressly stress that the data they can provide have internal consultation purposes and should not be published under any circumstances because it is confidential information. There is a need to design a tool that complies with security procedures, with two types of visualization: one for advanced users with restricting privileges consultation and the other open and public.

Different timing and precision of the data

Granollers Mercat has estimated the average daily demand per square meter of the local businesses (with ratios kwh/m^2) with the Statistical classification of economic activities in Spain. Furthermore, the hourly consumption of the high demand industrial factories has been registered.

Little graphic precision of network services

The information provided by companies may contain a significant margin of error. One of the main difficulties found has been the calculation of the free land available (space of the streets) to pass the new network (pipes diameters) depending on existing infrastructure. It has been found difficult to measure the free space of separation between one service and another and the specific location and depth of the network.

Availability of information on energy supply: information at regional level has been recently updated but with a low degree of accuracy.

-Potential geothermal project will be assessed in 2018
-Potential biomass will not be included in ICGC's analysis given the lack of forested areas in the municipality. Granollers is currently searching for information from the association of forest owners of *Montnegre Corredor*, with CREAF and with biomass cluster. Data on availability and potential use of biomass, average prices of biomass in different formats, and the average cost for each of the process (transport, dry, etc.) will be collected from them.
-Potential wind information is not available locally.
-Biogas: information available by the Consortium of waste and the '*Besós Consortium*'

A consortium of waste management companies will provide information on the yearly production of biogas in terms of m^3/hour. Values are being monitored so that variations between summer and winter time can be easily identified.

2.4.2 Proposed solutions

The local administration could consider municipal legal regulations for those new companies that are interested in joining the industrial parks, making it mandatory to install a thermal system from renewable energy sources or to be connected to the district heating. That would partially tackle the lack of specific regulation on DHC.

To face the difficulty in the management of data, the THERMOS tool should admit different sources of data and different load estimation procedures based on this information. Since the timing of data is also important for industry - an hourly base should be ideally considered - the definition of the tool must combine general consumption estimates and real data measurements that account for very specific demand profiles.

Confidentiality issues should be addressed by signing an agreement with the collaborating parties, mainly industrial consumers and service suppliers.

As for the little graphic precision of network services, a gradation of difficulty depending on the availability of space (the four levels previously described) and the costs associated with the type of pavement and the type of street or way (e.g. width, pavement) is proposed.

Finally, the lack of availability of information will be tackled through the stakeholders engaged for the Local Liaison Group. In addition, there are long time series of data for municipal buildings with monthly (and even hourly) information on energy consumption. This year the Granollers City Council is working with the platform Sentilo which has the first readings of sensors associated with the consumption of water, electricity and gas and solar thermal installations. Open data related to municipal buildings water and energy consumption is also available.

The last report to monitor Granollers' SEAP (Sustainable Energy Action Plan) shows a change in the consumption of natural gas (use for heating and hot water, therefore used for thermal demand). The report estimated a consumption of 3,471,149 kWh in 2005, which decreased to 2,841,573 kWh in 2015 considering only the existing municipal buildings in the reference year. That indicates a decrease of 18% in heat demand in municipal buildings.

2.4.3 THERMOS exploitation opportunities

The opportunity is to identify optimal thermal systems to be developed in the industrial area taking into account available and estimated data, helping local decision-makers invest in the most efficient systems and plan the optimal (from both an economic and an environmental perspective) phases to develop the network over the years.

In the future, the tool could be used not only in the industrial area but for the rest of the energy city planning, enabling the local authority to analyse alternatives in a more efficient way than today.

2.5 THERMOS Case Study

2.5.1 Objectives

The EcoCongost project aims to implement a heat network in the *Congost* and *Jordi Camp* industrial areas in Granollers. Granollers aims to combine the results from this project with THERMOS and focus the use of the tool in these industrial parks. Different objectives can be identified:

Environmental objectives:

- Reduction of GHG emissions and air pollutants in Granollers municipality
- Promotion of renewable energy generation
- Reduction of the fossil energy consumption and increase in energy efficiency
- Local energy transition
- Contribution to the building of a sustainable city brand

Economic promotion objectives

- Increase the capacity to attract new companies in Granollers industrial areas
- Increase the economic and environmental competitiveness of the companies placed in the industrial areas
- Increase the retention of the companies placed in the industrial area
- Create a collaborative (symbiotic) environment in the use of energy resources
- Promote concepts and benefits of industrial symbiosis and maximize the use of local resources

Social objectives

- Job security within companies already located within the industrial area
- Increase the occupation thanks to the moving in of new companies and to the improvement of the competitiveness of the original ones.
- Direct job creation in the implementation, management and maintenance of the infrastructures related with the project.
- Awareness and training in industrial symbiosis

In order to define the scenarios to be considered in the definition of the DHC network, the following elements have been considered:

- Expected scenario: only the industries monitored will be connected to the DHC network.
- Positive scenario: all the industries monitored and the other biggest companies located in the industrial park (>1M€ in sales) are connected to the DHC network.
- Negative scenario: only the industries monitored are connected to the DHC network, but some of them decrease their production due to financial problems and leave the network.

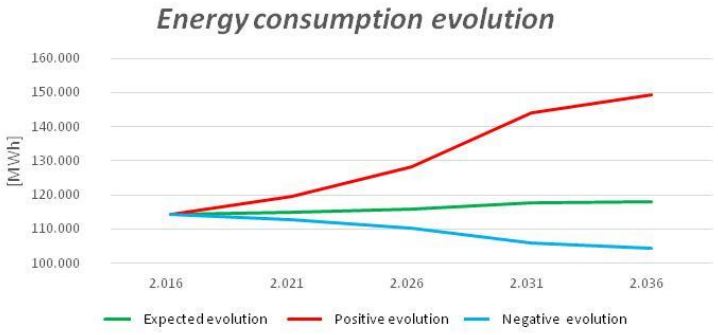
The following tables detail the total heat demand:

Totals (MWh- kW)	114,638.00	36,483.00
Average	17.71	35.41
AvePond	16.89	33.78

Big 5 (MWh- kW)	99,860.00	26,932.00
Average	15.15	30.29
Percentatge	87%	74%
AvePond	14.35	28.71

Finally, the following chart represents the evolution of each of the scenarios defined:

Energy consumption evolution	2016	2021	2026	2031	2036	
Years	0.00	5	10	15	20	
Production increase	0%	15%	40%	85%	100%	
Expected evolution	114,274	114,860	115,835	117,592	118,177	*Mwh*
Positive evolution	114,274	119,538	128,312	144,104	149,368	*Mwh*
Negative evolution	114,274	112,795	110,330	105,893	104,414	*Mwh*



2.5.2 Key stakeholders

- The project is led by the environmental and economic promotion departments of Granollers municipality, and a coordination group with other departments of the municipality holding regular meetings has been established.
- *Consorci per a la gestió dels residus del Vallès Oriental*: Waste management consortium is involved as one of the primary energy providers.
- *Consorci Besós Tordera*: Water consortium responsible of the management of the sewage water treatment plant the second biogas source.
- Industries
- Industrial and sites owners' association
- *Agència de residus de Catalunya*: Waste agency of Catalunya

2.5.3 KPI indicators table

The following chart summarizes a complete list of KPIs, developed in the framework of the CELSIUS Project

Celsius project KPIs

	General KPIs	UM
ENERGETIC	The yearly amount of thermal energy produced/provided by the new system	kWh/year
	Saved primary energy in comparison with baseline situation	kWh/year
	Energy efficiency of the project	%
	Energy recovery from waste/renewable sources	kWh/year
ENVIRONMENTAL	Yearly GHG savings in comparison with the baseline situation	%
	Yearly GHG emissions related to the project	ton CO_2,e/year
	Yearly pollutant emissions related to the project	kg/year
	Yearly reduction of polluting emission in comparison to baseline	
	Carbon footprint	ton C /year
	Ecological footprint	ha
ECONOMIC	IRR of the new investment	%
	Net present value	€
	Yearly depreciation rate per kWh of saved primary energy	€/kWh
	Yearly depreciation rate per ton of saved CO_2e	€/t CO_2e
	Total cost (yearly depreciation rate + OPEX) per kWh of saved primary energy	€/kWh
	Total cost (yearly depreciation + OPEX) per ton of saved CO_2e	€/t CO_2e
SOCIAL	Number of residents/users benefitting of the new project	
	Reduction/increase of complaints due to the implementation of new system in comparison with baseline situation	
	Variation of working hours per year for O&M of the new system in comparison with baseline situation	hours/year
	The internal floor area served by the new system	m^2

2.5.4 Financing status/ opportunities

There are several financing sources supporting the project development so far:

- Catalan Government: The department of Labour finances part of a salary of a technician partially working on the project.
- Barcelona Regional government: *Diputació de Barcelona* has provided finance during the last two year studies to develop some of the aspects of the project.

At the same time, the Council has participated in several project proposals from H2020 and UIA calls in order to finance part of the investment. Unfortunately, only one of those proposals has been accepted so far and without budget for investments.

Other instruments will be studied according to the financing opportunities described in 2.1.4.1 (pg21)

2.5.5 Exploitation of the opportunity

The following barriers can be identified for the development of the case study:

- Legal Barriers: linked to the use of industrial waste for the generation of biogas (use of industrial waste), and to the use of the biogas (transport and commercialization of biogas).

- Technical Barriers: Linked to the distribution of heat (steam) and with the heat network management with multiple points of generation, multiple point of waste heat recovery.
- Economic barriers: Linked to the finance of the project and the municipality role and the system profitability (dependency on industrial activity and its evolution)