REPLICATE	**Project no. 691735** **REPLICATE PROJECT** **Renaissance of Places with Innovative Citizenship And Technology**	This Project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 691735

REPLICATE PROJECT

REnaissance of PLaces with Innovative Citizenship And Technology

Project no. 691735

H2020-SCC-2015 Smart Cities and Communities

Innovation Action (IA)

D9.3 Sectorial Business analysis / Exploitation potential in the field of energy, ICT, sustainable mobility and other remaining sectors included in REPLICATE

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PP	Restricted to other programme participants (including the Commission Services)	
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This deliverable is a research study done by ESADE and the reader has to take into account that most of the actions were still at an early stage when the document was written.

Index of contents

This Project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement Nº 691735

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1. REPLICATE

The REPLICATE project will generate smart city business models, and tailor-made solutions in the areas of energy, transport and ICT starting from the districts: Urumea Riveside (San Sebastián), Novoli (Florence) and Ashley, Easton and Lawrence Hill Neighbourhood (Bristol). In summary there will be pilot actions in energy efficiency, efficient and sustainable transport and integrated infrastructures, being the latter the key elements for the integration and development of cross-sectorial solutions. Three follower cities participate in the project: Essen (Germany), Nilufer (Turkey) and Lausanne (Switzerland).

Being a demonstration project, the main concept that drives the project is REPLICABILITY: it will be necessary for the project results to be applicable throughout the lighthouse cities and in other cities that want to evolve towards the 'smart city' concept, and grow in scale too. To assure the large scale deployment of innovative technologies successfully in the lighthouse districts specific studies will be necessary for each of the demonstrated solutions to ensure that they are scalable and can be replicated.

Prior to the REPLICATE project San Sebastian, Florence and Bristol had already collaborated in a STEEP project (Systems Thinking for Comprehensive City Efficient Energy Planning) which allowed the cities to generate Smart City Plans. The STEEP project has defined a collaborative and participatory methodology to reach the objective of defining an Action Plan for particular districts of each city.

The main objective of the REPLICATE project is the development and validation in three lighthouse cities (San Sebastián - Spain, Florence - Italy and Bristol - UK) of a City Business Model that can enhance the transition process to a smart city in the areas of energy efficiency, sustainable mobility and ICT/Infrastructure, in order to accelerate the deployment of innovative technologies, organisational and economic solutions to significantly increase resource and energy efficiency, improve the sustainability of urban transport and drastically reduce greenhouse gas emissions in urban areas.

2. INTRODUCTION

2.1 Relation to Other Project Documents

This deliverable presents a sectorial business analysis from the industrial partners' points of view and it directly related to deliverables D9.2 (Methodology review and methodological framework definition) and D9.4 (Business opportunities validation).

The methodology used to develop the analysis was presented in the deliverable D9.2. Readers will be able to find there all the theoretical materials needed to support the tools used in this analysis.

The main conclusions of the sectorial analysis, which will be presented at the end of this deliverable, will be the basis of the business opportunities validation that will be carried out in D9.4.

2.2 Reference documents

This document is based on the following projects level documents:

Ref.	Title	Description
REPLICATE Grant Agreement signed 240713.pdf	Grant Agreement	Grant Agreement no. 691735
DoA REPLICATE (691735)	REPLICATE Annex 1 – DoA to the GA	Description of the Action
REPLICATE Consortium agreement signed December 2015 (7th December version)	Consortium Agreement	REPLICATE project – Consortium Agreement
REPLICATE Project Management Plan	D1.1 Project Management Plan	REPLICATE Project Management Plan
REPLICATE Cross cutting activities	D7.1 Report on peer-review methodology including templates and supporting materials	Compilation of information related to interventions
REPLICATE Business Models	D9.2 Methodology review and methodological framework definition	It is dedicated to present the holistic framework developed for analyzing business models in smart cities

These will also be stored on the shared online platform.

Where there are contradictions, the documents listed above supersede this plan. The Grant Agreement is the contract with the European Commission so takes precedence over all other documents.

2.3 Abbrevations list

GA	Grant Agreement
CA	Consortium Agreement
DoA	Annex I–Description of the Action
EC	European Commission
H2020	Horizon 2020
PC	Project Coordinator
PL	Pilot Leader
PMP	Project Management Plan
TC	Technical Coordinator
WP	Work Package
WPL	Work Package Leader

3. DELIVERABLE DESCRIPTION

3.1 Raison d'être

One of the main objectives of REPLICATE project is to provide to industrial partners a description of future business opportunities in order to ensure the replication of the deployed solutions in other places (districts or cities) and beyond the H2020 projects, which are co-financed by the European Commission.

An important issue for the viability of most industrial partners is competition within the industry. But what does sector mean? It is a group of firms (or organizations) producing products and/or services that are essentially the same (Johnson et al., 2016). Everything happening in the industry, although it is outside of a company and is not under its control, will affect it. So, it is essential, and a critical element of any strategic planning, to study the context of that company, because the environment is what gives companies their possibilities of success, creating opportunities and challenges. One way to make sense of the business industry context is to consider it in terms of distinct layers as it proposed in Johnson et al. (2016), as shown in figure 1.

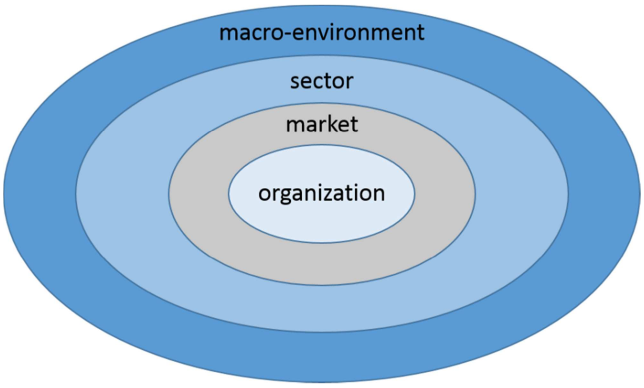

Figure 1.- Layers of business analysis (adapted from Johnson *et al.* 2016)

The macro-environment is the outermost layer. Its objective is to study which are the generic trends and behaviours that could affect or impact companies of one specific sector. Just below the macro-environment is the sector analysis, which tries to understand how attractive an industry is for a company, assessing the competitiveness among companies producing the same sort of services/products. After that, and according to the above proposed scheme, analysts should also study the market, the closest layer to the company. Taking into account the sector attractiveness, it will assess whether an opportunity is profitable or not.

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3.2 Methodology

This document will carry out a sectorial analysis in the following three fields: energy efficiency, sustainable mobility and ICT, without forgetting that the aim of the project is to promote the replication of the deployed solutions.

With the purpose of imbibing a practical nature to this document, and thus avoiding an excessively theoretical reflection, ESADE – together with the lighthouse cities – selected the following 5 interventions:

- Retrofitting (energy efficiency),
- District heating (energy efficiency),
- Demand side platform (energy efficiency),
- Recharging stations for electric vehicles (sustainable mobility), and
- Smart public lighting (ICT).

Lighthouse cities are developing or will develop these interventions with a similar essence but with different practical approaches. Therefore, the consortium will be able to study three (one per city) similar but different solutions for resolving the same need or problem. It will allow one to obtain comparable results, which in turn will allow concluding whether a type of intervention is replicable from an industrial partner point of view, under what circumstances and boundary conditions, and serve to select the most appropriate type of solution. Interventions that only take place in one of the lighthouse cities, such as Donostia's electric bus, won't be analysed because there is no possibility of making a comparison in other geographical areas, which is considered fundamental in this stage. Even so, it is not ruled out that a particular invention is incorporated later on.

Just to reinforce our selection, let us remark that The Business Models and Finance Task Group organized within the Smart Cities and Communities lighthouse projects, where ESADE is representing the REPLICATE project, has made, for its comparative study between projects, a totally aligned selection with the one made here. The only difference is that REPLICATE has additionally included the District Heating interventions as a part of the analysis.

Once the theoretical framework of this deliverable has been established, and having also explained which interventions are going to be analysed in detail and why, this is the moment to describe how the study will be carried out (see figure 2), which will go from the generic to the specific. First of all we will develop a PESTEL analysis (§4). It will study the macro-environment in which smart cities projects are being implemented in Europe, and more specifically in Spain, Italy and United Kingdom. Secondly, using Porter Five Forces, the deliverable will study the competitiveness of the industries related to the selected interventions (§5). Then, and focusing the analysis in each particular case, we will conduct a market analysis for each type of intervention in each lighthouse city (§6).

The sectorial analysis will be closed by developing the Value Creation Ecosystem of each of the interventions (§7), with the aim of identifying the actors that are necessary to create and deliver value to citizens. All these methodologies were presented in D9.2. Finally, the deliverable will present conclusions that will be the basis of future works (§8).

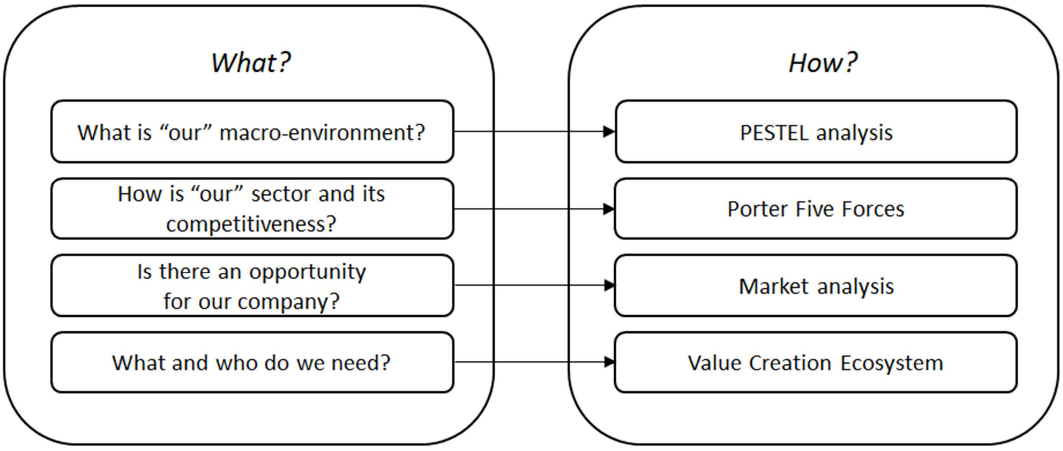

Figure 2.- Methodologies used to carried out the sectorial analysis

4. Macro-environment analysis

A PESTEL analysis is a methodological concept that is used to analyse the macro-environment of a particular industry. PESTEL is a mnemonic that denotes P for Political, E for Economic, S for Social, T for Technological, L for Legal and E for Environmental. These are all important aspects that a firm should consider before deciding to enter an industry, or when already operating in that industry, to understand how these macro-trends are evolving and how they might affect the firm. In this section, we carry out a PESTEL analysis of the energy, mobility and ICT sector in Spain, Italy and the UK. We analyse these at the national level mainly because the macro trends are likely to affect the whole country, rather than only one city. This can be important from a replication perspective, as firms consider markets outside the selected districts of the Lighthouse cities.

As previously laid out, the analysis provide an overview of the political, economic, socio-cultural, environmental, technological, and legal trends and factors relevant for energy, mobility, and ICT in Spain, Italy, and the United Kingdom.

4.1 Energy sector

4.1.1 Political environment

Political interest in improving energy efficiency in Spain and Italy is strongly linked to the European Union's environmental goals and commitments to reducing greenhouse gases. The three countries have also approved National Energy Efficiency Action Plan which they are working on implementing it by 2020. Similarly, Italy and Spain are semi-federal states while the United Kingdom is in the process of devolution mainly towards Scotland. This administrative division might imply that regions could also develop political initiatives in addition to the central governmental. For instance, in the energy sector Spanish regions are responsible for authorising power plants and energy networks.

In Spain and the United Kingdom conservative parties currently hold the central power, while a coalition government formed by centre-left, centre-right, and centrist parties govern Italy at present. Delving into this aspect, only Spain and the United Kingdom have a ministry addressing the energetic sector as such. In the Italian case, the country addresses the energetic sector as part of the portfolio of the ministry for climate change. Finally, Italy voted in referendum in 2011 to stop the operation of nuclear plants, while in Spain and the United Kingdom have no intention of following the Italian path.

4.1.2 Economic trends

Financial hurdles are the most significant barrier to increasing energy efficiency and investment in renewables in smart cities. All measures being undertaken in the Lighthouse cities, from building retrofitting to district heating systems, require significant investment into infrastructure and incentivizing final consumers to participate as well.

All three countries have set up special funds for incentivizing private investment into energy efficiency and renewable energies.

The following are worth mentioning in each of the three countries participating in REPLICATE:

In Spain, the financial crisis had a significant effect on the Spanish economy and must be mentioned in any economic analysis of the industry. According to a recent report by the International Energy Agency (IEA), energy consumption in Spain saw a decline during the economic crisis, but has since then almost fully recovered to its pre-crisis level (IEA, 2015). The industry and residential sectors are the largest consumers of electricity. This suggests that from an economic perspective, there are large savings to be captured both by residents and by businesses from energy efficiency measures.

In Spain, the following projects have been established for financing efficient hot water, heating and cooling systems powered by biomass, solar or geothermal energy: BIOMCASA II, GEOTCASA, SOLCASA and GIT (Ministerio de Energía, Turismo, y Agenda Digital, 2017). This provide funds and guaranteed demand to reduce uncertainty for firms that are willing to enter the market. BIOMCASA II aimed at implementing thermal biomass projects in buildings via ESCOs that have previously been authorised by the IDAE. This programme was allocated a total of EUR 5 million to finance projects; GEOTCASA programme was allocated a total of EUR 3 million and is aimed at implementing geothermal energy projects via ESCOs in buildings used for any purpose, provided the energy is not used in industrial processes; SOLCASA programme seeks to promote use of solar thermal energy systems to provide heating and/or cooling in buildings, provided the energy is not used in industrial processes. This programme was allocated EUR 5 million.

In Italy, legislation and funds have also been created to support energy efficiency measures. The National Energy Efficiency Fund, which among other actions supports investment in district heating and district cooling systems (Ministry of Economic Development, 2015, 2017). Resources account for EUR 800 million. The fund aims to aim to improve the energy performance of buildings owned by government bodies, create district heating and/or district cooling networks, improve the efficiency of public services and infrastructure including street lighting, improve the energy efficiency of entire buildings including social housing buildings and reduce energy consumption in industrial processes.

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Similarly, in the UK several funds have also been made available for energy efficiency measures. Among these the most significant one to mention is the National Comprehensive Agreement: £320 million Heat Network Investment Project, which aims to support investment in up to 200 projects, leveraging in up to £2bn of wider investment (Department for Business, Energy & Industrial Strategy, 2016).

4.1.3 Socio-cultural trends

Perceptions on energy savings among the general population are also strongly linked to increasing concerns with climate change and reducing greenhouse gas emissions. In the EU, these concerns are becoming more and more important for people living in cities. Solar energy and renewable fuels are regarded favourably. However, it is generally difficult for people to change their behaviours, which is why governments are focusing more on improving the efficiency of homes and appliances for using energy, rather than focusing on curbing demand through behavioural changes. That said, social tendencies to rely more and more on "smart" applications, such as mobile apps and sensors in homes, can be successful at helping people monitor their own consumption. The challenge here is to make such changes continuously, rather than just momentarily due to the novelty of reacting to new technologies. Another important socio-cultural trend to focus on relates to district heating and retrofitting of residential areas. City residents are increasingly aware of rising social inequality in urban areas, especially when communities are displaced from their neighbourhoods due to rising home rent or home ownership prices. This is important to observe as the effects of environmental improvements in some areas can have the unintended consequence of making them unaffordable for the communities already there.

4.1.4 Environmental trends

Smart city efforts in the energy sector are primarily driven by environmental concerns and countries' commitments to reduce their impact on global climate change. A main focus from a policy perspective has been on improving energy efficiency. Energy efficiency is seen as one of the most important actions that countries can promote to reduce their greenhouse gas emissions and meet their climate targets. Energy efficiency has been steadily increasing across the EU, which in turn has been shown to cause a decrease in overall energy consumption. This reinforces a lower dependence on oil and coal-generated power, both of which are strong sources of greenhouse gases. In Smart Cities, this translates directly into actions to improve the energy efficiency of buildings (Kylili and Fokaides 2015), which are considered a significant source of greenhouse gas emissions—heat in winter or air conditioning in summer, especially in Spain and Italy, tends to escape buildings whose walls or windows are not well insulated, which in turns, leads to increased energy consumption to continue powering heating or cooling systems. There is, therefore, increased demand in all three countries for building retrofitting solutions.

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4.1.5 Technological trends

There are at least four technological trends that can be highlighted in the energy sector of the Lighthouse cities participating in the REPLICATE project. These technological trends can be seen directly in the choice of pilot projects that the consortium has chosen to pursue in Donostia/San Sebastian, Florence, and Bristol. The technological trends are related to:

- *Retrofitting buildings:* one of the most important trends related to energy efficiency in smart cities is retrofitting old buildings. Much of the housing stock and commercial real estate in European cities like Florence is several decades old, which means that the materials used are not necessarily the most advanced for energy efficiency. These buildings often lack proper insulation so they lose heating or cooling through their walls and windows, thus requiring more energy consumption to maintain comfortable temperatures in summer and winter. Retrofitting buildings includes installing energy efficient heating, ventilation, and air conditioning (HVAC) systems, installing LED lighting, and improving the insulation of the walls and windows of buildings. In Italy, the total capacity of district heating installed is 8.558MWth, where 77% comes from direct renewables and recycled heat, which accounts for a total of 303 district heating systems. In the UK, there are over 2,000 district heating schemes occupying a market share of 2%, with a capacity of 335MWth and 46.701GWh of heat supplied by Combined Heat and Power which contributed to 5.8% of total national electricity production (Department of Energy and Climate Change, 2014).
- *District heating plants:* another technological approach that is gaining more and more attention despite not being a "new" technology is district heating. District heating systems replace individual boilers in homes from heating water and heating air by installing a centralized system that provides heat to the whole district. The heat is often obtained from a cogeneration plant burning fossil fuels but increasingly also biomass. District heating systems are much more energy efficient than individualised boilers, and if used with combined heat and power (CHPDH), are considered the cheapest method of cutting carbon emissions in cities. While the use of district heating in the UK, Spain and Italy is still quite low (in Italy for example, only about 3% of the residential heat sector is served by district heating, and in the UK the figure is closer to 2%) all three cities are implementing this technology and it is also becoming more prevalent at the national level.
- *Demand-side platforms:* another interesting technological development in the energy sector is the growing interest in demand-side platforms that allow electricity consumers to monitor their own consumption by using "smart meters" in their homes. These smart meters gather data regarding electricity consumption and display it in real time so that users can regulate their use themselves depending on

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the information presented. Demand-side platforms are part of a larger trend in big data collection and management, as well as the spread of internet-of-things technologies, by which objects can regulate their functioning through sensors and data. Such demand-side platforms and the use of smart meters are important tools in smart cities that empower final consumers to actively improve their energy efficiency.

4.1.6 Legal factors

The government either has or is currently working on implementing EU directives whose aim is to improve the energy efficiency of buildings. Among these directives, the following are important as they provide a legal framework for any subsequent commitments in this sector:

- Directive 2010/31/EC, whose goal is to improve the energy efficiency of buildings;
- Article 4 of the Directive 2012/27/EC, which encourages Member States to establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private;
- Article 14 of the Directive 2012/27/EC, which asks Member States to carry out a comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling;

At the national level, the following regulations are relevant in each of the three countries. The Spanish government has the following two long-term plans to indicate their political commitment to improving the country's energy efficiency:

- 2017-2020 National Energy Efficiency Action Plan;
- Long-term Strategy for Improving Energy Efficiency in Spain's Building Sector (ERESSEE 2014).
- Royal Decree 314/2006: regulatory framework that establishes the basic safety and habitability requirements that buildings must fulfil which includes energy saving;
- Royal Decree 1027/2007: regulates the minimum output requirements applicable to heating, cooling, ventilation and domestic hot water systems and periodic energy efficiency audits, as well as the design, size, assembly, and maintenance of such systems;
- Order FOM/1635/2013 raised the level of the minimum energy-efficiency requirements for new builds and for extension and renovation of existing buildings;
- Royal Decree 235/2013 adopted the basic procedure for building energy-efficiency certification lays down the obligation to provide the buyers or users of buildings with an energy efficiency certificate that must include objective information on the energy efficiency of the building and reference values;

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- Law 8/2013 and Royal Decree 7/2015 on urban renovation, regeneration and renewal which covers the obligation for buildings to have an evaluation report consisting of three documents, one of which must be the building's energy certificate;
- Royal Decree 56/2016 promotes efficiency in the production of energy for use in heating and cooling including the methodology to evaluate the cost-benefit analysis when a facility subject to performance of that analysis is planned or upgraded.

In Italy, the following legislation applies currently:

- Italian Energy Efficiency Action Plan
- Legislative Decree No 102 of 4 July 2014 transposing all the requirements of Directive 2012/27/EU which were not already in national law and which are consistent with the recommendations in the National Energy Strategy;
- Presidential Decree No 74/2013 on heating/cooling systems. This measure lays down a set of obligations and criteria applicable to public and private buildings. In particular these include new ambient temperature limits for heating for all buildings (the weighted average air temperature measured in the individual heated environments of each building unit must not exceed 18 °C + 2 °C tolerance for buildings for industrial or similar use, and 20 °C + 2 °C tolerance for all other buildings) and for cooling (the weighted average air temperature measured in the individual cooled environments of each building unit must not be below 26 °C-2 °C tolerance for all buildings).
- Law No 90/2013 on improving the energy performance of buildings such as nearly zero-energy buildings, or a minimum energy performance requirements.

In the UK, the central government has the following medium- to long-term plans to indicate their political commitment to improving the country's energy efficiency:

- UK National Energy Efficiency Action Plan
- 2013 Heat Strategy
- Heat Networks Investment Project Consultation Government response
- Climate Change Act 2008 requires the UK to reduce greenhouse gas emissions by at least 80% from 1990 levels by 2050
- Heat Generation Policy Statement of the Scottish Government which targets for district heating 40.000 homes to be supplied with affordable low carbon heat through district heating and communal heating by 2020 as well as 1.5 TWh of heat to be delivered to households, business, industry and the public sector by district heating by 2020 (Department of Energy & Climate Change, 2014).

4.2 The Mobility Sector

4.2.1 Political environment

Political interest in developing a free-fuel mobility sector in Spain, Italy, and the United Kingdom is also linked to the European Union's commitments to reducing greenhouse gases and mitigating climate change. Legally, the EU has translated this commitment into a directive on the deployment of alternative fuels infrastructure. An example of how the European Union has influence this cultural shift is the UK government's commitment that almost every car and van to be a zero-emission vehicle by 2050 with a commitment to invest £600 million by 2020 to support this (Department for Environment, Food, and Rural Affairs and Department for Transport 2017b). In fact, governments across Europe are interested in encouraging the usage of EVs due to the environmental, economic and energy security benefits that they could bring. They are thus encouraging manufacturers to develop and produce EVs and provided incentives to consumers to buy them.

In Spain, the Ministry responsible of development this strategy is the Ministry of Economy, Industry, and Competitiveness, similarly the portfolio in the Italian case responsible for such development is assigned to the Ministry of Infrastructures and Transports. In the case of the UK the strategic development was delegated to a cross-sectoral departments where electric mobility is part of the agenda the Department for Transport as well as the Department for Environment, Food, and Rural Affairs.

4.2.2 Economic trends

As in the energy sector all three countries are setting up funds to encourage investment in improving mobility, and in particular, in encouraging the use of electric vehicles and the deployment of electric stations in cities.

In Spain, for example, plan MOVELE (2010-2014) made EUR 10 million available for offering incentives for purchasing electric vehicles, and plan MOVEA allocated EUR 16.6 million to Promote Mobility using Alternative-Fuel Vehicles. So far, 3.938 vehicles were purchased thanks to this scheme (European Commission 2015).

In Italy, there were provisions for incentives for buying vehicles with overall low emissions worth a total of EUR 108 million in the three-year period 2013-2015, and the plan is being renewed. Additionally, the PNIRE project planned to allocate EUR 47.6 million for the three-year period 2013-2015. The call was opened for co-financing (up to 50%) projects for the installation of systems to develop infrastructure networks for recharging vehicles as part of programme agreements with regional and local authorities.

In the UK, there are several funds to encourage electric vehicle use. For example, the Green Bus Fund and the Clean Bus Technology Fund offer £89 million and £27 million, respectively, to support the purchase and operation of low-carbon and electric buses throughout the UK.

To encourage local action to accelerate uptake of ULEVs, OLEV is providing funding of £35million through the Go Ultra Low City Scheme. This aims to help fifte cities (Bristol and the West of England, London, Milton Keynes, and Nottingham) become national and global exemplars with significantly increased uptake of ULEVs, through innovative measures such as rapid charge point hubs and a range of local incentives, e.g. free or reduced parking for ULEVs as set out in the Clean Air Zone Framework for England. The scheme is also providing £5 million of development funding for specific initiatives in Dundee, Oxford, York and the North East (Department for Environment, Food, and Rural Affairs and Department for Transport, 2017a).

4.2.3 Socio-cultural trends

We can identify several socio-cultural trends that favour a more environmentally sustainable mobility sector. The first of these trends is that city residents seem increasingly interested in "car-sharing" seems that allow them to use a car when they need it, even just for a few hours. Especially young people are less interested in owning cars now and see car-sharing schemes as a way to enjoy the benefits of having access to a car without the costs and responsibilities of ownership. Of course, such schemes fare better in cities where public transportation is a viable option for the majority of trips that do not require a car. This trend is also positive for bicycle-sharing schemes or so-called city bikes, as people can enjoy the convenience of using them to travel short distances even if they do not own their own bicycle. The trend towards increased bicycle use is reinforced by increased awareness of the health benefits of exercise. Finally, familiarity with digital tools and smart applications means that city residents are increasingly able to access innovative transport options, e.g. by using their smart phone to find the nearest city bicycle or to plan a journey that requires transfer between types of transport. For the mobility sector, these socio-cultural trends, which tend to be more visible among younger, urban populations than in others, favour a shift towards more efficient transport systems. The challenge is to make these systems as integrated as possible to make the person's journey from point A to point B as seamless as possible regardless of changes in the mode of transport along the journey.

4.2.4 Technological trends

We can identify several technological trends that are currently influencing developments in the mobility sector. These technological trends can be seen directly in the choice of pilot projects that the consortium has chosen to pursue in Donostia/San Sebastian, Florence, and Bristol. The technological trends are related to:

- *Electrical vehicles and charging stations:* probably the most serious technological trend in this sector is the increased popularity of electric vehicles (EV). In Spain, by 2015 there were 10.893 battery electric vehicles.

Among which 3.086 correspond to motorbikes, 2.588 to quadricycles, 4.150 to passenger cars, 1.061 to light commercial vehicles, and 8 to buses). The country also presents 1.462 Plug-In Hybrid Electric Vehicle (109 motorbikes, 1.308 passenger cars, and 45 buses). To absorb the current demand Spain has deployed a network of 1.029 recharging stations and 1.766 recharging points (European Commission, 2016a). Moving to Italy, in 2015 there were 15.720 battery-powered vehicles accounting for 6.541 passenger cars, and 9.179 light commercial vehicles, and 2.388 Plug-In Hybrid Electric passenger cars. The government of Italy has so far installed 1.212 recharging stations and 2.483 recharging points to deal with the total number of electric vehicles (Ibidem). In the UK, the number of battery-powered Electric Vehicle has escalated in 2015 up to 25.378, which can be disaggregated in 1.013 motorbikes, 555 quadricycles, 19.155 passenger cars, 4.501 light commercial vehicle, and 154 buses. In terms of Plug-In Hybrid Electric Vehicle the country presents 24.268 passenger cars; regarding recharging points, the country has a total of 3.758 stations and 9.314 points (*Ibidem*).

- *Autonomous cars:* also known as self-driving cars, these vehicles use a variety of technologies such as radar, laser light, GPS and advanced control systems to detect their surroundings and adjust their path. Among their benefits are increased safety from the elimination of human error and increased efficiency as these vehicles could continue circulating after they have dropped off a passenger. As firms, especially American firms, such as Tesla, have started to experiment with autonomous cars on roads, we can also expect their eventual application to buses and trucks. It is also expected that autonomous cars will be electric.
- *Battery technology for e-vehicles:* the most important technology in e-vehicles is the battery. It is also the most expensive component and can be the biggest disadvantage of e-vehicles because they have limited lifetime and long charging times. Therefore, developments in battery technology will determine the growth potential and attractiveness of the EV industry.
- *Charging stations for EVs:* similarly, improvements to the charging infrastructure of EVs are crucial to their widespread use. All three Lighthouse cities in the REPLICATE project are currently experimenting with "fast charging stations" that can fully charge an EV in 20 minutes. Electric taxis are currently being given priority to use them, but there is still an issue of having to schedule an appointment to use the charging station ahead of time to avoid over-burdening the system and to avoid long waiting times. Increased installation of charging stations in people's private home or building will also support the uptake of EVs in smart cities.
- *Integrated transport systems:* as their name indicates, these are systems in which all modes of public transportation are integrated into one operating platform. For users, this means that their tickets are valid for the entire integrated transport system, i.e.

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you can get on and off as often as you want to with a single ticket until you have reached your destination. The better the system's integration, the more seamlessly that a user should be able to move around the city. One very important part of this that is currently being improved through ICT platforms is that users have access real-time service information about their journey (i.e. when their bus is coming, where they can transfer, how long the entire journey should take and how much it will cost). This helps users make informed decisions about travel modes. The development of apps and web portals for these information services are currently very important trends.

4.2.5 Environmental trends

Interest in EVs is primarily driven by environmental concerns to reduce greenhouse gases and mitigate climate change. All three countries, Spain, Italy and the UK have placed an emphasis on low-carbon mobility as part of their commitments to reduce greenhouse gases. One environmental concern regarding EVs is that although they produce zero emissions, there are concerns regarding the disposal of batteries, whose components can cause environmental damage as they start to decay, but might never degrade completely. How to deal with the used batteries will be an issue, although perhaps not the principal concern for most users. Nonetheless, if batteries can be recycled appropriately, battery electric cars will have the strongest competitive advantage over traditional cars or cars who combine other low-carbon fuels.

4.2.6 Legal factors

The following legislation in each of the three countries provides a general idea of what mobility measures the legal framework currently envisions:

a) In Spain

- Law 2/2011 of 4 March 2011 on the sustainable economy creates a legal framework for promoting sustainable mobility plans.
- Law 22/2013 of 23 December 2013 on the general state budget which covers the application of a mechanism by which to evaluate energy efficiency criteria when awarding state aid to public transport systems.
- Royal Decree 647/2011 of 9 May 2011 regulating the role of charging network operators and introducing a new electricity rate linked to time-of-use offers to encourage night-time charging was adopted.
- Royal Decree 1053/2014 of 12 December 2014 defines the minimum requirements for electric vehicle charging infrastructure installed in new buildings or parking lots and on public roads, the wiring diagrams for electric vehicle charging systems (single-family houses and collective car parks)

- Royal Decree 639/2016 of 9 December 2016 transposing the Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the Deployment of Alternative Fuels Infrastructure.

b) In Italy

- Legislative Decree No. 257/2016, transposing Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the Deployment of Alternative Fuels Infrastructure.
- Legislative Decree No. 257/2016 seeks to reduce Italy's dependency on foreign oil and to mitigate environmental impacts caused in the transportation sector. The legislation sets forth minimum requirements for the construction of infrastructure; for the development of alternative fuels and the establishment of charging stations for electric vehicles; and for establishing charging stations for vehicles that use natural gas, hydrogen, and liquefied oil gas.
- National Action Plan on Intelligent Transport Systems. Spells out the requirements for the deployment of intelligent transport systems throughout Italy, identifying actions and sectors of intervention. It also describes priority actions aimed at the efficiency, streamlining and cost-effectiveness of using ITS.
- National Infrastructure Plan to set up electric vehicle charging points (PNIRE). The measures embodied in the plan includes co-financing (up to 50 %) of projects for the installation of systems to develop infrastructure networks for recharging vehicles as part of programme agreements with regional and local authorities as well as making a provision for incentives for buying vehicles with overall low emissions.

c) In the United Kingdom

- A draft of an Automated and Electric Vehicles Bill is in its second reading at the Parliament.
- A draft of an Automated and Electric Vehicles Bill is in its second reading.
- Office for Low Emission Vehicles which through the regulatory delivery enforces the design, use and regular technical maintenance of recharging points, public accessibility of alternative fuel stations, including 'ad hoc' use and provides guidance and geographic information.
- Centre for Connected and Autonomous Vehicles aims to support the market for connected and automated vehicles. The Centre also paves the way to the government to develop policy requirements and amendments as of the technological disruption of electric and automated vehicles.

- The Plug-In Car Grant seeks to reduce the cost of plugin vehicles for consumers by cutting the cost of eligible vehicles by 25% up to £5.000, this governmental initiative was launched in 2011.

4.3 The ICT Sector

4.3.1 Political environment

ICT innovation in the EU is an important political goal that is aligned with the EUs efforts to increase its global competitiveness. All three countries involved in REPLICATE—Spain, Italy and the UK—have policies to support research and development (R&D) into innovation in technology, especially ICT. These policies are also linked to European "umbrella" policies, whose main focus is to support education, investments in SMEs, entrepreneurship, and investment into infrastructure for innovation (such as investment in broadband internet and data platforms for cities). This is especially visible in policies to foster more smart cities across the EU. According to research undertaken by the European Parliament (European Parliament Policy Department, 2014), Spain, Italy and the UK are the top three countries in Europe with the highest number of smart city initiatives. Only in Spain, for example, there are more than 30 cities with over 100,000 inhabitants that are investing in smart city initiatives, with Donostia/San Sebastian clearly among them. The figure for Italy and the UK is also growing, which shows political support in all three countries for continued investment in smart city initiatives that are inherently linked to investment in technology and ICT (Mas, Fernández de Guevara, and J.C Robledo, 2017).

4.3.2 Economic trends

ICT has become one of the most important economic sectors globally. In the last few years, the ICT sector has represented approximately 5% of total GPD in the EU. While the figure fell slightly between 2006 and 2015 due to the economic and financial crisis, it has since recovered rapidly. In 2014, the ICT sector employment in the EU already exceed 5.6 million jobs, which is a fivefold increase from 1995, when statistics about the ICT sector started to be collected. Total employment in ICT in the EU was mainly concentrated in Germany (18.0%), UK (17.4%), France (12.5%), Italy (9.8%) and Spain (6.6%), which are also the five largest EU economies. Together, they represented, in 2014, 64.3% of total ICT sector employment in the EU (Mas, Fernández de Guevara, and J.C Robledo, 2017). While this has increased in recent years, ICT employment in Eastern European countries, such as Poland and Estonia, is also growing rapidly. Much of the employment in ICT is in R&D positions, with more of these positions available in the ICT services sub-sectors than in the ICT manufacturing sub-sector.

ICT manufacturing and ICT services are the most important sub-sectors. During the 1990s, the ICT manufacturing sector has larger than the ICT services sector, but the two positions reversed in the early 2000s. The two largest ICT manufacturing sub-sectors in the EU are the manufacture of electronic components and the manufacture of communication equipment.

In the case of ICT services, the main sub-sectors are telecommunications and Computer programing, and consultancy and related activities. During the economic crisis of 2008 to 2010, employment in ICT services was more resilient than other sectors, including the sub-sector of ICT manufacturing. This could also be a positive indication of future resilience. In general, the sector has also seen more improvements in productivity than any other sector in the EU. In the last 3 years, ICT sector productivity has been approximately 60% higher than that of the total European economy.

The positive economic trends in the ICT sector clearly indicate that it can support continued growth and will continue to be an attractive investment in years to come. This is important for smart cities as much of their underlying technology relies on ICT, from the functioning of smart sensors to the functioning of integrated transport applications.

4.3.3 Socio-cultural trends

The following social trends are important for smart cities, and therefore, also for the ICT sector, since it underlies so much of the technology that allows cities to offer smart services to their citizens (Neirotti et al., 2014). A very important trend across Europe is that cities are growing rapidly as people are attracted to the economic opportunities that urban centres offer. While higher density can make cities more dynamic and creative, it also means that they face the challenge of managing services for larger amounts of people. Some of the ICT applications mentioned in this section can enable city councils to allocate resources more efficiently to growing populations. Another important trend in Spain, Italy and the UK is that they all have aging populations, and are experiencing increases in life expectancy. This means there is a clear need for new solutions in health care and in social care for senior citizens and the elderly. There is, therefore, much room for ICT applications to offer such solutions. Finally, it is worth mentioning that although unemployment in these three countries, especially in Spain, is recovering, there are still many people who have not recovered economically from the economic crisis. As already mentioned, the ICT sector is currently an important source of employment. This means that retraining programs for unemployed people, especially in cities, should focus on skills that are useful and sought after in the ICT sector.

4.3.4 Technological trends

Sensors and the Internet of Things: A key element related to ICT and the deployment of sensors is the 'Internet of Things' (IoT), a term that describes a ubiquitous network in which items, equipped with sensors, are connected to each other via wireless internet connectivity and can collect and transmit real-time data on a vast number of factors. Smart city applications of the Internet of Things, some of which are being introduced in the EU's Lighthouse cities, include 'smart lighting posts' that adapt their brightness to income traffic and collect data on temperature, pollution, and congestion and 'smart bins' that can notify the trash collection service when they are full to optimize collection routes and schedules. This type of information can be very helpful either for improving or for increasing the efficiency of the services being provided.

Big data: Big data is a term that refers to the large volume of data that is generated on a day-to-day basis by online applications and sensors, such as those that were mentioned in the Internet of Things description. Businesses, and now cities, can be analysed to generate insights about a system, such as a city ecosystem, that can then enable a city council to make better decisions about their strategy. These decisions are usually better if based on big data, because not only is it collected in real-time, its volume also makes it more reliable. In cities, the data gathered through sensors and online applications are analysed to see how we are consuming resources, how people are moving through the city, how they are using energy, and how infrastructure is working in the city. Based on this analysis, cities can be more strategic about how to make more efficient use of those resources or how to organize their services and activities better to improve their residents' quality of life.

City ICT platforms: Smart cities platforms are management systems for the city that use ICT to gather information from different sources such as sensors on infrastructure, a City Council's own systems or even people's smartphones, which can act as sensors too. Gathering and analysing the big data produced in one city platform enables city councils to make decisions using real-time data about what is happening in the city. These city platforms are becoming an essential component of management in Smart Cities.

The main current challenge for developing city platforms is related to problems of interoperability. There are no formal norms that city platform developers are required to follow to make sure that city platforms are interoperable, which means that it is still very difficult to exchange data between different systems in the city, or between different cities. Addressing this problem will open the door to many opportunities for using data platforms to improve smart city services.

4.3.5 Environmental trends

Just like in the energy and the mobility sector, we see many activities in the ICT sector as related to concerns with climate change and with EU commitments to reduce greenhouse gases in Member States. The ICT technologies mentioned above are seen as tools to enable governments to make more efficient use of resources. Smart lightning posts, for example, use sensor to only turn on when there are people around that need light, so they do not waste electricity when nobody is around.

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Sensors in people's homes that enable them to see where they are using most electricity can also help them self-regulate their consumption. Such new uses of ICT are in high demand by smart cities and there is growing available investment for companies whose aim is to create more sustainable cities.

4.3.6 Legal factors

One of the most important legal factors that is shaping how ICT is used in cities is related to data privacy concerns that citizens share (Kitchin 2014). Regulatory models for open data will need to address the role of citizens in sharing their data and in deciding how it will be collected and used. Local and national governments must address the fact that companies or organisations with access to big data and machine learning will have a great deal more power than those who do not, such as regular citizens or smaller organisations. Englobed in the Digital Single Market initiative, the European Commission is working worked on the regulation on the protection of natural persons with regard to the processing of personal data and on the free movement of such data as approved by the Regulation 2016/679. According to the Regulation, from now onwards persons and organizations collecting and managing personal information have to protect users from misuse while respecting certain rights of data owners. Data owners are now empowered and con complain and obtain redress if their data is misused anywhere within the EU. This regulation will be transposed into national legislation complementing or developing member states legislation regarding not only data protection or management, but also the use made of it.

5. Competitiveness of business sectors

From a microeconomic perspective, competitiveness is based on the capacity of a firm to be profitable, by producing services or goods that meet the requirements of an open market (Martin, 2009). In order to study this competitiveness in each of the selected industries or sectors – retrofitting, district heating, demand side platform, recharging stations for electric vehicles, and smart public lighting (see §3.2) – we will use the *Five Forces governing competition in an industry* (Porter, 1979):

- rivalry among existing firms,
- bargaining power of suppliers,
- bargaining power of customers,
- threat of new entrants, and
- threat of substitutes.

5.1 Retrofitting

This section analyses the sector formed by companies facilitating housing reforms, by financing partially or totally the costs of guaranteeing a certain level of energy saving, level of saving that in the long-run will economize the investment. Energy Service Companies (ESCOs) is the name given to this type of organizations.

5.1.1 Rivalry among existing firms

There are many ESCOs in Europe. In 2012 registered companies in the European Energy Efficiency Platform (European Commission, 2017) accounted for 117. This number has not stopped growing ever since.

In this industry you can find companies with different characteristics, from multinational companies of the construction sector to small companies formed by few workers and with a small investment capacity. They offer services with low differentiation, even though the experience is considered as a guarantee of quality. In this scenario, big players have an advantage, as citizens already know their brands. ESCOs have low margins, so the payback is high.

Building owners wanting to carry out such a type of intervention usually rely on local companies, which is very common in the construction sector. The main reason is based on the knowledge local and national companies have on national regulations as well as the administrative procedures needed to fulfil to carry out the intervention. This is a key issue when reducing rivalry among existing companies.

On the other hand, there is a high social awareness with buildings' energy efficiency, and with reducing CO_2 emissions. Given the lack of resources of many families and companies, it is an industry with great potential.

By way of conclusion, it can be stated that the rivalry is medium.

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5.1.2 Bargaining power of suppliers

This kind of solution cannot be done without the construction companies, which are usually responsible for both the project and the construction works. For this reason, there is a high risk of vertical integration. The medium and large construction companies could perfectly play the role of ESCOs and co-finance interventions. Small construction companies represent a lower risk for ESCOs as they still suffer from liquidity problems derived from the recent economic crisis experienced in Europe.

On the other hand, the switching cost of changing suppliers is very low. In any case, this is a sector where trust between ESCOs and construction companies is fundamental as well as the experience (know-how) of the team implementing the retrofitting. Because of this, when an ESCO is used to working with a specific company (supplier), the ESCO would do their best to keep on working with the supplier as it helps to avoid the uncertainty related with change.

In other words, the bargaining power of suppliers is quite high.

5.1.3 Bargaining power of buyers

Building retrofitting (figure 3 shows two examples of houses under a retrofitting works), as we will point out in the market analysis (§6), is far from being affordable. The average cost for retrofitting a dwelling is around 150 to 170 €/m² (Kuusk and Kalamees, 2015). At this time, it is not easy to find owners willing to pursue such an investment, as the cost per dwelling remains high and they are very price sensitive. Even if the potential number of customers is very high, the actual number of "buyers" willing to finance a percentage of the investment remains very low. This forces the companies to carry out two complementary actions. First of all, they have to prepare detailed studies showing potential customers the economic advantages of their investment. Secondly, ESCOs have to finance a higher part of the investments in order to get the engagement of homeowners.

Figure 3.- Exemples of retrofitting

In any case, solutions are quite standardized, but each customer/building needs a particular solution depending on its characteristic. This is a key element to slightly reduce the power of buyers.

Under these conditions, it can be concluded that the bargaining power of customers is rather high..

5.1.4 Threat of new entrants

Although there are many companies in this industry, it is foreseeable that the number will continue to increase. Small companies will try to enter this sector when they see that this is a useful and viable model. To do so, small companies will need to assess how to face the different entry barriers.

The purchase of construction materials is based on economies of scale. This is a clear disadvantage for those willing to enter this sector. ESCOs, as it has been previously said, will need to continue covering a significant percentage of the construction cost. In that sense, new entrants should have an important financing capacity, which referring to small companies is not the everyday. The lack of experience and know-how in this type of project could turn into a handicap when offering projects to owners. Similarly, it can also mean that these companies do not have the access to public subsidies to help these owners on financing the retrofitting.

Therefore, it can be concluded that the power of new entrants is low-medium.

5.1.5 Threat of substitutes

There is no clear substitute for retrofitting if it is understood as the integral rehabilitation of a dwelling or building. The financing model is the only possible variation to develop this type of intervention. There is a traditional system where the owner of the house pays the rehabilitation without taking into account the intervention of an ESCO. In that case, the owner would not have a co-financing option, and should assume the totality of the investment. Considering the existing difficulties to get citizens' engagement, it can be confirmed that this substitute product is not solid enough.

As such, it can be concluded that the threat of substitutes is low.

Figure 4 presents a summary of the forces that determine the competitiveness of Retrofitting industry.

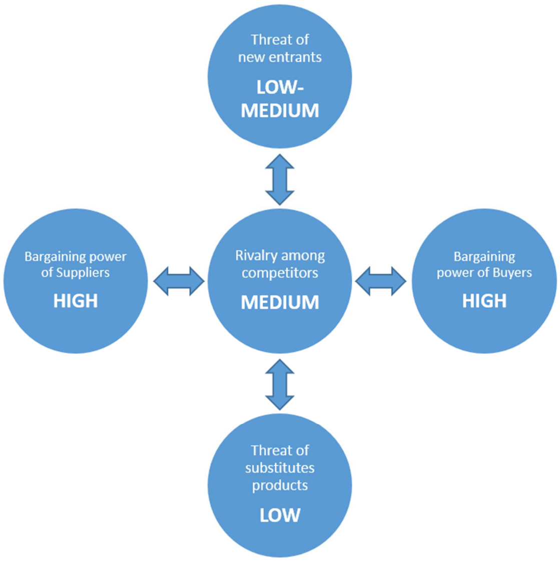

Figure 4.- Porter five force of Retrofitting

5.2 District Heating

This section analyzes the industry of district heating (DH) operators. A DH is an implemented system for distributing heat generated in a centralized location and circulating throughout an urban network supplying residential and commercial buildings.

5.2.1 Rivalry among existing firms

Districts heating, a priori, can only be built and operated by large companies since the structural costs of construction (they require an important civil works in urban spaces), maintenance and operation are high. This reduces the number of actors present in this industry, thus reducing the rivalry.

There are important barriers to success, a factor that needs to be considered. These services are linked to public procurements for a defined number of years. Operators have to offer the service until the exploitation contract ends. Supposing that the operational circumstances are not optimal (from an economic point of view) as the boundary conditions have changed, the operator should assume them. In order to win the procurement, in addition to an economic offer, it is necessary to present technical solution guaranteeing a reduction of CO_2 emissions while improving the city's energy efficiency. These are two of the reasons explaining why few companies compete in this sector, which in turn reduces rivalry. Moreover, during the procurement contract period, there is no rivalry in the area as no one can operate there.

For all these reasons, it can be considered that rivalry is quite low.

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5.2.2 Bargaining power of suppliers

There are two types of providers in this sector. On the one hand, industrial companies that manufacture the essential machinery to build DH. If switching costs are very important and the replacement of their products is rather complicated, the power of these companies is high, especially when DH have already been build. Moreover, these suppliers tend to have a low dependency of this industry due to the fact that their products can be used in other areas and sectors. Finally, there is no risk of vertical integration. In this case, it can be said that the power of the suppliers is relatively high.

On the other hand, we can identify the energy providers. One of the great advantages of DH is that they reduce the energy dependence of cities. Most of DH are using local renewable energy sources, such as biomass from forests, parks and municipal gardens, solar power, or free resources coming from incinerators of urban solid waste (López de Lema 2012).

Therefore, there are many suppliers with medium power over the DH operators.

5.2.3 Bargaining power of buyers

Customers connected to district heating do not have the possibility to choose their provider. Their bargaining power is very low. In order to choose another provider, customers would need to look for other sources of heating. This option would bear relatively high costs and in addition would need a consensus in the case of neighbourhood communities. Usually, the number of customers is high and each one of them with rather low billings and this is something that reduces their power too. Given its dual role as judge (who grants the infrastructure to the operator and authorizes the occupation of public space) and judged (who uses DH to heat municipal buildings), municipalities are the sole type of customers having power over the operator.

5.2.4 Threat of new entrants

When addressing new entrants, two different scenarios can be considered. The first one where new entrants build and operate a new DH, or a second one in which new entrants wait until the end of the concession periods and then start to compete in DH public tenders. In any case, it is necessary a high initial investment, either to build the new infrastructure, or to perform the maintenance and improvement actions that are usually required in this type of public tenders. Although in the first scenario the investment is higher, both amounts represent an important barrier to entry.

DH management companies use economies of scale, which represents another important entry barrier. New entrants don't have either the experience or the necessary know-how to efficiently operate this type of infrastructure. It is also important to bear in mind that the sector is highly regulated, representing another entry barrier.

It is possible to conclude that new entrants represent a low threat for companies that are already operating in this industry.

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5.2.5 Threat of substitutes

There are different heating systems that can replace District Heating. According to European Commission (2016), natural gas (43%), electricity (13%), fuel oil (12%) and biomass (11%) highlight among them for their market share, as it is possible to see in figure 5.

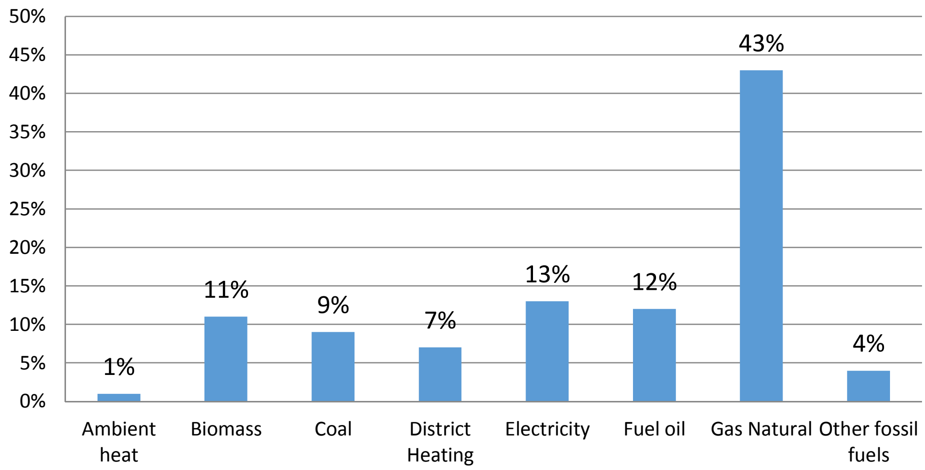

Figure 5.- Heating systems' market share in Europe
(Adapted from European Commission, 2016)

These data clearly shows that there are well-established substitutes in the market. These substitute products solve the users' needs aptly, meaning that users will not be willing to change their source of heat for a district heating one. In the case of buildings under operation, owners should assume very high switching cost to be plugged into a DH.

It is important to emphasize that many dwellings are using individual heating systems. These are another type of substitute product which are significant for many reasons, but particularly because they are affordable and easy to install.

These are very powerful points justifying the very high power of substitute products.

Figure 6 presents a summary of the forces that determine the competitiveness of the District Heating industry.

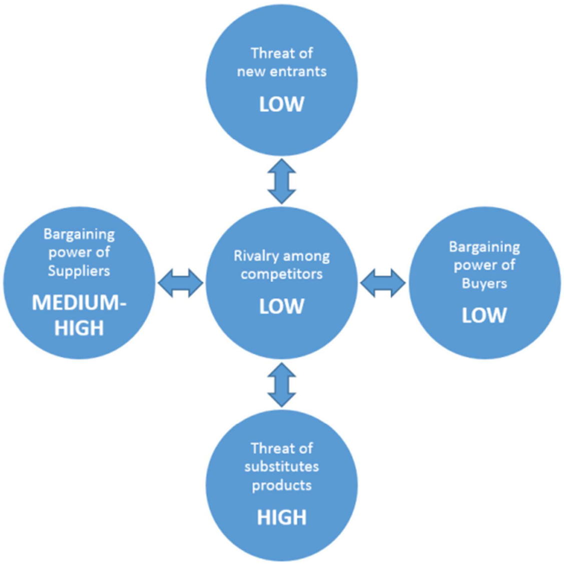

Figure 6.- Porter five force of district heating

5.3 Demand Side Platform

This section analyzes companies offering an online platform that, by monitoring the household energy consumption with smart meters, gives insights on how to save energy.

5.3.1 Rivalry among existing firms

Nowadays, civil society is increasingly aware of the need to reduce energy consumption to attain environmental sustainability. Families and companies are looking for ways to reduce their bills, given the loss of purchasing power suffered by many fellow Europeans in recent years (REF). This is clearly an industry with high growth potential.

Currently, the main value proposition is offering an extra value to customers of the utility companies (especially electricity ones), therefore the commercial margins are still low. However, if the aggregation of a large amount of data from many users is achieved, a second window of opportunity could be opened: the sale of data where the margins are much higher.

It is also important to remark that actors involved in this industry are not equal. Participants range from small startups to large ICT multinationals.

Due to all these conditions, we can conclude that rivalry among operators is medium-high.

5.3.2 Bargaining power of suppliers

Two types of suppliers stand out in this industry. The first group englobes smart meters' manufacturers, while the second one is made of people deciding to install smart meters in their homes.

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The first group of suppliers having power over operators since switching costs to another supplier is not negligible. When a company uses a certain KID to measure users' consumption, changing its supplier could cause integration problems in the data management system as well as with KIDs' installation and maintenance processes, which are usually done by the company that is managing the demand side platform.

Users, which could become future customers, are the second group of providers, as it had been previously pointed out. They are fundamental for these platforms. The problem lies on the high level of distrust with these type of technologies, mainly as they are worried about their privacy. For this reason, governments have developed numerous regulations protecting users, giving them an important bargaining power. In order to achieve such kind of engagement, it is necessary to guarantee an anonymous and safe information management, and this requires an important and common effort by the whole industry.

5.3.3 Bargaining power of buyers

Currently, two types of clients can be identified. Public administrations (to a lesser extent) and electricity companies. Private users do not seem sufficiently aware of their direct potential benefits if paying for this service. Public administrations, where city councils are standing out, might have a special interest in having a demand side platform in order to improve their building energy efficiency as well as providing better services to citizens or companies. Electric companies in that sense can provide this service as an added value to their customers. Therefore, the number of clients would be rather small.

There is also a clear risk of backward integration. Electricity companies could play the role of the demand side platform operators.

It is also true that it is not a standardized product, which can count on intellectual property rights, and there would be important switching costs.

This is why we can say that the power of the clients in medium-high.

There is another possible group of customers, which currently could be considered secondary, but with a very high potential. This group is related to the data market, where aggregated and anonymized data could be sold. In this case the customers' power would be very low given the fact that the demand of this product is huge, and there are many potential customers.

5.3.4 Threat of new entrants

In this industry, it is essential to have access (distribution channels) to the users of the electricity network that will provide data to operators. In this case, companies that are already operating have a preferential access, being this an important barrier to entry to newcomers.

Another key element is the network effect: the later you enter, the worse access you have to customers. These customers, undoubtedly, will prefer to contract entities that have a large amount of data coming from many users.

Companies that are already operating have other incumbent advantages that cannot and should not be underestimated, the most relevant one being experience in such a delicate area as private data management.

Given all these barriers to entry, it is clear that the threat of new entrants is low.

5.3.5 Threat of substitutes

Currently there are no substitute products.

Figure 7 presents a summary of the forces that determine the competitiveness of the Demand Side Platforms sector.

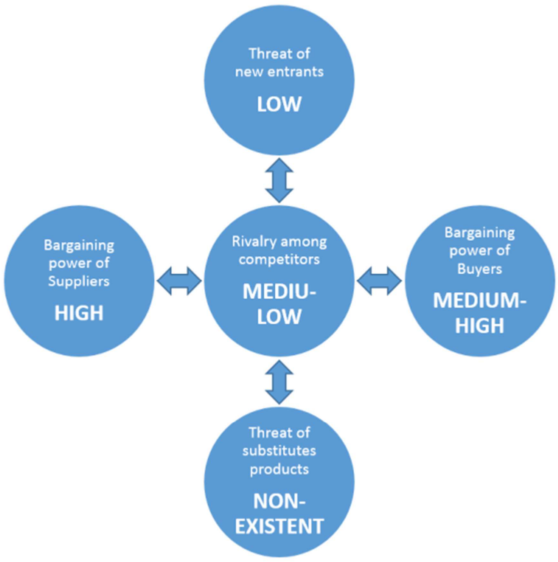

Figure 7.- Porter five force of demand side platforms

5.4 Public Recharging Stations for Electric Vehicles

This section analyzes the sector englobing companies dedicated to offer public points for recharging electric vehicles.

5.4.1 Rivalry among existing firms

Electric vehicles, especially electric cars (EC), have started to represent a real alternative to fuel powered cars around the globe. Although there are still relatively "few" electric vehicles on our streets, in a few years they have increased markedly, as shown in the tendency line of figure 8, with data coming from the International Energy Agency (2017). This is a trend that

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seems highly likely to continue. In order to ensure its consolidation, public administrations have to promote the development of recharging infrastructure according to the expected demand.

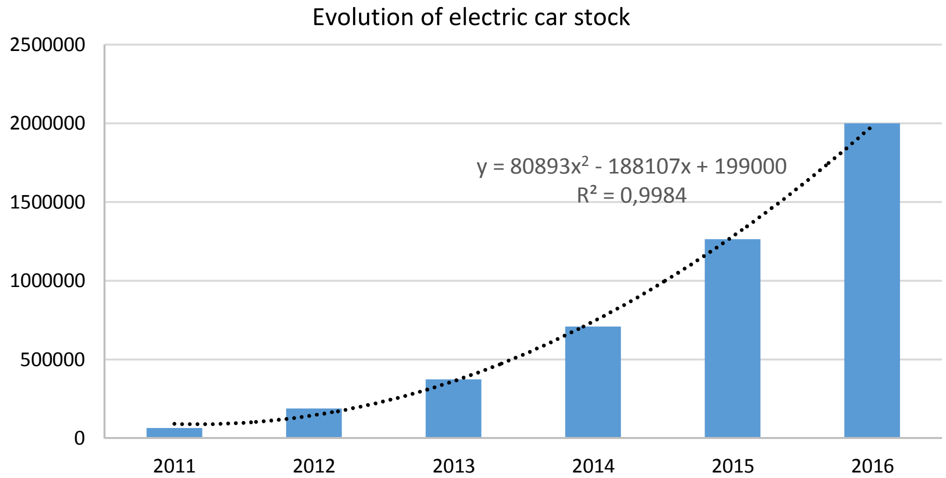

Figure 8.- Evolution of world's EC stock (data from International Energy Agency (2017))

Even though this is a growing sector, at present there aren't many private actors that have installed recharging points in public spaces in order to capture value. Currently the main players in this sector are the energy commercialization companies (Figure 9 shows a station operated by E-Distribuzione) and the owners of traditional service stations, the so-called petrol stations. Having a recharge network fitting the demand is a salient issue for promoting electric vehicles. In this case, the fact that there are different companies promoting this sector through the construction of networks will be beneficial for all the actors that are already participating in it.

Figure 9.- Example of recharging station operated by E-Distribuzione

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Currently, there are few actors offering recharging points since the market is not big enough. Consequently, rivalry among them is low. If the market grows, aspects such as the few differentiations between recharging stations (as it happens today with petrol stations) should be considered. Users have a minimum technical knowledge, so it is complicated for them to distinguish between operators. The differentiation, a priori, will only be achieved through the price of the recharge and its speed. Therefore, it can be concluded that the rivalry between companies in the sector is still low, but may increase in the near future.

5.4.1 Bargaining power of suppliers

Although recharging stations are a highly technological product and there are patents linked to some models, this is a very standardized technology with high number of potential suppliers. Even so, the switching cost of changing suppliers is not negligible for reasons such as operational efficiency, the consolidation of a corporate image and the training of technicians who have to be in charge of the machines' maintenance, among others issues.

Energy providers are other important actors to take into consideration in this stage of the analysis. In this case, and due to the fact that electricity supply is a highly regulated activity in Europe, they have few power over operators of the recharging stations. Moreover, it is not expected that there be vertical integration.

Faced with this situation, it can be said that the power of the suppliers is quite low.

5.4.2 Bargaining power of buyers

Currently, recharging stations located in cities can have two types of customers: the municipality or the owners of electric vehicles (users of the service). Cities can be considered as customers because some of those have free recharging stations in public spaces. In these cases, the municipality is assuming the cost of consumed energy. At all events, both cities and vehicle owners have relatively low power given the limited network of recharging stations (public and private). However, cities – as regulators of all activity carried out in a public space – usually have a greater bargaining power than citizens have and get better conditions.

5.4.3 Threat of new entrants

This sector is closely linked to innovation, therefore the emergence of some kind of new technologies that revolutionize the market can not be ruled out. Even so, everything indicates that the main operators will be either the electric companies or the current owners of the petrol stations. This market could be also occupied by the electric car manufacturers through a forward integration in the value chain. In fact, at the end of 2016, some of the main brands of the automotive sector (Ford, Volkswagen, BMW and Daimler) signed an agreement to deploy a network of 400 stations in Europe with the Combined Cargo System

(CCS), although it isn't currently clear who will manage the operation of this network. Tesla could be an example. It owns its recharging network only to offer service to vehicles of its brand.

Even so, the threat of new entrants is relatively low in short term, but it may increase in the future depending on the appetite of other players in the industry.

5.4.4 Threat of substitutes

There are two different products that are becoming real substitutes even if there are entering into the settlement phase.

The first one are the private chargers that the owners of electric vehicles can install where they park their vehicles regularly during at least 6 hours (for example at night). Everything indicates that this solution will be consolidated and most private parking will incorporate the possibility of charging EV, both in single-family homes and neighborhood communities. This will mean that only three types of vehicles will recharge their batteries in the streets: those that do not have private parking, those that must travel many kms daily (the number of these vehicles will be reduced when batteries improve their performance) and finally those vehicles that must stay overnight outside of its "home".

It is important to emphasize that batteries could increase autonomy in the future, therefore it won't be so necessary to charge them during the day.

Beyond the "conventional" recharging stations, there are other type of devices to recharge the electric vehicle in the street. Once a vehicle has been parked, these devices allow recharging via connecting the vehicle with the lamppost. Figure 10 shows an example of one of this devices (ubitricity.com). Cars owners pay the recharge to the manufacturer of the devices, and this in turn pays the public lighting operator.

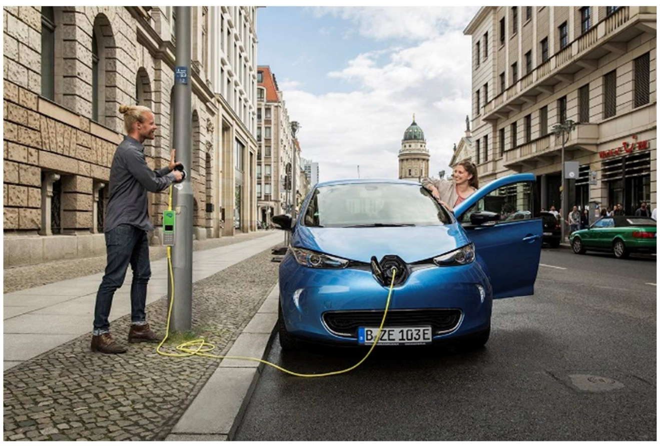

Figure 10.- EV enjoying a charge from a lamppost (from ubitricity.com)

Additionally, in the future, it is possible electric vehicles can be recharged by electromagnetic induction through electrified roads or platforms. European Commission within the 7th Framework Program promoted research in this type of charging system, specifically into sustainability of the inductive load for the urban environment, however, there is still a long way to go.

Therefore, it is possible to conclude that the rivalry between companies in this sector is still low, but may increase in the near future.

Figure 11 presents a summary of the forces that determine the competitiveness of Public Recharging Stations for Electric Vehicles.

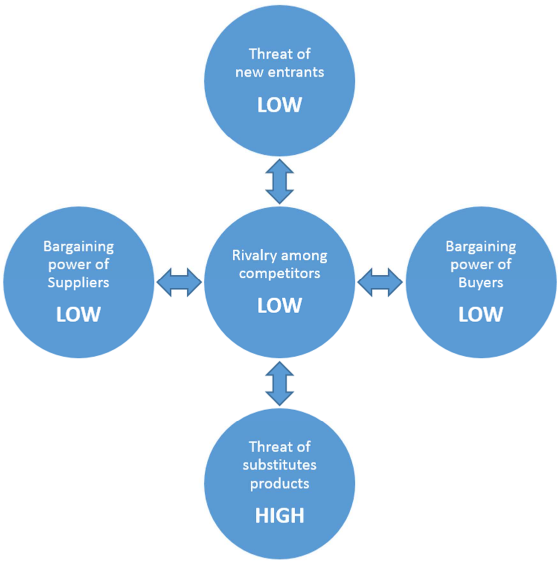

Figure 11.- Porter five force of Public Recharging Vehicles Stations

5.5 Smart Lighting

This section analyses the sector formed by the companies dedicated to manufacture intelligent infrastructures for public lighting.

5.5.1 Rivalry among existing firms

There are an increasing number of organizations that are developing what is known as smart lighting (figure 12 shows two different examples of it). Most of them are entities with a long tradition in the public lighting sector. Through innovation, these companies have developed new products that incorporate technologies related to ICT. In that sense, smart lighting regarding lamppost involves different types of products. There is a wide range, from led based in electricity to those based in renewable energies, such solar energy.

Economies of scale are very important and represent significant competitive advantage for large companies. However this is an industry with a high growth potential, at least in upcoming years. According to Bain (2015), it is necessary to upgrade 60-90 million streetlights, most of which are more than 25 years old, to more efficient technology.

Figure 12.- REPLICATE's smart lighting: a) Donostia (source: Leycolan); b) Florence

In general terms, smart lampposts are difficult to differentiate for citizens, although there are technical characteristics that make each product almost unique, therefore switching costs are high.

For all these reasons, it is possible to conclude that the rivalry is medium.

5.5.1 Bargaining power of suppliers

There is little concentration of suppliers, and it implies that - as an industry - they have a lot of power over their customers. Moreover there is low dependence on industry, due to the fact that the supplier have many buyers from other sectors. However, there is an important standardization of the elements that make up a smart lamppost. It means low differentiation, and therefore it would be easy to purchase similar products from different suppliers. In addition, a backward integration could happen. So, we can conclude that the Bargaining power of suppliers is medium.

5.5.2 Bargaining power of customers

Cities are the main customers of smart lamppost manufacturers, which means that the number of clients is quite limited in number but not in purchasing power.

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New smart lampposts are quite standardized because they should be able to be incorporated into the existing lighting network without problems or incompatibilities. Although the technological proposal is a very important element, as with many other public facilities, smart lampposts are usually bought through a public tender, where the price is a fundamental variable. On the other hand, switching costs are very high.

It can therefore be concluded that the bargaining power of customers is quite high.

5.5.3 Threat of new entrants

This is a sector with important barriers to entry. First of all in order to manufacture lampposts an important initial investment is necessary and not all companies have it available. Economies of scale are fundamental in lamppost production, which are difficult for a new entrant for obvious market share reasons. Experience and reliability are very important requirements in public tenders, and these always benefit actors that are already well established in an industry. Existing actors also have preferential access to the distribution channels. For all these arguments, it is possible to conclude that the threat of the new entrants is low.

5.5.4 Threat of substitutes

Maybe the first and most important substitute would be the so-called zero alternative, that do not change the current lighting system. The main need of lighting public areas has already been already resolved in developed countries. In fact, it was solved many years ago. So, considering that the economic situation is not yet particularly correct, as has been seen in the PESTEL analysis, in a short term it is difficult to propose a massive replacement of traditional lighting.

Another possibility is to replace the current lighting system for a LED lighting technology.

This is not a smart technology, but it solves the main problem presented by current public lighting: the high energy and operating costs. LED lampposts improve energy efficiency with less initial investment if we compare it with a smart solution. LED lampposts are simple from a technological point of view, and it implies that they are easy to manage.

Figure 13 presents a summary of the forces that determine the competitiveness of the Smart public lighting sector.

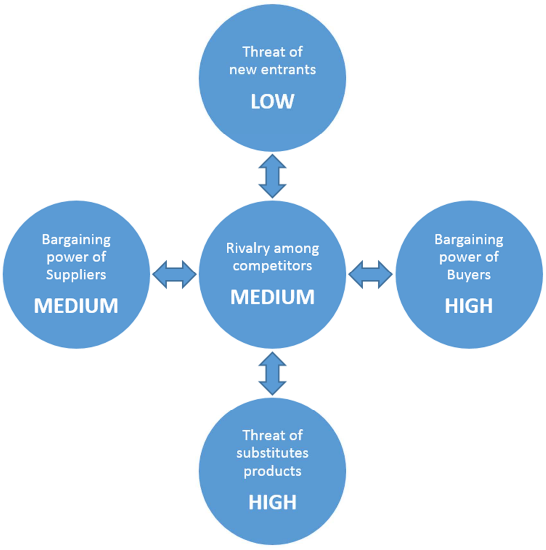

Figure 13.- Porter five force of Smart public lighting

6. Market analysis

When a company defines a sector as attractive, it is imperative to carry out a market study, identifying whether or not there is a real demand, and measure how large this market is and its potential (Sull, 2005). It allows companies to know more about their customer base and the pricing point for the solution they propose.

As explained in D9.2, Blank and Dorf (2012) suggest that a good starting point for assessing the market size is estimating the following "market types", which are calculated in revenues or unit sales:

- Total Available Market (TAM): It is the total market demand that a company can reach with the new product or solution.
- Serviceable Available Market (SAM): it is the proportion of TAM that a company could target based on its business model.
- Share Of Market (SOM): It is the percentage of SAM that the company will realistically reach in the short-term.

Theoretically, it is considered that the TAM's analysis must be made worldwide (do not forget that this concept is mainly related by technological products). Anyway, in this case and due to the fact that the interventions are closely related to a series of local characteristics (auxiliary infrastructures, geolocation, population, etc.) we understand that the TAM should be reduced to the each lighthouse's region or country at most. Because of the fact that the analysis is focused on the selected interventions in each of the lighthouse cities, TAM will not be calculated. The study will focus its efforts on calculating the SAM,

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which represents the total potential market in each city, and the SOM, which represents the market that is wanted to be served during the REPLICATE project.

The market size, as usual, will be quantified in euros. To carry out this work data from some REPLICATE's documents has been used - DoA REPLICATE (691735), D7.1 Report on peer-review methodology including templates and supporting materials and D9.1 Baseline definition and integration and results from WPs 3, 4, 5 and 8 - as well as from secondary sources and future forecasts and hypotheses made by ESADE's team that will be justified timely and rigorously.

6.1 Retrofitting

One of the ways of achieving sustainable development in cities is by reducing the energy consumption of buildings, especially the oldest ones, which are the main retrofitting target. We consider as old buildings those of around 50 years old or more (Buildings Performance Institute Europe, 2011). They represent around 35% of the total number of buildings in Europe. According to Kuusk and Kalamees (2015), the investment cost for retrofitting a dwelling is around 150-170 €/m^2. Thereby the SAM and SOM of this type of intervention will be calculated through eq. 1.

(Eq.1A)

(Eq.1B)

6.1.1 San Sebastian

There are approximately 88.000 dwellings in San Sebastian. Fomento de San Sebastián has estimated that 8% of them have been already retrofitted and another 10% are new or semi-new. According to this data, Fomento de San Sebastián has estimated that 72,000 dwellings could need a retrofitting. In Spain, the average size of dwellings is 94m^2 (Sebi, Lapillonne and Routin, 2013). Taking 160 €/m^2 as an average cost of retrofitting, the SAM will be 1,000M€ approximately (see eq. 1A and 2).

(Eq.2)

REPLICATE plans to retrofit 156 dwellings. Taking into account that there are 2.53 people per dwelling, (INE, 2014), it will directly benefit 395 people (see eq. 3). Moreover, the project plans also to retrofit 34 commercial premises. The whole project plans to retrofit 18.350 m^2, considering both dwellings and commercial premises. Using eq.1B, we have that SOM will be 2.9M€ approximately (see eq. 1A and 4).

(Eq.3)

(Eq.4)

6.1.2 Florence

According to Florence's 2017 Structural Plan, it is planned to retrofit 9,286 apartments (75 square meters / accommodation), therefore 696,450m² and about 211,600 m² of facilities. Taking 160 €/m² as an average cost of retrofitting, the SAM will be 145M€ approximately (see eq. 1B and 5).

(Eq.5)

REPLICATE plans to benefit 700 people in Florence through retrofitting interventions (D7.1). Taking into account that there are 2.3 people per dwelling (D7.1), this means that approximately 300 dwellings should be retrofitted (see eq.12). Florence knows (DoA) that the net surfaces to retrofit is about 20,207m². With this surface and using eq.1B and the same cost per m², we have that SOM is equal to 3.2M€ approximately (see eq. 1 and 7).

(Eq.6)

(Eq.7)

6.1.3 Bristol

According to Bristol City Council (2012), in 2011, there were 182,747 dwellings in Bristol. A minimum of 75% of them were built before 1967 (Opinion Research Services, 2012). Hence, there are 135,233 dwellings with the potential to be retrofitted (eq. 14). In England, the average size of dwellings is approximately 75m² (Sebi, Lapillonne and Routin, 2013). Taking 160 €/m² as an average cost of retrofitting, it means that SAM is equal to 1,600M€ approximately (see eq. 1A and 15).

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(Eq.8)

(Eq.9)

REPLICTATE plans to benefit around 552 people in Bristol through retrofitting interventions (D7.1) using the following assumptions. It is assumed there are approximately 2.3 people per dwelling with an aim to retrofit 240 dwellings (see eq.16). Using eq.1 and the same average size of dwelling as before with the same cost per m², we get a SOM of 2.9M€ approximately (see eq. 1A and 11).

(Eq.10)

(Eq.11)

6.2 District heating

A district heating system contributes to improve a city's energy efficiency. Beyond its efficiency rate, its main advantages is to use renewable energy sources and reduce CO2 emissions, as well as other benefits generally associated with economies of scale. Its construction is quite complicated because at the very least it has to include the deployment of piping, infrastructure, the heat generation station and a control system for heat generation. In order to calculate the SAM and SOM (see eq. 12), we will consider the expected energy consumption by each of the districts heating of our lighthouse cities and the price of this energy. In this case, and according to Fernández et al. (2016), we will consider 0,113 €/KWh (VAT included)

(Eq.12)

6.2.1 San Sebastian

In San Sebastian, currently it is only foreseen to build the District Heating planned in the REPLICATE Project, which will include approximately 1,500 dwellings. This means that SAM_{SS} and SOM_{SS} are equal. Supplying the area of Txomin Enea, this District Heating will consume 1710MWh/year approximately (DoA). It means that SOM is almost 195,000€ (see eq. 12 and 13).

(Eq.13)

6.2.2 Florence

In Florence, currently it is only foreseen to build the District Heating planned in the REPLICATE Project. It will include the same buildings considered in the retrofitting intervention. As in San Sebastian, SAM_{SS} and SOM_{SS} are equal. According to Florence municipality, the DH will consume consumption 46.6 KWh/m^2 per year. Taking into account that the net surfaces to retrofit is about 20,207m^2, the District Heating will consume 941,646.2 KWh/year approximately (see ep. 14). It means that SOM is almost 150,000€ per year (see eq. 12 and 15).

(Eq.14)

(Eq.15)

6.2.3 Bristol

There is an existing district heating system operating in Bristol. The city has understood the benefits produced by this type of infrastructure and plans (subject to amendment approval) to connect two energy centres to allow for two larger heat networks providing the potential for further connections to around 15 (2+13) housing blocks and office buildings in the coming years. When all of the buildings are connected, their aggregate consumption will be 17,235.356MWh/year. It means that SAM is almost 2M€ per year (see eq. 12 and 16).

(Eq.16)

As part of the above mentioned action, REPLICATE plans to install and connect a network extension between the biomass boilers at Broughton House in Redcliffe (private building) to the Council's offices at 100 Temple Street (public sector), where a new gas CHP is being considered. This will enable holistic energy demand management and future connections to this network. In supplying these buildings, the district heating scheme will consume

7,071.203 MWh/year approximately. It means that SOM is almost 800,000€ per year (see eq. 12 and 17).

(Eq.176)

6.3 Demand side platform

One of the best ways to reduce the CO_2 and improve the environmental sustainability of our cities is by reducing energy consumption. Demand side platforms (DSP) are being designed in order to provide information to citizens. The users of the DSP will be able to understand how their energy behaviour is and how they can reduce their energy bills. REPLICATE is developing a DSP in each of the lighthouse cities, so there is no future market on that. For this reason, market analysis will be focused on how many information kits (devices) will be potentially necessary in each city. It's true that there are many types of kits, but for this purposes of this section we will follow the case of the Florence's Pilot and consider that each kit cost 100€. Thereby the SAM and SOM of this type of intervention will be calculated through eq. 18.

(Eq.18)

6.3.1 San Sebastian

According to Fomento de San Sebastián, there are 88.000 dwellings approximately in San Sebastian, where it would be possible to install an information kit to register and understand the energy behaviour of the owners/tenants. It means that SAM is equal to 8,8M€ approximately (see eq. 18 and 19).

(Eq.19)

REPLICATE plans to connect to de demand side platform of San Sebastian 1,500 dwellings approximately. This connexion is part of the DH intervention, so it does not represent an extra investment in terms of smart devices. It means that SOM will be zero

6.3.2 Florence

There are 382,346 habitants in Florence (ISTAT, 2017), if the dwellings average occupancy is 2.3, there are 166,237 dwellings where would be possible to install an information kit to register and understand the energy behaviour of the owners/tenants (see eq. 20). It means that SAM is equal to 16,6M€ approximately (see eq. 18 and 21).

(Eq.20)

(Eq.21)

REPLICATE plans to connect approximately 600 dwellings to the Florence demand side platform. It means that SOM is around 60,000€ (see eq. 18 and 21).

(Eq.21)

6.3.3 Bristol

There are 454,200 habitants in Bristol (Bristol City Council, 2017), if the dwelling average occupancy is 2.3 people, there are approximately dwellings where it would be possible to install an information kit to register and understand the energy behaviour of the owners/tenants (see eq. 29). It means that SAM is equal to 19,7M€ approximately (see eq. 18 and 23).

(Eq.22)

(Eq.23)

REPLCIATE plans to connect approximately 150 dwellings to the Bristol demand side platform. It means that SOM is around 15,000€ (see eq. 18 and 24).

(Eq.24)

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6.4 Recharging stations

Cities are working hard in order to promote Electric Vehicles (EVs). They are offering many advantages like exclusive access to some city areas, buying EVs for their own fleets, offering grants to potential private buyers, etc. However one of the most important tasks that they have to do is to foster an appropriate recharging infrastructure network in the whole city. Electric vehicles will be deployed with guarantees, only if the necessary recharging points are secured.

REPLICATE plans to increase this type of infrastructure in our three lighthouse cities, so the market analysis will be focused on how many public recharging stations will be potentially located in each city. Thereby the SAM and SOM of this type of intervention will be calculated through eq. 25A.

(Eq.25A)

There are many types of stations, but for the purposes of this section we will consider an average cost per station equal to 4,500€ (Smith and Castellano, 2015). Table 1 presents the features of the considered station. Obviously, there are better and also worse stations, however this is an average station type.

Table 1.- Features of the selected recharging station (Smith and Castellano, 2015)

Charging Level	Vehicle Range Added per Charging Time and Power	Supply Power
AC Level 2	10 mi/hour @ 3.4kW 20 mi/hour @ 6.6kW 60 mi/hour @ 19.2 kW	208/240VAC/20-100A (16-80A continuous)

According to Hall and Lutsey (2017), there is no universal ratio for the number of electric vehicles per public charge point. However, Harrison and Thiel (2017) found that the private market can profitably support 95% of public charging stations, up to a ratio of 25 electric vehicles per charge point, so we will use this ratio as a reference for our market analysis. It means that SAM and SOM can be calculated with eq. 25B.

(Eq.25B)

6.4.1 San Sebastian

Theoretically, there will be 6,000,000 Electric Vehicles in Spain by 2030 (Deloitte, 2016). We can assume that these vehicles will be homogenously spread all over Spain. Taking into account that there are 186,064 citizens in San Sebastian (0.4% of the population of Spain) and there are 46,560,000 citizens in Spain (INE, 2017), we can suppose that there will be 23,977 EV in San Sebastian in 2030 (see eq. 33). Therefore, SAM is equal to 4,3M€ approximately (see eq. 25B and 27) due to the fact that the city would need about 959 recharging stations.

(Eq.26)

(Eq.27)

Beforehand, we want to remind that San Sebastian has not decided how will deploy this intervention yet. Even so, nowadays REPLICATE estimates to install 30 recharging stations in San Sebastian. It means that SOM is about 135,000€ (see eq. 25A and 28).

(Eq.28)

6.4.2 Florence

There will be 9,000,000 Electric Vehicle in Italy in 2030 (Licata, 2017). We can suppose that these vehicles will be homogenous spread across the country. Taking into account that there are 382,346 citizens in Florence (0.63% of the population of Italy) and there are 60,500,000 citizens in Italy (ISTAT, 2017), we can suppose that there will be 56,878 EV in Florence in 2030 (see eq. 29). Therefore, SAM is equal to 10,2M€ approximately (see eq. 32B and 37) due to the fact that the city would need about 2,275 recharging stations.

(Eq.29)

(Eq.30)

REPLICATE plans to install 147 recharging stations in Florence, 40 of them in Novoli district. It means that SOM is about 661,500€ (see eq. 25A and 31).

(Eq.31)

6.4.3 Bristol

There will be approximately 9,000,000 Electric Vehicles in UK in 2030 (Vaughan, 2017). We can suppose that these vehicles will be homogenously spread across the country. Taking into account that there are 454,200 citizens in Bristol (0.69% of the population of UK) and there are 65,600,000 citizens in UK (Office for National Statistics, 2017), we can suppose that there could be up to 62,314 EVs in Bristol in 2030 (see eq. 32). Therefore, SAM is equal to 11,2M€ approximately (see eq. 32B and 40) due to the fact that the city would need about 2,492 recharging stations.

(Eq.32)

(Eq.33)

In combination with another funded project (Go Ultra Low West), there are plans to install 120 recharging stations (or 'points') around Bristol. Between 6-11 of these are planned within the REPLICATE in the project area. It means that SOM is about 540,000€ (see eq. 25A and 34).

(Eq.34)

6.4.4 Energy potential expenditure

The number of recharging stations is clearly related to the number of EVs (Harrison and Thiel, 2017). The owners of these vehicles (or someone else) will have to pay for the energy consumed. Therefore, energy providers will appreciate knowing the value (money) they can capture either from public or private recharging points per year. To calculate this, we need to know the number of EVs per country, and lighthouse city, per year.

Knowing the number of EVs in 4 different years (see table 2) and knowing that the increase of EV is potential (see figure 8), we have calculated a continuous function that describes the evolution of EV in each country (see last column of table 2) using the method of least squares.

Table 2.- Evolution of Electric Vehicles in Spain, Italy and UK

	N° of Electric Vehicles					Equation
	2013	2017	2020	2025	2030	
Spain	-	$18 \cdot 10^3$ (Europapress, 2015)	$110 \cdot 10^3$ (Saura, 2017)	$2 \cdot 10^6$ (Deloitte, 2016)	$6 \cdot 10^6$ (Deloitte, 2016)	$y = 42615x^2 - 93427x + 14346$ $R^2=1$
Italy	-	$21 \cdot 10^3$ (Palmieri, 2017)	$1 \cdot 10^6$ (FIMS, 2016)	$3 \cdot 10^6$ (Licata, 2017)	$9 \cdot 10^6$ (Licata, 2017)	$y = 55845x^2 - 59503x + 233630$ $R^2= 0{,}9926$
UK	$3{,}5 \cdot 10^3$ (Church, 2017)	$63 \cdot 10^3$ (Church, 2017)	$1 \cdot 10^6$ (Clarke, 2012)	-	$9 \cdot 10^6$ (Vaughan, 2017)	$y = 38912x^2 + 179640x + 90466$ $R^2=1$

Table 3 shows the number of EVs in each country and in each lighthouse city from 2020 to 2030. Again, we have assumed a homogenous distribution of EVs, and we have used the population ratio to calculate the number of EVs per city.

Table 3.- Potential evolution of Electric Vehicles in Spain, Italy and UK from 2020 to 2030

	N° of Electric Vehicles					
	Spain	San Sebastian	Italy	Florence	UK	Bristol
2020	117,600	470	557,726	3,525	979,594	6,782
2021	322,478	1,289	889,138	5,619	1,431,618	9,912
2022	612,586	2,448	1,332,240	8,419	1,961,466	13,581
2023	987,924	3,948	1,887,032	11,926	2,569,138	17,788
2024	1,448,492	5,788	2,553,514	16,138	3,254,634	22,534
2025	1,994,290	7,970	3,331,686	21,055	4,017,954	27,819
2026	2,625,318	10,491	4,221,548	26,679	4,859,098	33,643
2027	3,341,576	13,354	5,223,100	33,009	5,778,066	40,006
2028	4,143,064	16,557	6,336,342	40,044	6,774,858	46,908

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2029	5,029,782	20,100	7,561,274	47,786	7,849,474	54,348
2030	6,001,730	23,984	8,897,896	56,233	9,001,914	62,327

It is necessary to note that, on average, a European car runs approximately 13,000km per year (ADAC, 2015). It is also important to determine how much recharging an EV could cost. In that sense, for a public station, we will consider data from Florence (Ferrara, 2017), where it is possible to recharge an EV for 0.0388 €/km; and according to Costas (2017) we will consider that it is possible to recharge an EV at home for 0.0176 €/km. Table 4 presents the maximum and minimum amount of money that owners could spend from 2020 to 2030 in San Sebastian, Florence and Bristol recharging their EV according to the data presented in table 3. Figure 14 presents the same values but in a more visual way.

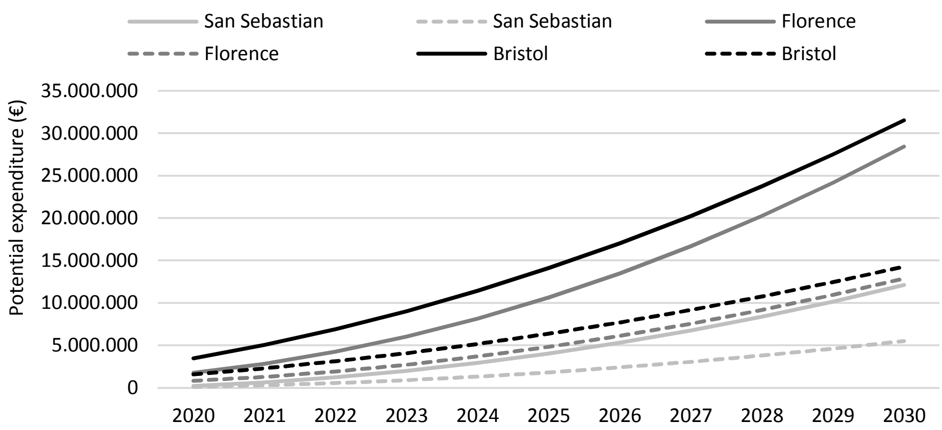

Figure 14.- Potential evolution of Electric Vehicles in Spain, Italy and UK from 2020 to 2030

Table 4.- Recharging EV: Potential expenditure in San Sebastian, Florence and Bristol

	San Sebastian		Florence		Bristol	
	Max (€)	Min (€)	Max (€)	Min (€)	Max (€)	Min (€)
2020	237,589	107,526	1,781,931	806,451	1,551,835	3,428,927
2021	651,506	294,853	2,840,791	1,285,661	2,267,913	5,011,172
2022	1,237,614	560,109	4,256,499	1,926,370	3,107,278	6,865,829
2023	1,995,914	903,294	6,029,056	2,728,579	4,069,928	8,992,897
2024	2,926,405	1,324,407	8,158,462	3,692,287	5,155,864	11,392,377
2025	4,029,086	1,823,449	10,644,717	4,817,495	6,365,086	14,064,268
2026	5,303,959	2,400,420	13,487,821	6,104,202	7,697,593	17,008,571
2027	6,751,023	3,055,320	16,687,774	7,552,410	9,153,387	20,225,286

2028	8,370,279	3,788,149	20,244,575	9,162,116	10,732,466	23,714,413
2029	10,161,725	4,598,906	24,158,226	10,933,323	12,434,830	27,475,951
2030	12,125,362	5,487,593	28,428,725	12,866,029	14,260,481	31,509,901
TOTAL	53,790,462	24,344,026	136,718,578	61,874,922	169,689,592	76,796,661

6.5 Smart public lighting

In order to become smart, cities have to improve their public lighting infrastructures, which are an essential element of urban environment. Having the right illumination in the right moment implies many benefits such as increasing citizen's safety, cities walkability and diversity, as well as reducing light pollution, energy consumption and operation costs. This infrastructure is composed by the smart lampposts and by a management system. REPLICATE is developing the management system in each of the lighthouse cities, so the market analysis will be focused on how many smart lamppost will be potentially necessary in each city. In this type of intervention the SAM and SOM will be calculated through eq. 35.

(Eq.35)

6.5.1 San Sebastian

The replication of this intervention is nowadays considered in 6 industrial areas, where currently there are about 852 lamppost. We have to remind that in many areas of San Sebastian, the lampposts are an important part of the landscape. As such it is not possible to replicate this solution across the whole city. According to Leycolan, who is designing, building and installing the smart lamppost in REPLICATE, the cost of one new public column is 915€ (workforce included). It means that SAM is equal to 780,000€ approximately (see eq. 35 and 36).

(Eq.36)

** SAM_{SS} is noticeably lower than the one in Florence and Bristol because San Sebastian only plans to replace the lamppost of 6 industrial areas.*

REPLICATE plans to install 90 new smart lamppost in San Sebastian. It means that SOM is around 80,000€ (see eq. 35 and 37).

(Eq.37)

6.5.2 Florence

There are about 40,500 lampposts across Florence (D7.1). According to Florence Municipality (D7.1), the average cost of each smart lamppost that will be installed is about 380€. It means that SAM is equal to 15,4M€ approximately (see eq. 35 and 38).

(Eq.38)

REPLICATE plans to install 6,000 new smart lampposts in Florence, the 80% of the total lampposts in the Novoli district, where the REPLICATE'S interventions is being deployed. It means that SOM is around 2,3M€ (see eq. 35 and 39).

(Eq.39)

6.5.3 Bristol

According to Lee (2017) there are around 40-45,000 lamppost columns across Bristol. The municipality has already replaced 4,500 of them to a combination of LEDs and intelligent LEDs. Thereby, there are around 40,000 lamppost columns still to be replaced in the city. Taking 850€ as an average cost of a new smart lamppost (all installation cost included), the SAM is equal to 34M€ approximately (see eq. 35 and 40).

(Eq.40)

Bristol does not plan to install new smart lamppost as a part of REPLICATE. Its idea is deploying sensors on intelligent lighting columns as they are upgraded to measure air quality, environmental and atmospheric factors. In order to deploy this network of sensors, which is called "Array of Things", the Municipality plans to invest around 205,000€ (eq. 41), this amount can be considered as the SOM of this intervention.

(Eq.41)

6.6 Market size summary

Table 5 shows a summary of the results presented during this section per city and intervention.

Table 5.- Market size summary per city and type of intervention

	San Sebastian (M€)		Florence (M€)		Bristol (M€)		TOTAL (M€)	
	SAM	SOM	SAM	SOM	SAM	SOM	SAM	SOM
Retrofitting	1,000	2.9	1,450	3.2	1,600	2.9	2,745	9
District Heating	0.195	0.195	0.100	0.100	2	0.8	2.345	1.145
Demand Side Platform	8,8	0	16.6	0.060	19.7	0.015	45.1	0.075
Public recharging stations	4.3	0.135	10.2	0.661	11.2	0.540	25.7	1.336
Smart Public lighting	0.78	0.082	15,4	2,3	34	0.205	50.18	2.587
							2,868	14.093

This market size analysis has shown the amount of money involve in each of the industries for every city. Moreover, when the final users are common citizens, it has shown how many people could be interested on each solution, and what budget they need to afford them.

Overall, lighthouse cities create markets to ensure the sustainability of the companies that could be involved on them. It is clear that there are associated risks, especially for SMES, but the numbers presented in this section will allow companies to respond in the initial stages with a greater knowledge.

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7. Value chain of the selected interventions

The development of a smart city creates a network of organizations working "together" in a value chain in order to produce products or services. We will use the Value Creation Ecosystem (VCE) method to build a map that helps to understand how our lighthouse cities could develop each of the selected interventions. Moreover, each VCE will allow us to identify what value is created through an intervention, what stakeholders have to be involved, what relations there are among them, and what value they receive as a payback.

This section will show fifteen VCEs, which have to be understood just as a theoretical guide or scheme. It is possible that the interventions finally follow another approach because they are part of live projects. Nevertheless, these VCEs will allow us to recognize stakeholders around whom it is possible to develop an interesting business model – which is the main objective of this deliverable and a key issue for the next one, D9.4.

The authors will give a broad overview of the significant aspects of each VCE in the following subsections. However, it is important to take into account some theoretical concepts to fully comprehend the proposed VCEs. In the following figures, black arrows show the value that stakeholder "A" offers to stakeholder "B", and red arrows show the payback (the value captured) that stakeholder "A" receives from stakeholder "B". Each arrow has an attached name that indicates the type of value transferred or captured. Paybacks are sometimes presented in orange, which indicate that they are the result of a saving. If two values are related, they have the same name and each one bears an asterisk (*). Occasionally, VCEs present a green rectangle with a dashed line that frames two stakeholders; the municipality is always one of them. It means that the municipality could play the role of both actors if it wants to.

7.1 Retrofitting

7.1.1 San Sebastian

Figure 15 shows the VCE of San Sebastian retrofitting intervention. Giroa-Veolia, acting as an ESCO, will retrofit the apartments for improving its energy efficiency. Most of the owners will pay that intervention with the monthly savings in the energy (heating) bills. However, those with greater purchasing power could decide to pay the intervention beforehand. The energy saving will improve the whole city environment. Giroa will pay the construction company for the retrofitting of the apartment. FSS, who leads the transition to a Smart City at the request of the municipality, will help Giroa with city engagement.

Giroa – Veolia is the key industrial partner in this intervention and the business model foreseen seems interesting enough to be further studied in next deliverable.

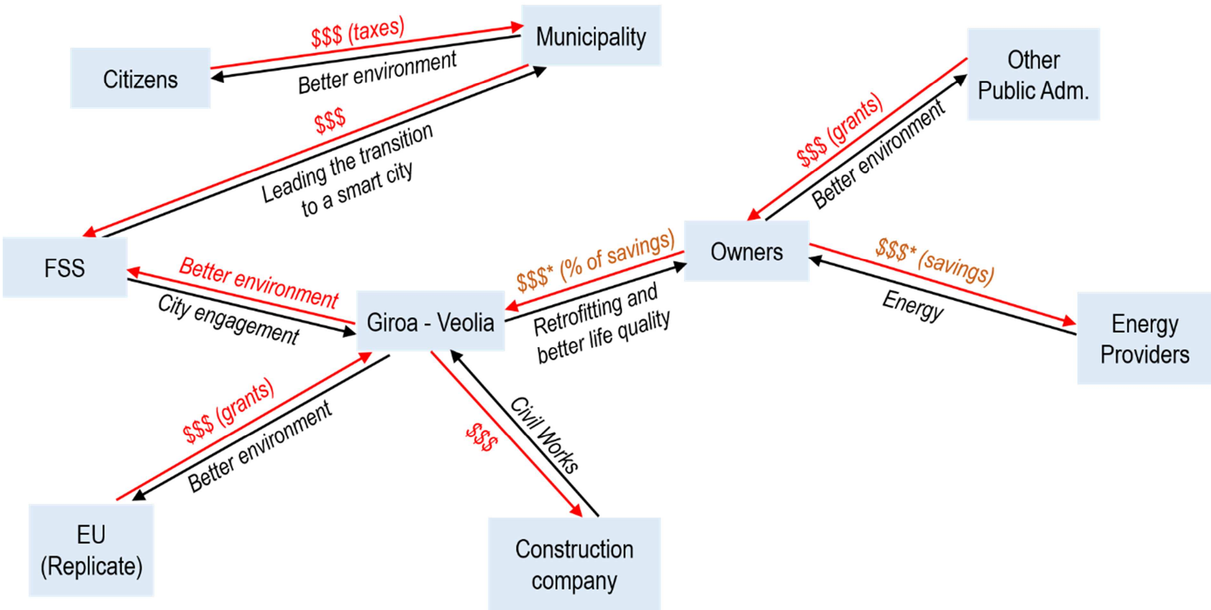

Figure 15.- VCE of San Sebastian retrofitting intervention

7.1.2 Florence

Figure 16 presents the VCE of Florence retrofitting and district heating intervention. These two interventions involve the same buildings, have many issues in common and will be analyzed together. The municipality will commission one (or several) company(ies) to carry out the necessary work to retrofit two municipally owned social housing buildings. These works will include the construction of district heating, as well. The municipality will pay for the work with taxes, grants and loans it receives from both the EU and other public administrations. Casa Spa will manage the rehabilitated buildings, and will rent them to families with social and economic needs. Casa Spa will have two revenue sources, one from the municipality, as a manager of the building, and the other from the tenants, who will pay a social rent. Thanks to the intervention the tenants will spend less energy, reducing their bills and contributing to the improvement of the City environment.

Casa Spa is key stakeholder in this intervention and its business model seems interesting enough to be further studied within next deliverable.

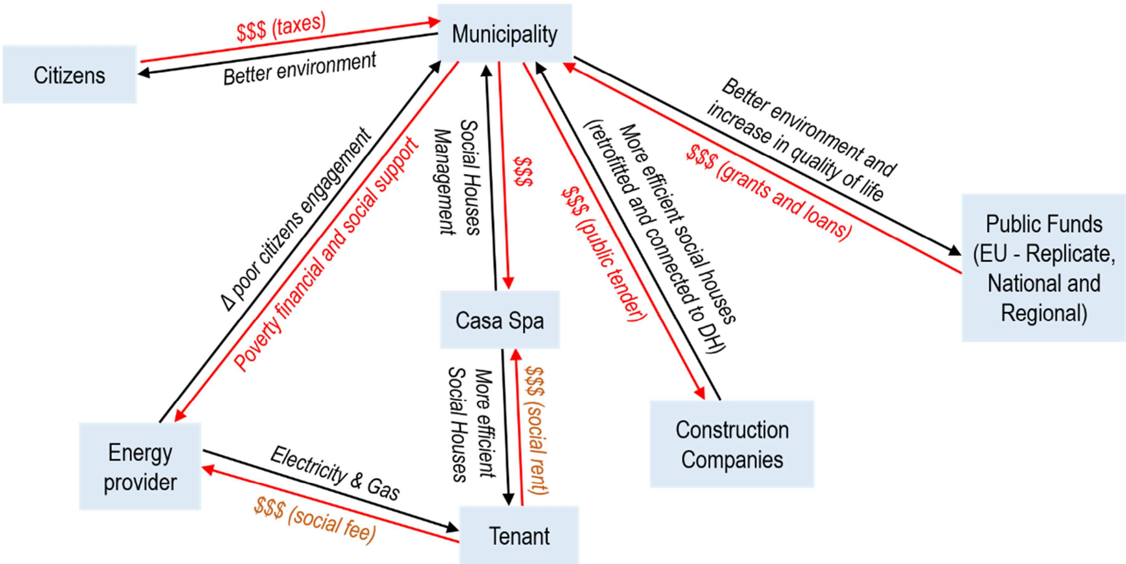

Figure 16.– VCE of Florence retrofitting and district heating intervention

7.1.3 Bristol

Figure 17 presents the VCE of Bristol retrofitting intervention. The municipality offers local loans to promote retrofitting and improving the environment in Bristol. KWMC, which is an arts center and charity, is in charge of involving owners in this type of intervention. KWMC will have two revenue sources: 1) a grant from the EU, 2) a payment from by Warm Up Bristol, in charge of retrofitting the dwellings. In turn, Warm Up Bristol will also have two revenue sources: 1) a grant from the EU, 2) a payment from apartment owners for its retrofitting work. Thanks to retrofitting, owners will spend less on energy, reducing their bills and contributing to the improvement of the environment.

KWMC and Warm Up Bristol are key stakeholders in this intervention and their business model seem viable enough to be further studied within next deliverable.

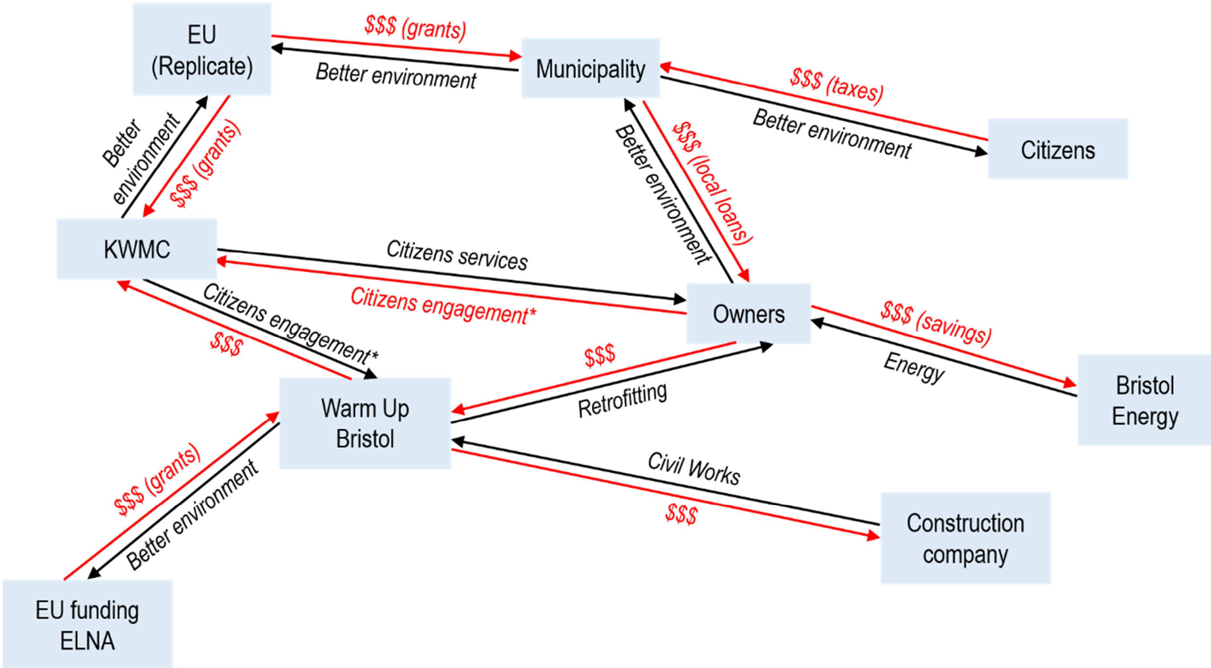

Figure 17.- VCE of Bristol retrofitting intervention

7.2 District Heating

7.2.1 San Sebastian

Figure 18 presents the VCE of San Sebastian district heating intervention. FSS leads the transition to a smart city on behalf of the municipality. FSS will concede a concession to a DH operator to build and manage the DH. That operator will offer clean heating to dwellings connected to the DH and the owners of these dwellings will pay their bills to the operator.

The DH operator is a key stakeholder in this intervention and its business model seems interesting enough to be further studied within next deliverable.

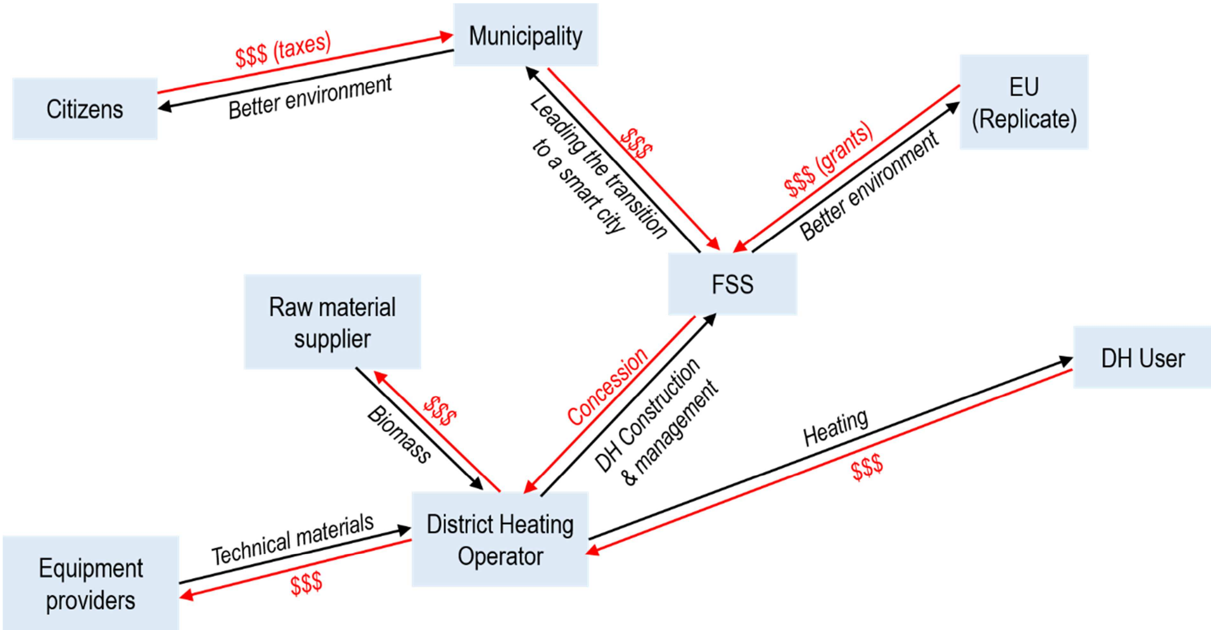

Figure 18.- VCE of San Sebastian district heating intervention

7.2.2 Bristol

Figure 19 presents the VCE of Bristol district heating scheme intervention. In this VCE the municipality can also play the role of the district heating (DH) operator, both building and also managing the DH. This is why these two stakeholders are framed within a dashed green line rectangle with. For the sake of a broader analysis we are treating them as two separate stakeholders.

REHAV will build the DH scheme as a municipality supplier. The municipality could offer a concession to an operator to run and manage the DH. This operator would pay for the concession. In any case, the operator will offer clean energy, more comfort and savings to DH users, which will have to pay for this service. The municipality will improve the environment of the city with this type of intervention, offering a better quality of life to its citizens and a more environmental option to energy use.

The DH operator is a key stakeholder in this intervention and its business model seems viable enough to be further studied within next deliverable.

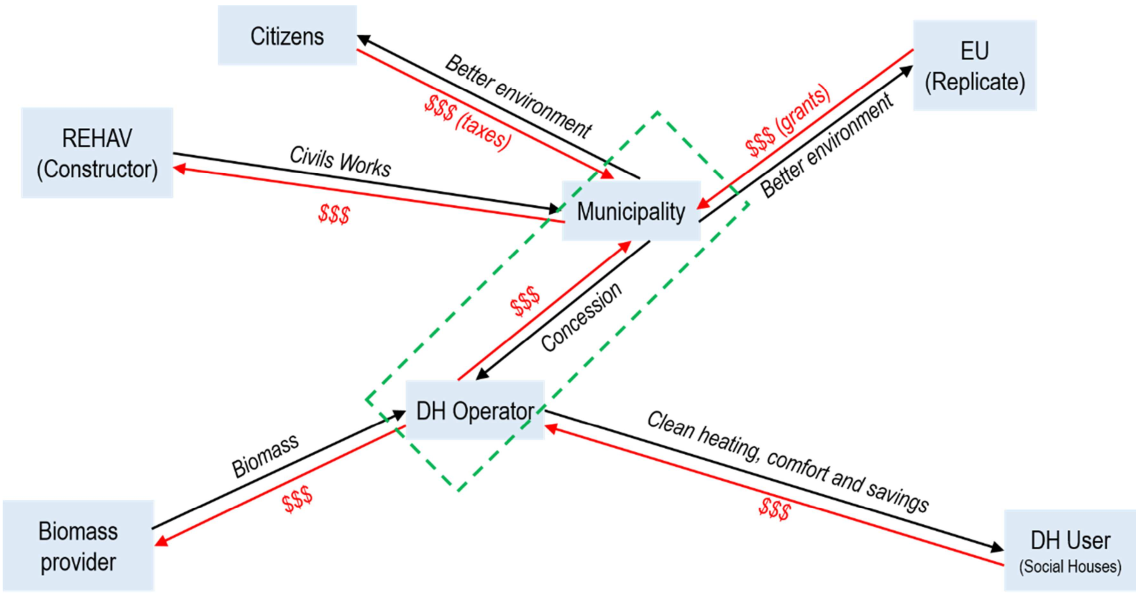

Figure 19.- VCE of Bristol district heating intervention

7.3 Demand Side Platform (DSP)

7.3.1 San Sebastian

Figure 20 presents VCE of San Sebastian demand side platform (DSP) intervention. In this case, FSS could also play the role of the platform manager in the future. Here we also have separated both roles because it enriches the analysis. Tecnalia will develop the demand side platform for FSS. Tecnalia will be the manager of DSP during the project. After that, FSS will offer al concession to a Demand Side Platform Manager, which will be paid for that services. The DSP Operator will offer smart devices to citizens connected to the district heating (it could be extended to other citizens). Thanks to the demand side platform (DSP), the platform manager will get information from users and will also offer them information related to their energy consumptions. These users will be able to use this information to reduce their consumptions and in turn their energy bills. The platform operator will also offer information to the DH operator.

The DH operator is a key stakeholder in this intervention and its business model seems interesting enough to be further studied within next deliverable.

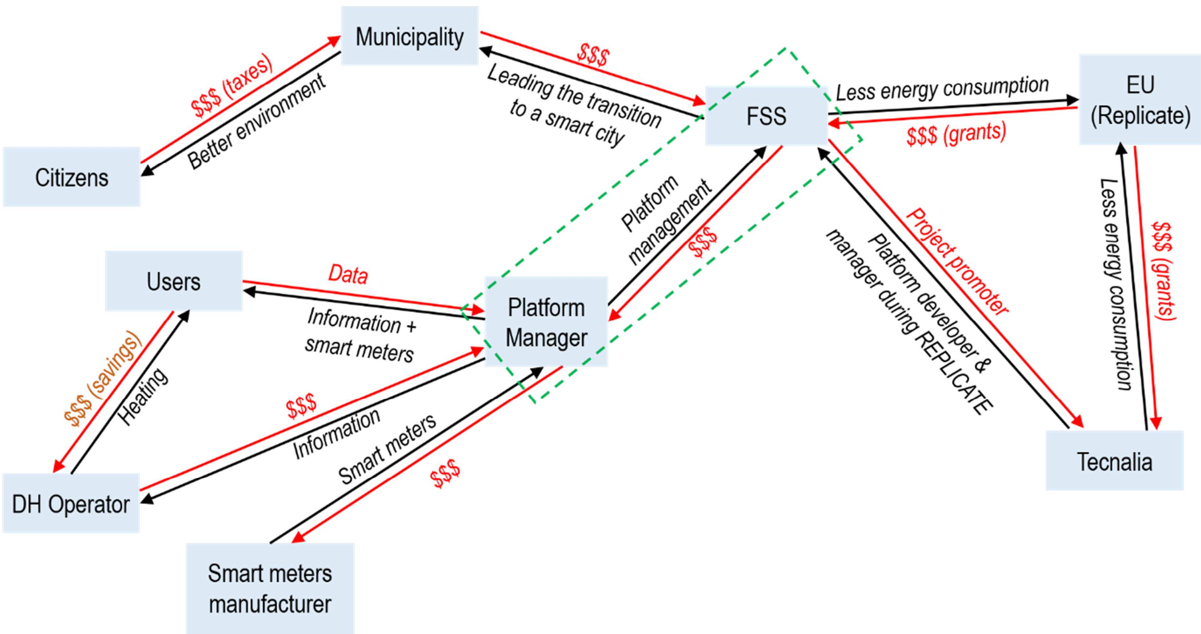

Figure 20.- VCE of San Sebastian demand side platform intervention

7.3.2 Florence

Figure 21 presents the VCE of Florence demand side platform (DSP) intervention. E-Distribuzione will be in charge of the DSP of Florence, and will outsource the development of the platform whilst paying for it. E-Distribuzione will provide devices ("Smart info") to citizens, and will get data from them. E-Distribuzione will analyse this data and will provide information to the users related to their energy consumptions. Thanks to this information, DSP users will use less energy (about 4%), reducing their bill and contributing to the improvement of the environment. E-Distribuzione will have two sources of income: 1) The EU-Replicate grant, and 2) a citizens' fee for distribution and metering services.

E-Distribuzione is a key stakeholder in this intervention and its business model seems interesting enough to be further studied within next deliverable.

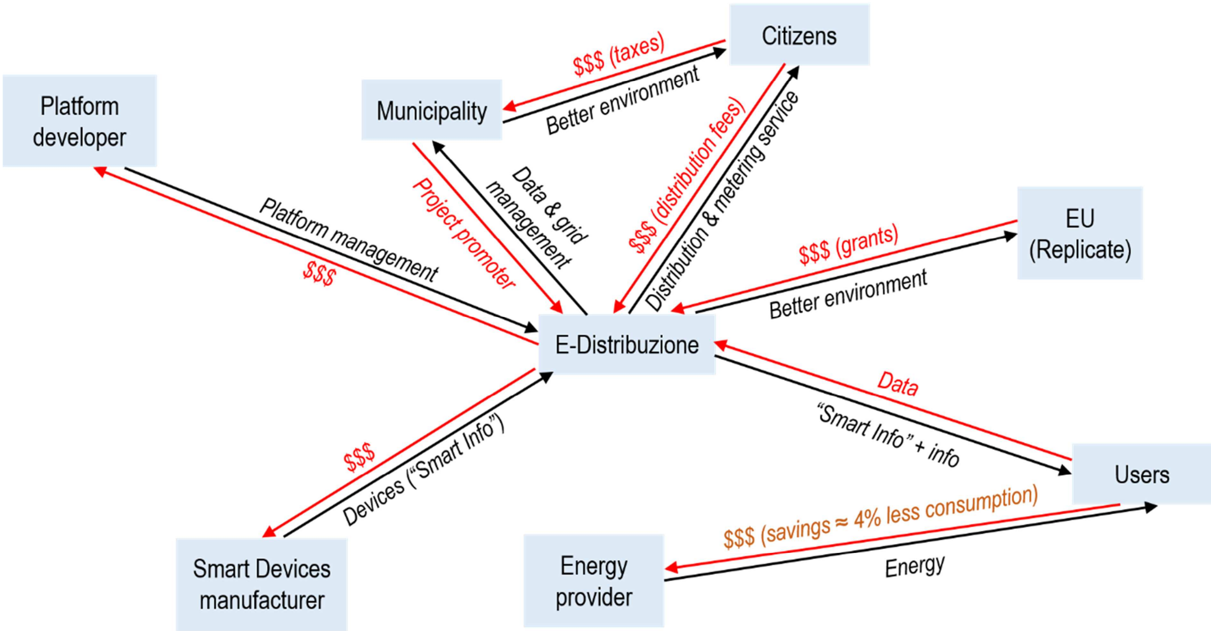

Figure 21.- VCE of Florence demand side platform intervention

7.3.3 Bristol

Figure 22 presents the VCE of Bristol demand side platform intervention (DSP). The municipality as a promoter of the DSP and will buy smart wet white good devices to distribute among households in the project area to test with the DSP. The municipality will outsource to NEC to design and implement the Bristol DSP. NEC will act also as a manager of the DSP. NEC will get data from users through their smart devices and will provide information to them about all their energy consumptions. This information will allow users to reduce their energy consumptions and in turn to reduce their energy bills. NEC will also offer information to energy providers as required. This VCE incorporates the possibility to sell anonymized and aggregated data in a free market; activity that other ecosystems could also contribute to.

NEC is a key stakeholder in this intervention and its business model seems viable enough to be further studied within next deliverable.

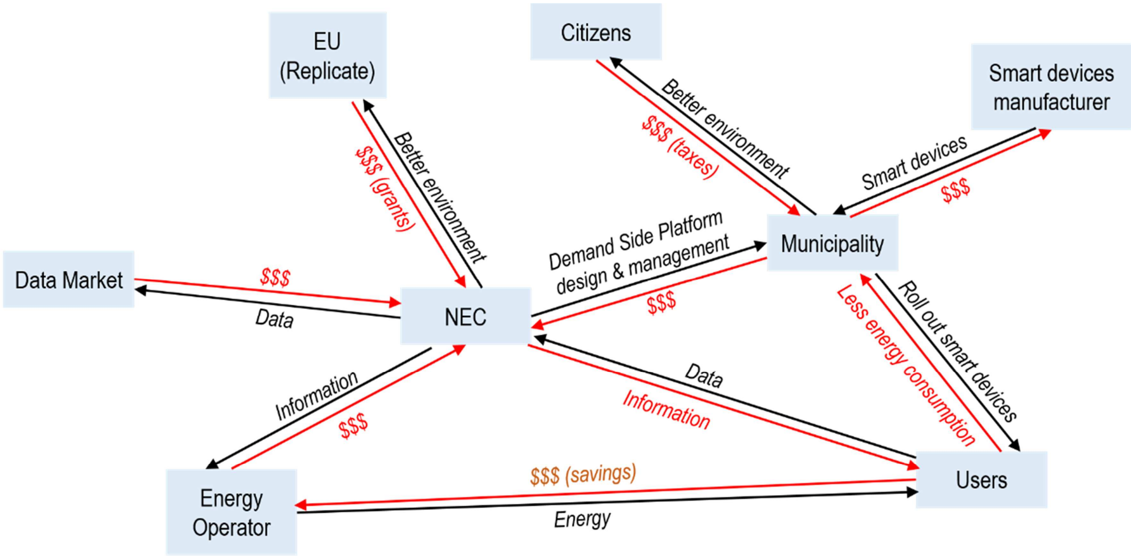

Figure 22.- VCE of Bristol demand side platform intervention

7.4 Public Recharging Stations

7.4.1 San Sebastian

Figure 23 presents the VCE of San Sebastian recharging stations intervention. This is a theoretical model developed by ESADE due to the fact that San Sebastian has not decided how will deploy this intervention yet. The municipality offers public spaces to the recharging station operators to install the stations, which will have to pay for the occupation of the public road. Likewise, the municipality will have an electric mobility (EM) platform to ensure the efficiency of electric mobility. For this analysis we will consider the EM platform will be managed by another entity. The recharging station operators will offer recharging points to electric vehicles owners, who will have to pay for the energy. These owners will have advantages offered by the municipality such as free parking, access to restricted areas, etc. The EM platform will get data from the EV owners and from the recharging stations operators, and will improve the usage rate/occupancy level of the recharging points. The deployment of recharging stations in San Sebastian is a key issue to ensure the consolidation of EV, which will mean less CO_2 emissions.

The recharging stations operators and the EM platform manager are key stakeholders in this intervention and their business model seem interesting enough to be further studied within next deliverable.

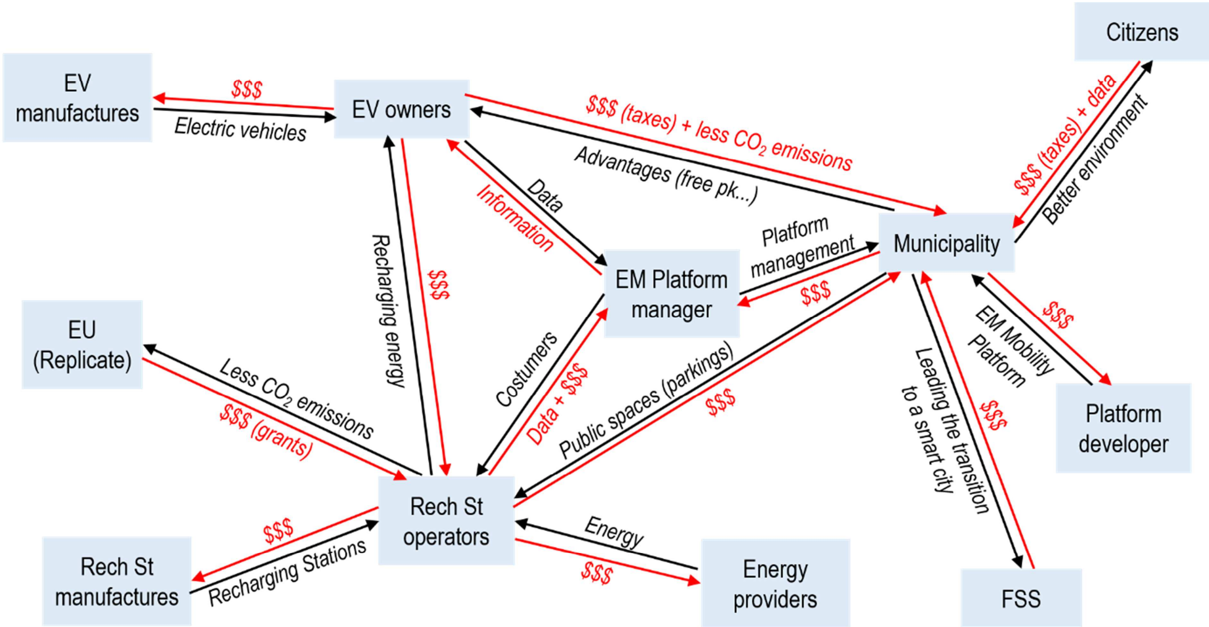

Figure 23.- VCE of San Sebastian public recharging stations intervention

7.4.2 Florence

Figure 24 presents the VCE of Florence fast recharging stations intervention. Despite the fact that REPLICATE will also install regular recharging stations, ESADE, according with Florence Municipality, has focused its analysis on the fast recharging ones because they represent an interesting particularity in REPLICATE project. Nowadays it is on planning the integration with the regular ones.

The municipality offers public spaces to E-Distribuzione to install their fast recharging stations. These stations are exclusive for e-taxis. These stations will allow this type of taxi to recharge their batteries in about 20 minutes. All energy providers will be able to deliver energy to e-taxis through these fast recharging stations. Moreover, the municipality will offer e-taxis a discount in the license price. In turn, these taxis will provide eco public transport to Florence's citizens. A mobility management platform will be used by the municipality to ensure the efficiency of the urban mobility considering the protection of the data and its use.

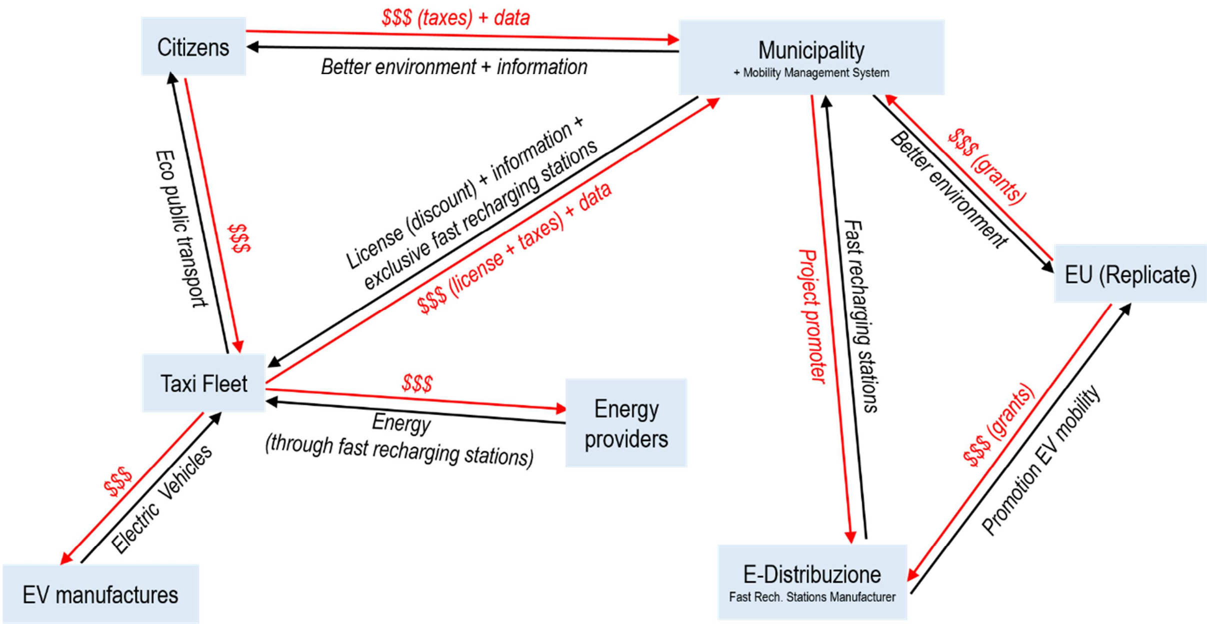

Figure 24.- VCE of Florence public fast recharging stations intervention

E-Distribuzione and the municipality are key stakeholders in this intervention and their business model seem interesting enough to be further studied within next deliverable.

7.4.3 Bristol

Figure 25 presents the VCE of Bristol recharging stations intervention. The municipality offers public spaces to the recharging stations operators to install the stations. As in the cases of San Sebastian and Florence, Bristol will have a mobility platform to ensure the efficiency of the mobility interventions. The platform management could be done either by the municipality or another public or private entity. It is anticipated the platform will get data from the municipality, the EV owners, recharging stations operators and citizens. The platform manager will provide information to all of them, and will also facilitate the access to the recharging points improving their usage rate/occupancy level.
Likewise, the municipality is exploring to adapt some of its lampposts to allow the charging of EV through Ubitricity (for more information §5.4.5) devices or other similar ones.

The recharging stations operators, Ubitricity and the mobility platform manager are key stakeholders in this intervention and their business model seem interesting enough to be further studied within next deliverable.

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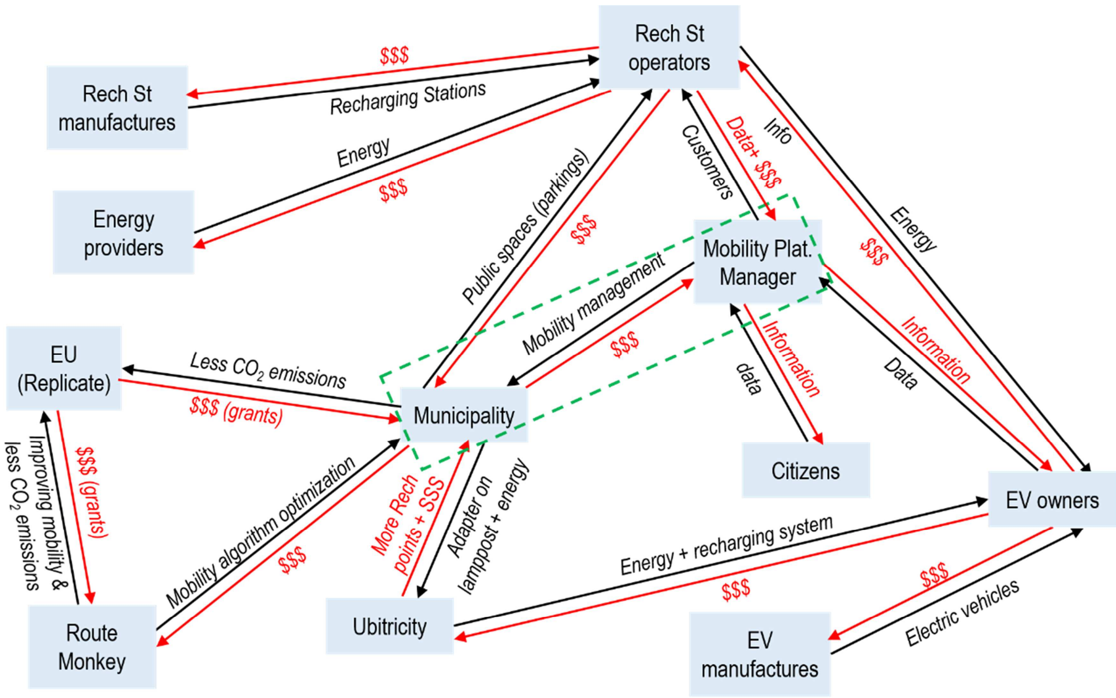

Figure 25.- VCE of Bristol public recharging stations intervention

7.5 Smart Lighting

7.5.1 San Sebastian

Figure 26 presents the VCE of San Sebastian smart lighting intervention. The municipality is replacing the traditional lampposts for smart ones because it wants to be able to light its streets, as usual, saving energy, and offering extra services to its citizens. Leycolan is in charge of building these advanced smart lampposts and maintaining the whole infrastructure. Thanks to these new smart lampposts, the municipality will spend less energy lighting its streets and will reduce its energy bill.

Laycolan and the municipality are key stakeholders in this intervention and their business model seems interesting enough to be further studied within next deliverable.

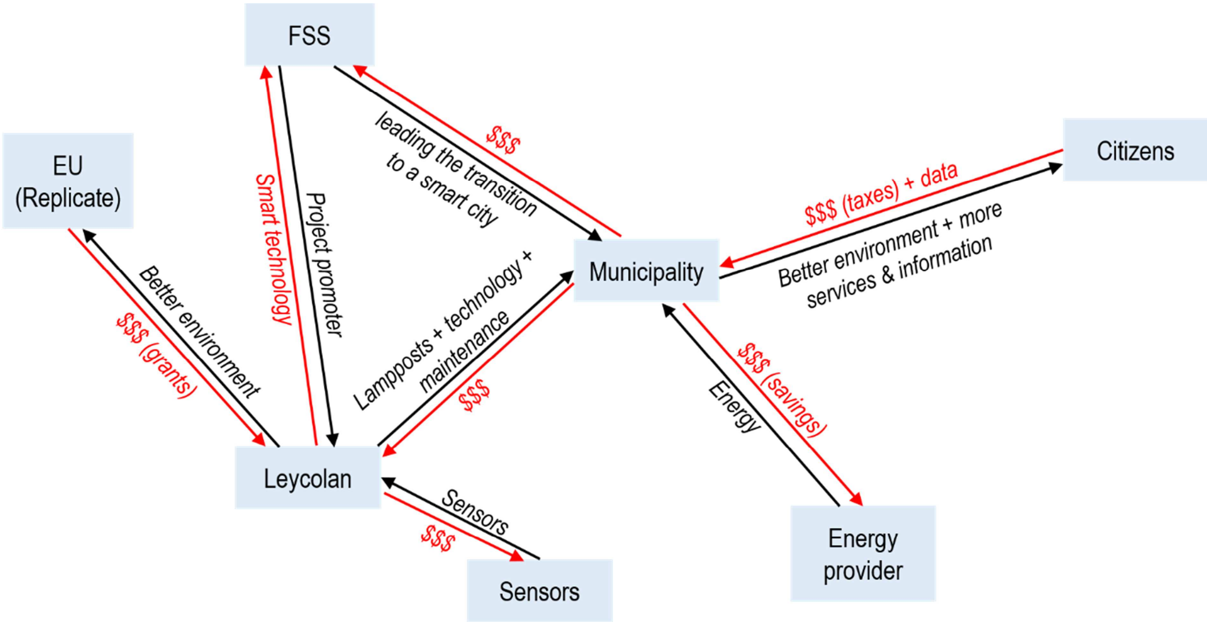

Figure 26.- VCE of San Sebastian smart lighting intervention

7.5.2 Florence

Figure 27 presents the VCE of Florence smart lighting intervention. SILFI manage the public lighting of Florence. It will replace the traditional lighting system for smart ones. Thanks to this, the municipality will be able to light its streets, as usual, saving energy, and offering extra services to its citizens. As a result of these savings, citizens will have to pay less taxes for the lighting system or less part of their taxes will be used to pay the cost of energy. The lampposts will get information from citizens, which will be used by SELFI to improve the management of the whole infrastructure.

SILFI is the key stakeholder of this intervention and its business model seems interesting enough to be studied for the next deliverable.

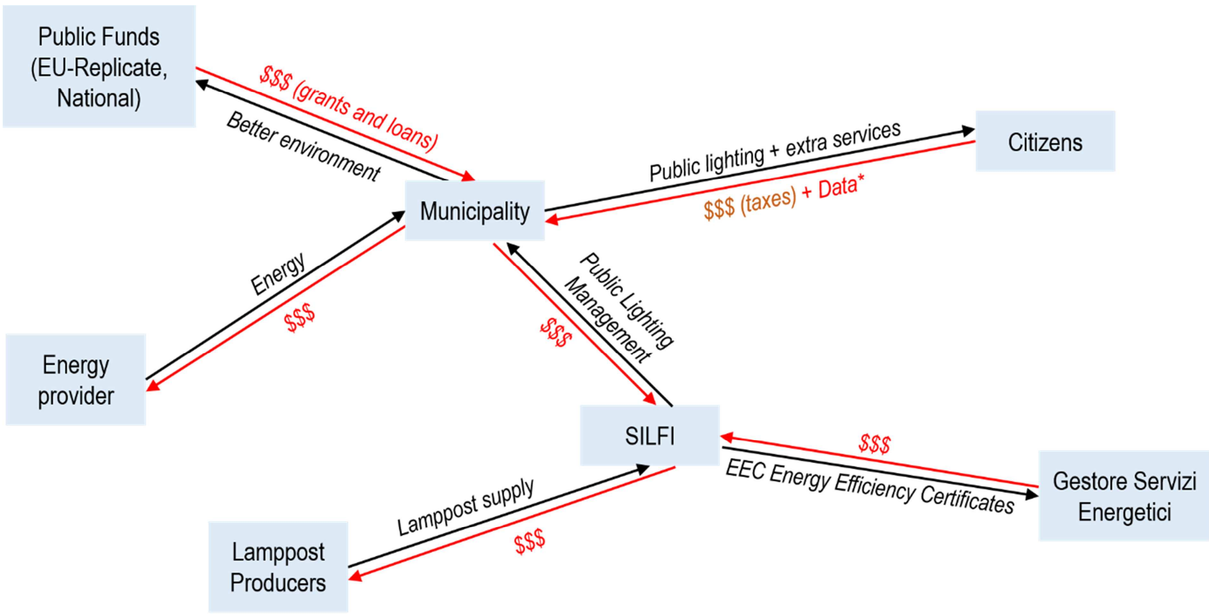

Figure 27.- VCE of Florence smart lighting intervention

7.5.3 Bristol

Figure 28 presents the VCE of Bristol smart lighting intervention. This VCE uses, once again, a green rectangle with a dashed line to frame the municipality and the operator of the public lighting to highlight that the municipality could play both roles. The municipality through the operator, and potentially the new lampposts that have already been installed and those yet to be upgraded in Bristol, will offer an improved public lighting and extra services. The new smart lamppost will allow a reduction the energy consumption and reduce the municipality energy bill while providing additional valuable data. The operator could use the smart lamppost to promote products or services of other companies.

The operator, whether it is the municipality or a private company, is the key stakeholder of this intervention and its business model seems viable enough to be studied for the next deliverable.

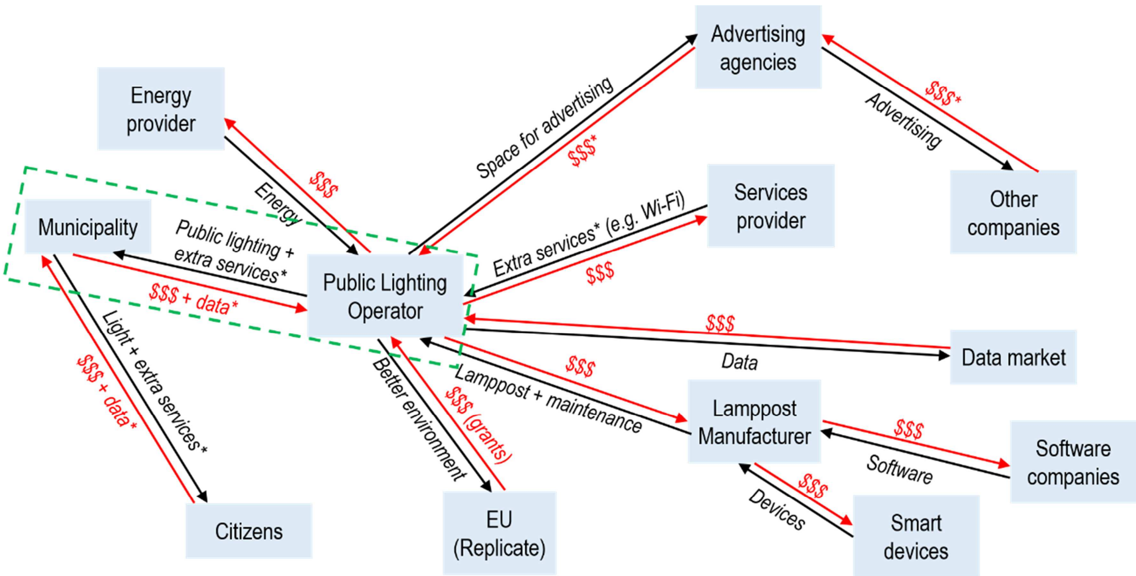

Figure 28.- VCE of Bristol smart lighting intervention

7.6 Value creation ecosystem summary

Table 6 shows a summary of the key industrial partners in each intervention. The business model of these partners will be considered for a further study in the next deliverable.

Table 6.- Value Creation Ecosystems summary per city and type of intervention

Intervention	City	Partner
Retrofitting	San Sebastian	Giroa-Veolia
	Florence	Casa-Spa
	Bristol	KWMC & Warm Up Birstol
District Heating (DH)	San Sebastian	FSS & DH operator
	Florence	Casa-Spa
	Bristol	Municipality & DH operator
Demand Side Platform (DSP)	San Sebastian	Tecnalia
	Florence	E-Distribuzione
	Bristol	NEC
Public recharging stations (PRS)	San Sebastian	EM Platform manager & PRS Operator
	Florence	E-Distribuzione & Municipality
	Bristol	PRS Operator, IBItricity & Mobility Platform manager
Smart Public lighting	San Sebastian	Leycolan
	Florence	SILFI
	Bristol	Public lighting operator

8. Conclusions

The holistic sectorial analysis carried out in this deliverable has served to reach the following conclusions:

- Investments in the energy sector in Spain, Italy and the UK are primarily driven by environmental concerns and commitments to reduce greenhouse gases to mitigate climate change. At the urban level, this has materialized in efforts to improve the energy efficiency of buildings, and to a lesser extent, in increasing renewable energy sources, such as through solar panels on roofs. The main influential factors will be economic, as efforts to retrofit buildings and install district heating system require large up-front investments and only see savings in the long term. It is important, therefore, to continue developing investment funds and incentive schemes.
- The main trend of the mobility sector will be an increase in the use of electric vehicles, promoted through incentives schemes. The socio-cultural preferences of consumers in these markets will play a major role in the future development of the auto industry, in the choice of vehicles and how these are used. The most important factor, however, will whether the technologies behind EVs, both batteries and the ICT components, are able to advance enough to reduce the “hassle” of owning an EV that must be charged and to make them more affordable. The second important trend will be improvements in public transport to create a more seamless journey for users and to use intelligent software and data to coordinate different transport modes more efficiently.
- The ICT sector is crucial to the development of Smart Cities. Smart cities inherently rely on ICT for much of what makes them “smart”, which includes the use of sensors, the analysis of “big data” and widespread use of the internet to make services more easily accessible and user-friendly. The main challenges right now are getting city platforms to use interoperable systems so that data can be shared, ensuring that legislation is up to date with the technologies available, ensuring that there are data protection policies in place, and most importantly, that there is open debate with citizens regarding the usefulness of ICTs in the city to validate whether projects that involve ICT actually solve the problems that citizens and communities are facing.
- The Porter Five Forces analysis shows us that the five studied industries (retrofitting, district heating, demand side platform, public recharging stations for electric vehicles and smart public lighting) are attractive, in terms of competitiveness, to engage private companies in developing business around them. According to this study, public recharging stations and district heating are the most attractive sectors for industrial partners. The less attractive industry would be retrofitting, although the differences among sectors is quite small.

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- The market size analysis quantifies the amount of money involve in each of the industries for every city. These amounts of money are essential to ensure the replicability of the interventions, at least in other districts of the same city.
- Taking into account the differences in terms of population and extension of our lighthouse cities, the market size of each one is quite similar. Thus, it would not be risky to say that the three cities present similar business opportunities for industrial partners to participate in REPLICATE type of interventions.
- According to the Porter Five Forces analysis, retrofitting is the industry with the heist rivalry, but it is also the industry with a biggest market size. Its greater volume of market compensates its low level of attractiveness. In any case, retrofitting is also very interesting sector for industrial partners.
- According to the analysis carried out in this deliverable, it can be said that this interventions will be replicable in other cities as long as the basic features of these cities are similar to those of our lighthouse cities.
- Finally, Value Creation Ecosystems has been a fundamental tool to identify industrial partners or public companies that positively contribute to the implementation of the smart services to help the transition from a traditional city to a smart one.
- The authors have identified 22 potentially interesting stakeholders. They are listed at the end of section 7, in table 6. A selection of these industrial partners will be further analysed in task 9.3 from a business model point of view.
- Additionally, our lighthouse cities have known and utilized the VCE tool and this has allowed identifying the similarities and dissimilarities with which each cities implements their smart services. Without any kind of doubt, these particularities enriches the whole project and its related studies.

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