THERMOS

Baseline Replication Assessment Report – Pilot Cities

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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 Cascais

2.1 Introduction

Located in the Metropolitan Area of Lisbon, the municipality of Cascais is bordered to the north by the municipality of Sintra, to the east by Oeiras and to the south and west by the Atlantic Ocean. With an area of 97.4 km^2 and 206 429 residents, it is the 6th most populous city in Portugal.

With a mild climate, marked by an extensive coastline (30 km), it has many beaches and protected natural landscapes. Cascais is within the Lisbon's Metropolitan Area, located only 30 km from the centre of the capital.

Image: ATC Rui Cunha

In the early 20th century, in 1914, the visionary entrepreneur Fausto Figueiredo, with its project design for Estoril, marked the coastal area as the cradle of tourism in Portugal, an activity that by far exceeded the previous fishing vocation and gave Cascais international recognition as a top-quality tourist destination. The nobility has brought the bourgeoisie leading to the intensification of social life, and generating significant changes in lifestyle. The chalets and palaces are still a benchmark of the built heritage of the municipality.

Now identified as "The charm of the Atlantic Coast", Cascais seeks mitigation of the ecological footprint and focus on an increasingly sustainable tourism, promoting activities throughout the year in scenarios between the Sintra Mountains and the sea, which provide a unique landscape for sustainable tourism.

Currently, the Municipality has a consolidated infrastructure that brings higher quality of life for its residents, but also works towards economic investment.

With the strong goal of developing the economic structure of the municipality, Cascais has established partnerships fostering entrepreneurship through implemented projects aimed at developing the value chain and help them create wealth and job openings.

2.2 Heating and Cooling in the Local Context

2.2.1 Local energy system

2.2.1.1 Introduction

The final energy consumption in Cascais in 2015 reached 177 417 toe. Considering the resident population in Cascais in 2015, the final energy consumption per capita amounted to 0.84 toe/ inhab (or 9.8 MWh/ inhab. and 35.3 GJ/ inhab).

According to the provisional energy balance, the final energy consumption in Portugal in 2015 was 15 320 636 toe, corresponding to 1.5 toe/ inhabitant, a figure well above that estimated for the municipality of Cascais.

Table 1: Final energy consumption in Cascais by energy source (2015)

Type of energy	Final energy consumption			Percentage
	tep	MWh	GJ	%
Electricity	52 845	614 482	2 212 134	30%
Natural gas	20 412	237 353	854 470	12%
Butane	2 041	23 737	85 454	1%
Propane	2 687	31 241	112 466	2%
Gasoline	25 727	299 148	1 076 933	15%
Diesel	57 057	663 450	2 388 421	32%
Fuel	851	9 892	35 612	0.5%
Vegetable waste	15 520	180 462	649 663	9%
Others	277	3 222	11 599	0.2%
Total	**177 417**	**2 062 987**	**7 426 752**	**100%**

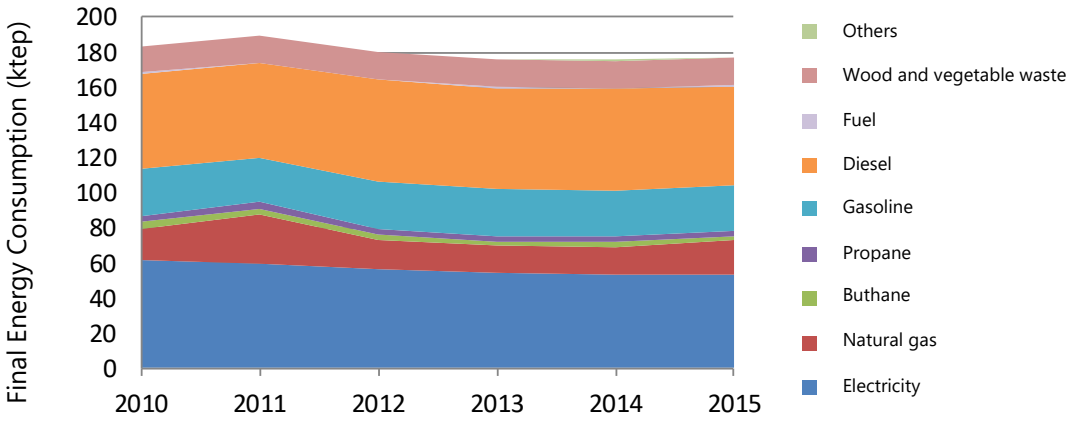
Source: Cascais energy matrix (2015)

Gas oil and electricity were the most consumed energy sources in Cascais in 2015 (accounting for 32% and 30% respectively), followed by gasoline and natural gas, with 15% and 12%

respectively. Firewood and vegetable waste and renewable resources have a very significant fraction (9%). Auto gas and heating oil are included in the 'Others' category.

The evolution of the final energy consumption by energy source in the period from 2010 to 2015 in Cascais is presented below:

Figure 1: Evolution of the final energy consumption in Cascais by energy source (2010-2015)



Source: Cascais energy matrix (2015)

The total final energy consumption decreased by about 3% in the period under study (2010 to 2015). The only energy sources whose consumption increased were diesel, which rose by 6% and natural gas, with an increase of 19%. The consumption of butane and propane decreased by 45% and 26%, respectively. These figures may indicate a shift in the gas supply in the domestic sector in Cascais from butane and propane to natural gas. With regards to electricity, the consumption reduction was of the order of 15%. Gasoline consumption fell by 6%, as firewood and vegetable waste (13% decline).

The following table shows the sectoral distribution of final energy consumption in Cascais in 2015.

Table 2: Final energy consumption in Cascais by sector

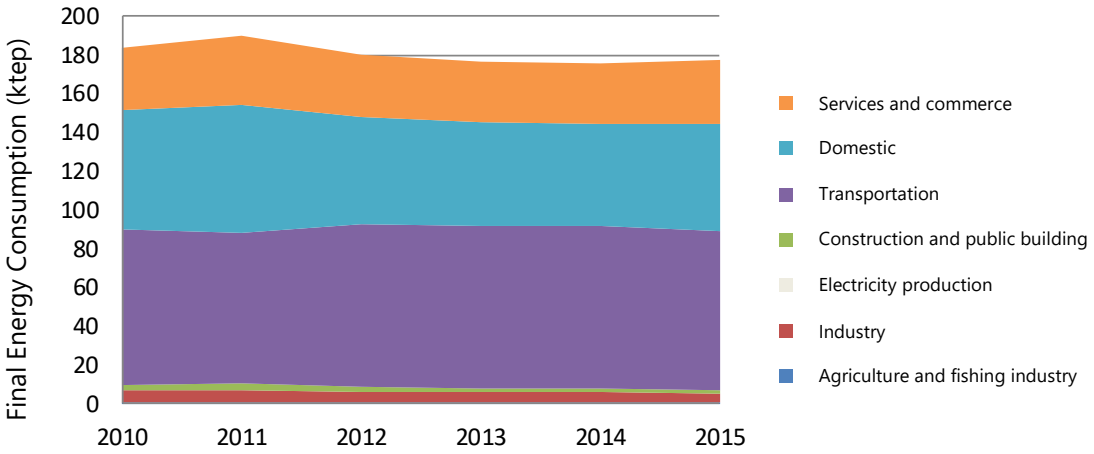
Activity sector	**Energy consumption final (tep)**	**Percentage (%)**
Fishing and agriculture	574	0.3%
Industry	4 270	2%
Electricity production	18	0.1%
Construction and public infrastructure	1 751	1%

Transports	82 138	46%
Domestic	55 726	31%
Service and commerce	32 941	19%
Total	**177 417**	**100%**

Source: Cascais energy matrix (2015)

The transport sector accounted for about 46% of final energy consumption in the municipality of Cascais in 2015. The domestic and commercial sectors and services (which represent buildings) accounted for about 50% of consumption. The remaining consumption corresponded to other sectors such as industry or construction and public infrastructure.

Figure 2: Evolution of the final energy consumption in Cascais by sector (2010-2015)



Source: Cascais energy matrix (2015)

2.2.1.2 Thermal energy supply and demand

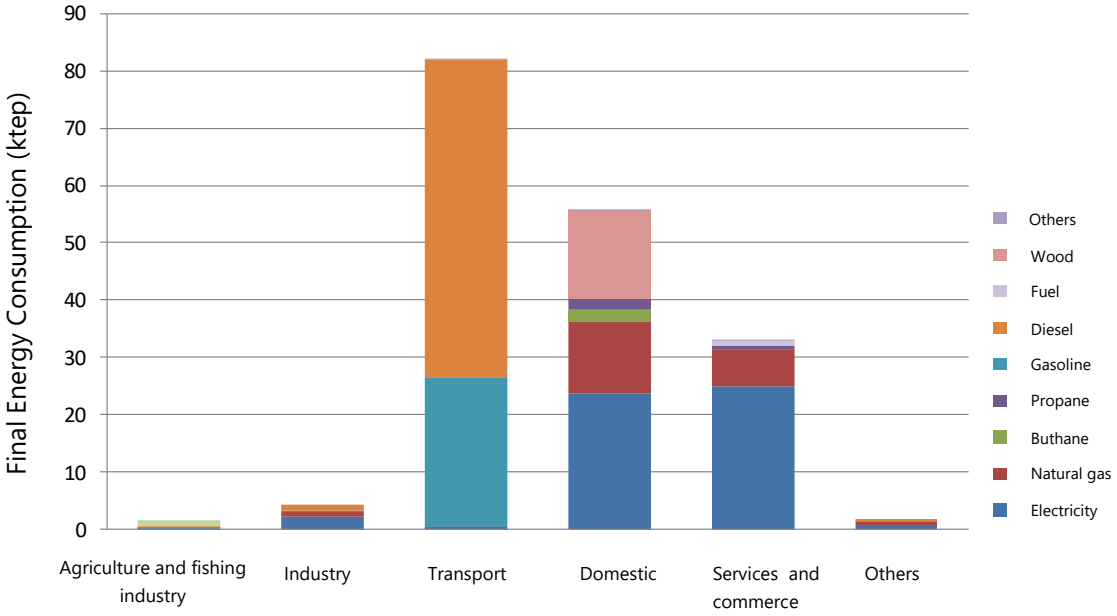
The final energy consumption in the domestic sector per accommodation in Cascais in 2015 amounted to 0.51 toe/ housing, slightly lower than in 2010 (0.57 toe/ housing).

When comparing the final energy consumption in 2010 and 2015, it is observed that in the electricity production sector there was a decrease of around 135% (from 42 toe to 18 toe), and in construction and public works the decrease was of the order of 67% (2 932 to 1 751 toe). However, these two sectors have residual consumption in the municipality of Cascais.

In the same period, the domestic consumption decreased by 10%. On the other hand, the final energy consumption in the transport and trade and services sectors and in the agriculture and fisheries sectors increased by 2% and 42%, respectively. It should be noted that the consumption in this last sector is also residual, so this increase does not have a significant impact on the energy consumption mix in Cascais.

The graph below shows the final energy consumption by sector activity and by energy source in Cascais in 2015.

Figure 3: Final energy consumption in Cascais by energy source and by sector (2015)



Source: Cascais energy matrix (2015)

As for acclimatization, Cascais does not have quantified information about used solutions or energy sources.

It is widely known that most solutions correspond to heat pumps, AVAC systems, thermal solar panels and gas tanks at location (both propane and butane). There are some areas where heating is provided by natural gas as the infrastructure is relatively recent and located in denser areas. Finally, many houses still use fireplaces for heating.

The lack of information is a handicap for the municipality, but the energy demand of the domestic sector can be assessed from the energy matrix.

Key performance indicator	
Buildings' energy consumption in the residential sector (MWh/ year)	276 101
Buildings' energy consumption in the commercial sector (MWh/ year)	290 407
Buildings' energy consumption in the industrial sector (MWh/ year)	27 124

2.2.2 Key Heating and Cooling policy and legislation

The current legislation in Portugal related to heating/ cooling is closely linked to the issue of the national Energy Certification of Buildings.

With the introduction of the European Energy Performance Directive for Buildings (EPBD) in 2006, and with the first three Decrees in this area, the Portuguese Government published in 2013 a new Decree upgrading the quality of the previous ones and setting out the framework for National System for Energy and Indoor Air Quality Certification of Buildings (SCE):

- Decree n. º 118/2013 - Approves Energy Certification of Buildings, Regulation of Energy Performance of Residential Buildings and Regulation of Energy Performance of Trade and Services Buildings, implementing Directive n. º 2010/31/EU of the European Parliament and of the Council of 19 May 2010, on the energy performance of buildings.

Five other legislative documents (Portaria n.º 349-A/2013, Portaria n.º 349-B/2013, Portaria n.º 349-C/2013, Portaria n.º 349-D/2013, Portaria n.º 353-A/2013) were published. They are aimed at a wide range of topics such as: determining the skills of the managing body of the Building Energy Certification System (SCE), regulating the activities of the SCE technicians, establishing the categories of buildings, defining the methodology for determining the class of energy performance for the type of pre-certified and certified SCE, setting out requirements relating to the design of thermal quality of the environment and the efficiency of technical systems in new buildings, buildings undergoing major intervention and existing buildings and establishing minimum flow rates of new space for air and protection thresholds and reference conditions for pollutants inside buildings of commerce and new air services, subject to existing major intervention and assessment methodology. All of those documents were updated in the last years.

2.2.3 Heating and Cooling within urban development and renovation programmes

2.2.3.1 Heating and Cooling Objectives

There are currently no plans for collective or other infrastructure for heating or cooling. The main principles regard the further development of renewable energy sources.

2.2.3.2 Energy Efficiency Opportunities

The potential energy efficiency for heating and cooling can be assessed from an integrated approach in new buildings or new urban areas planned. There is, however, a general lack of knowledge for these collective solutions at planning and supply levels.

2.2.3.3 Renewable Energy Adoption and Potential

There is no significant renewable energy production in Cascais. Only some individual investments on microgeneration (namely solar and wind powered) have been performed.

Overall, thermal solar equipment on the domestic sector is the main source of renewable energy for water heating (sanitation and heating). These are mandatory on new buildings as previously mentioned.

2.2.3.4 Transport and infrastructure

The public transport in Cascais is managed by a private company which has the concession for urban bus. Also, there is a train line (the oldest in Portugal) which connects Cascais to Lisbon in just 20 km of line. This is managed by CP, a public owned company.

These concessions limit the range for action by the municipality. Nevertheless, Cascais heavily invested in the promotion of an innovative integrated approach for mobility. In 2016, the public network for mobility in Cascais (MOBY) was presented. It merges parking, train and bus services, bicycle sharing, electric car charging or internet services, among others, altogether with an application to manage the services.

This is a complementary service intended to find new solutions for mobility and to promote sustainable use of resources. (https://www.mobicascais.com/)

Image: City of Cascais - Cascais 2020

2.2.4 Financing Opportunities and Instruments

There is no available funding for thermal energy projects. Some EU-based programs (like H2020) might help us further the knowledge on these solutions. However, there is a general lack of knowledge and the service technology is duly matured with respect to this type of solutions in Portugal.

When public buildings or new residential areas are refurbished or qualified there is the opportunity for a service provider to develop a solution and help with the understanding on the savings on thermal infrastructure. It will also be possible for them to leverage the costs of implementation, so the investment will be payed according to the savings.

2.3 Stakeholder Identification and Engagement

2.3.1 Local stakeholders

2.3.1.1 Camara Municipal de Cascais

As the main promoter of urban management, the local government can push for more sustainable and efficient solutions to other stakeholders for new urban areas or for refurbishments. As the territorial manager, all other stakeholders need permission or share potential heating/ cooling responses when a building process is submitted for approval. Additionally, it is possible to promote a discussion between stakeholders as to surpass any barriers for this technology.

It is also relevant to mention that the Camara Municipal de Cascais, as a public body, has numerous buildings for public service that could become the reference to promote district heating and cooling. This could serve to boost testing and confidence on the financial and technological viability of these solutions between stakeholders.

2.3.1.2 Residents

Residents are the final consumers of the technology and they are the ones who demand the service or the solutions for acclimatization to equipment providers. If a given technology is available, they can use it if preferable to other solutions or they might be helpful to understand the demand needs and preferences.

2.3.1.3 Building and planning managers

As a new technology or service is available, the professionals from the building sector must propose new solutions to increase the added value for end users and clients. If properly involved, they might understand the solution as viable and build confidence to the whole chain value.

2.3.1.4 Energy sector business

Whether as service providers or energy suppliers, the energy related businesses must foresee the district acclimatization as a more efficient option to consider. Together, they can help validate or improve a business proposal for implementation of such technology as it might be more competitive than existing ones.

2.3.2 National stakeholders

2.3.2.1 ERSE, the Regulatory Entity for Energy Services.

As a regulatory body, they can help introduce or assess, or even validate, the technology and business models.

2.3.2.2 ADENE, the National Agency for Energy.

ADENE promote energy efficiency and renewable energy sources by engaging stakeholders and technology for this process. They are also responsible for energy efficiency certificates

which might help the understanding of any formal needs for the implementation of new projects.

2.3.2.3 ANMP, National network of municipalities

The ANMP represents local governments and promotes liaison activities and information sharing between each other. It is a national reach institution which can help through dissemination and capacitation of municipal staff.

2.3.2.4 IGOT-UL Faculty of Geography and Planning of Lisbon University

The IGOT-UL is the most renown planning superior school in Portugal. As far as GIS use, they provide training to future professionals on this sector and will also provide critic evaluation on THERMOS to ensure its broader reach.

2.3.2.5 FCT-UNL Faculty of Sciences and Technology of the new university in Lisbon

The FCT-UNL is a respectable university on environmental studies and is responsible for many courses on planning and energy efficiency (including engineering). They also have summer schools where we could easily benefit to introduce the THERMOS tool.

2.3.2.6 INTELI – SMART CITIES NETWORK

The INTELI Network has many partners, including smart city prone municipalities. They organize events to promote the dissemination of new technology and projects within the subject.

2.3.2.7 IST – Technical Superior Institute

The IST is one of the most renowned superior institutes for technology and engineering. With a reach for international students, they are also developers of technology and studies for urban and energy efficiency.

2.3.3 Local stakeholders

2.3.3.1 Cascais Ambiente

Cascais Ambiente is the municipal company for waste management, environment promotion and qualification of the ecological system. As such, it is a relevant partnership to help the local council to technically support stakeholders.

2.3.3.2 Cascais Próxima

Cascais Próxima is the municipal company for infrastructure (public) and transport management. As such, it is a relevant stakeholder to facilitate information and knowledge on infrastructure management and planning.

2.3.4 Existing stakeholder participation processes

There is no participation process for stakeholders to take part in. When proposals for new building or refurbishment of existing ones are submitted, the *Camara Municipal de Cascais* must approve the proposals according to existing ruling with some degree of leverage to demand more efficient solutions. However, this is limited as general ruling must apply to

proposed solutions which are more efficient or competitive (applied on many sectors such as water, infrastructure, green areas, etc.).

2.3.5 THERMOS Local Liaison Group

ERSE	Energy services regulatory body
APE	Portuguese Energy Association
ADENE	National Agency for Energy
ANMP	National network of municipalities
IGOT	Faculty of geography and planning of University of Lisbon
FCT-UNL	Faculty of science and technology of the New University of Lisbon
Cascais Ambiente	Municipal company of Cascais
Cascais Próxima	Municipal company of Cascais (infrastructure)
Instituto Superior Técnico	Faculty of technology of the New University of Lisbon
INTELI	Smart cities network (national)

2.3.5.1 Stakeholder roles towards THERMOS model replication

ERSE, APE and ADENE will have significant collaboration potential through dissemination and support for regulation to promote district heating and cooling. These, together with the ANMP and INTELI can also promote the THERMOS tool within the municipalities and other local government managers on heating/ cooling energy services as well as smart cities initiatives.

Cascais Próxima and Cascais Ambiente are both municipal companies responsible for environmental and infrastructures services and can help promote and even implement certain projects.

The faculties are related with the knowledge and scientific exploration. They can train future professionals and students working on energy solutions.

2.3.6 Stakeholder Engagement Strategies

ERSE, ADENE, ANMP and INTELI can help the dissemination of the THERMOS tool and the increase of model performance by engaging the municipalities and other end users.

The universities can help during the training process as the students are usually more found of new technology and are aware of state of the art tools that might be useful to compare with THERMOS.

The municipal companies can be constantly involved to help the collaboration of local stakeholders and promoters of infrastructure/urban projects and to evaluate the potential of new technology for heating and cooling.

All of them will be involved in presentation workshops and meetings to ensure their collaboration from the start of the project and their opinions will be considered during the development stage.

2.4 Towards THERMOS Uptake

2.4.1 Barriers

As Cascais is a well-established urban municipality, heating or cooling infrastructures have to be implemented by a refurbishment process and this is a costly process where our financial situation might not support the full implementation.

As there are many different owners, district infrastructure is an evenly distributed process and costs need to be divided. However, some agents (mainly investors) might not be up for the additional investment.

Secondly, planning, zoning and building regulation are not ready to promote these solutions. Building stakeholders follow the cheapest solution under the regulation to ensure a more competitive pricing for clients or to maximize their profit.

Finally, it is worth mentioning that all stakeholders involved prefer a matured technology which is already well experienced and where they have a confident work experience.

2.4.2 Proposed solutions

The financial aspect could be surpassed with funding of a test area where gains are well assessed and considered. This financial model is well seen by banks or national funding programs. Also, the assessment of gains has to be matured to give investors the confidence that this is the best solution at the medium and long term. We can even consider a joint application for funding based on energy efficiency (and gains) as well as environmental benefits.

The district networks are better considered in new urban areas or where a refurbishment's scale compensates the investments.

Best practice cases should be shared among professionals at EU level. The definition on new regulation must follow existing examples for quicker and safer implementation.

A network of professionals or investors in the heating business and IT tools could be created to cross check ideas and best practices. At this level, the participation of European partners is fundamental to explain the challenges and how to surpass them.

2.4.3 THERMOS exploitation opportunities

As technology progresses, so does the modelling. The THERMOS tool could provide an easy access to new forms of evaluating the return of investment and environmental and operational gains. The identification of the most suitable areas for this technology could also constitute a relevant first step for implementation.

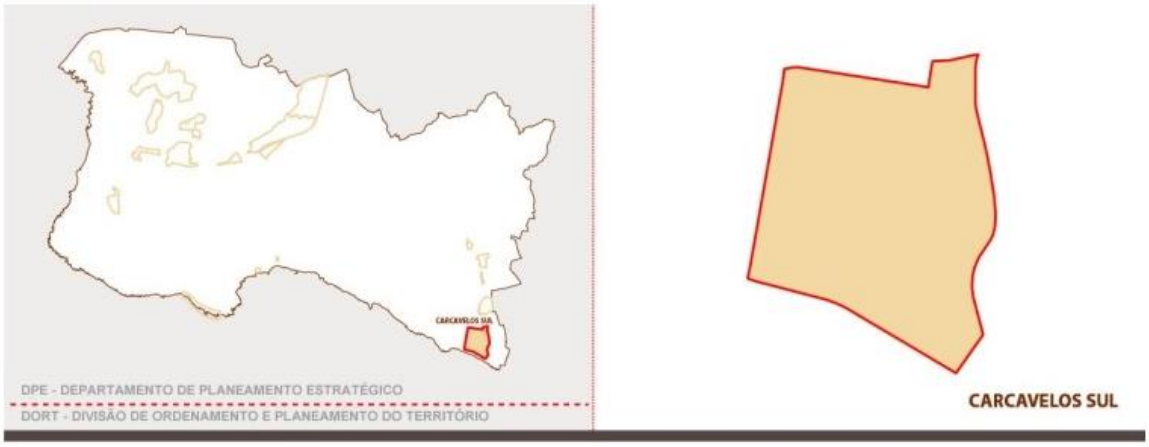
In addition, given that acclimatization is a significant percentage of housing consumption (namely half of it), it is widely seen as one of the most efficient issues to tackle when improving energy efficiency in buildings. One solution can have a greater impact on the overall consumption.

2.5 THERMOS Case Study: Carcavelos - Sul

2.5.1 Objectives

The Carcavelos-Sul urban area is a 54 hectares urban program that will build new housing and infrastructures, such as school, sports centre, cultural and social equipment as well as services and entrepreneurship centre. The process is already duly planned (the corresponding urban regulation has been completed and approved).

As a new urban area with denser occupation and relevant infrastructures, district networks might be a solution for this type of investment/ project. As investors, clients and promoters are working together with the Camara Municipal de Cascais. This can set an example and a benchmark on modelling these infrastructures. If we are able to provide evidence of the system's efficiency, it is possible to consider this solution for the whole area or at least one of the equipment.



2.5.2 Key stakeholders

- Camara Municipal de Cascais as the local government and territorial manager can demand, up to a certain extent, the inclusion of given technologies and consider infrastructure for future implementation.

- The investment promoter is the one who might implement the district acclimatization infrastructure. Together with the Camara and other technology partners there might be a chance to consider these solutions in this case or in future scenarios in other urban areas.

- Universities and energy sector partners can be useful to support technological proposals at the development/ planning stage.

2.5.3 Financing status/ opportunities

The implementation of the heating infrastructure is unfunded and not foreseen at the moment. As a new project, the promoter must ensure its implementation fully.

If the systems' efficiency and economic gains are well assessed, we could promote a financing solution to energy suppliers where savings (compared to a traditional individualized solution) are supported by users or promoters until the investment is amortized. As an energy efficient solution, the leverage by funding with the same process might be possible, only if the economic assessment is sufficiently solid.

2.5.4 Exploitation of the opportunity

2.5.4.1 Barriers

Cultural barriers can be identified, as regulation and service providers do not consider district solutions right from the start. Lack of overall knowledge and the desirable speed of process does not allow for a correct "introspection" on these solutions.

In addition, there are financial barriers. No allocated benefits at the moment might prevent a solution in due time.

2.5.4.2 Proposed solutions

Cultural barriers might be surpassed with a workforce that includes all stakeholders in finding a solution which is viable according to expected benefits (economic and environmental).