Deliverable due date: M32 – July 2020 (M44)

D6.13 Innovative business models and public procurement innovation in follower cities

WP6, Task 6.4

Transition of EU cities towards a new concept of Smart Life and Economy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

Project Acronym	mySMARTLife	
Project Title	**Transition of EU cities towards a new concept of Smart Life and Economy**	
Project Duration	1st December 2016 – 30th November 2021 (60 Months)	
Deliverable	D6.13 Innovative business models and public procurement innovation in follower cities	
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Due date	M44 31/07/2020 FINAL	
Work Package	WP6	
Lead beneficiary	ESADE Business School	
Contributing beneficiary(ies)	ESA, CAR, VTT, NBK, BYD, RIJ, PAL,	
Task description	D6.13 Innovative business models and public procurement innovation in follower cities. This task will develop and deliver an investment plan to implement the interventions. Learning from T1.2, and in collaboration with WP8 and WP7, mainly the EIP on SCC, Action Cluster of Business Models, Finance and Procurement all municipalities supported by RTOs and IND, will find out what are the innovative funding schemes, find opportunities and share experiences. In the case of innovation in public procurement the main driver will be to speed up the implementation of innovative solutions by using PPIs as a launch pad. The project will be looking at the Procurement of Innovation Platform for getting ideas and discuss possibilities with other international stakeholders.	

Date	Version	Author	Comment
19/12/2019	V1.1	ESA	Action Plan and Business Tools' description
08/05/2019	V1.2	VTT	First version of sharing experiences
18/5/2020	V1.3	PAL and ESA	Development and description of VCEs of pilot interventions
20/5/2020	V1.4	BYD and ESA	Development and description of VCEs of pilot interventions
26/5/2020	V1.5	RYJ and ESA	Development and description of VCEs of pilot interventions
12/06/2020	V2.1	BYD	Development and description of CMCs of pilot interventions
17/06/2020	V2.2	VTT	Final version of sharing experiences
17/06/2020	V2.3	RIJ and ESA	Development and description of CMCs of pilot interventions
13/07/2020	V2.4	PAL and ESA	Development and description of CMCs of pilot interventions
21/07/2020	V3	ESA	Version sent to the partners reviewers: CAR & SEZ; and follower cities: PAL, BYD & RIJ
29/07/2020	VF	ESA	Final version, which incorporate the comments of reviewers and follower cities

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THIS DELIVERABLE HAS NOT YET BEEN APPROVED BY THE EC

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Abbreviations and Acronyms

City	Actions considered
mySMARTLife	Transition of EU cities towards a new concept of Smart Life and Economy
DoA	Description of Action
DH	District Heating
EV	Electrical Vehicle
CSO	Charging Stations Operator
ESCO	Energy Service Company
PPI	Public Procurement Innovation
GHG	Greenhouse Gas
CMC	City Model Canvas
VCE	Value Creation Ecosystem
EU	European Commission
LHC	Lighthouse City
FC	Follower

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1. Executive Summary

The main goal of mySMARTLife project is to develop an urban transformation strategy implementing different interventions in three lighthouse cities in the fields of energy efficiency, electric mobility, and ICT platforms to support these and other European cities in the transition from traditional cities to smart ones. This deliverable, which is part of WP6: Replication Strategy, is dedicated to analyzing and understanding the specific business models that each follower cities —Palencia, Bydgoszcz, and Rijeka— could implement to replicate the main interventions of this project.

This deliverable starts analyzing the importance of business models and the public value related and created to and by them, paying special attention to innovation in business models. The authors carefully present the Value Creation Ecosystem (VCE) and City Model Canvas (CMC), which will be used to develop the required analysis. Both tools are key to develop the city business models —which are completely different from companies' business models— and to describe visually how follower cities create, deliver and capture value for their citizens offering new smart solutions.

In the second part of this report, the authors and follower cities of mySMARTLife project analyze the most promising and interesting smart city interventions —taking into account, of course, the particularities of each city— they planned to replicate at the beginning of the project. Developing the value chain and city business model of each intervention, authors and follower cities are capable to understand how to organize their resources to develop the interventions with a sustainable development approach in terms of social inclusion, environmental protection, and financial viability.

Finally, the third part of deliverable present the key elements of public procurement innovation which can help municipalities to move from resource and output-driven service procurement practices towards procuring outcomes and values. Moreover, the deliverable shows the Finnish experience in this field.

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2. Introduction

2.1 Purpose and Target

The main objective of this deliverable is to develop city business model, which are completely different from companies or other type of stakeholders, for different interventions of follower cities. The research team, led by ESADE Business School, has concentrated its efforts on analyzing the most promising interventions according to different studies developed in lighthouse cities and the availability and interest of Palencia, Bydgoszcz, and Rijeka. The interventions under analysis are presented in table 1.

Table 1: Smart Actions considered for the follower cities in the studies of WP6

City	Actions considered
Palencia	District Heating with biomass in public and private buildings Electric Vehicles for municipal services fleet Energy Monitoring of public buildings
Bydgoszcz	E-mobility (E-buses, public charging station, EV) PV in public buildings Smart lighting system
Rijeka	Smart metering and smart data management Smart public lighting

One of the main objectives of the project is to ensure the replicability of the smart interventions, considering a long-term sustainability in terms of social inclusion, environmental protection, and economic viability. This deliverable is useful to understand how cities can create, deliver and capture value offering new smart city services to their inhabitants.

In order to study this particular type of business models, follower cities and the research team used as it was done by lighthouse cities, two business tools developed by ESADE Business School as a part of this research project, the Value Creation Ecosystem (VCE) and City Model Canvas (CMC). This systematic approach ensures an accurate analysis of each intervention.

This paper is divided into eight sections. Having outlined the aims of the research and its significance in this section, section 3 will present a review of the literature on business models and innovation, and methodologies used to develop this study. Section 4, 5 and 6, will present the business model analysis of the smart city services of mySMARTLife project follower cities, Palencia, Bydgoszcz and Rijeka, respectively. Section 7 presents the key elements of public procurement innovation, which will be key in the near future to offer better smart city services. Finally, the conclusions will be presented in Section 8.

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2.2 Contributions of partners

Table 2 depicts the main contributions from participant partners in the development of this deliverable.

Table 2: Contribution of partners

Participant short name	Contributions
ESA	Overall methodological development. In close collaboration with follower cities, analysis of each intervention. Redaction of the deliverable.
CAR	Coordination of partners.
NBK	Coordination of partners.
PAL	Analysis and validation of business tools and cowritten the analysis of the three intervention of Palencia.
BYD	Analysis and validation of business tools and cowritten the analysis of the three intervention of Bydgoszcz.
RIJ	Analysis and validation of business tools and cowritten the analysis of the intervention of Rijeka.
VTT	Sharing experiences in funding schemes and redaction of subsection 7.2

2.3 Relation to other activities in the project

The following table depicts the main relationship of this deliverable to other activities (or deliverables) developed within the mySMARTLife project, which should be considered along with this document for further understanding of its contents.

Table 3: Relation to other activities in the project

Deliverable Number	Contributions
D2.1	This deliverable has provided the baseline information of Nantes demonstrator area.
D3.1	This deliverable has provided the baseline information of Hamburg demonstrator area.
D4.1	This deliverable has provided the baseline information of Helsinki demonstrator area.
D1.7	This deliverable will find out what is the needed ecosystem (key drivers) for big players to replicate their participation in other areas of the city or other cities.
D1.8	This deliverable will find what are the elements that can help the development of ecosystems for SMEs, star-ups and local economy.
D1.9	This deliverable focuses on the study of innovative business models in the project (procurement, crowdfunding, leasing on innovation, RES, ESCO models, etc.) to understand how they work and can be replicated.
D6.8	Replication Plan of the City of Palencia.
D6.9	Replication Plan of the City of Bydgoszcz.
D6.10	Replication Plan of the City of Rijeka.
D8.3	Technology and market supervision activities

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3. Business models

3.1 Business Models: sense and usefulness

During the last 20 years, the business model concept has gained prominence until its consolidation as an essential element in the development of a product or service by a private company. The first reference of this concept is found in Drucker (1994) although in this case the author speaks about "theory of Business" in order to answer questions such as Who is the customer and What does the customer value? Magretta (2002), who is considered one of the first relevant experts in this field, complements Drucker (1994) stating that business models are stories about how companies work and they usually answer the following questions: How do we make money? What underlying economic logic explains how we can deliver value to customers at an appropriate cost? Such rationality is summarised in the magic triangle of business models presented in figure 1 (Gassmann et al., 2014).

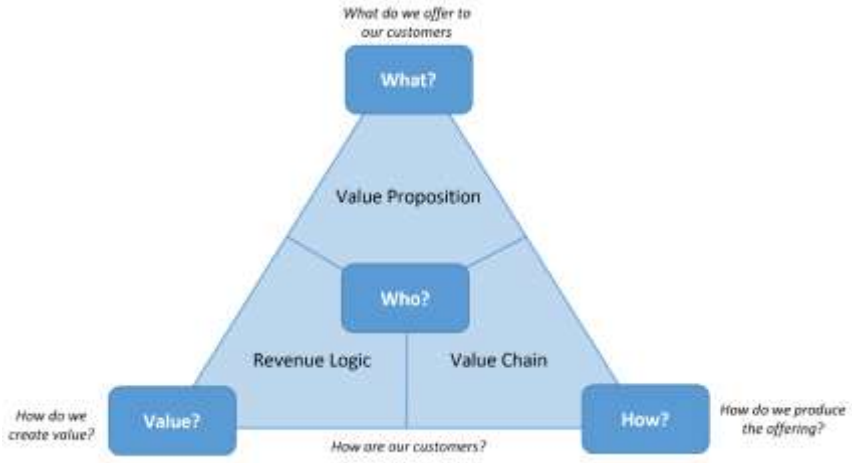

Figure 1: The magic triangle of business models

Source: Adapted from Gassmann et al. (2014)

But what really is a business model? According to Osterwalder et al. (2009) a business model is a rationality that explains how a company creates, delivers and captures value Figure 2. Magretta (2002) states that business models are for manager the equivalent of the scientific method for researchers, declaring that both begin with a hypothesis that must be validated with a test, and that can be revised if necessary. In that sense, Seelos (2014) explains that the implementation of common frameworks helps in explaining what works and what does not work to create value in each specific business.

Taking into account that business models are based on hypotheses, another key aspect is testing the solutions before their scale-up, as done in the mySMARTLife project and in the other lighthouse projects. This increases considerably the chances of success, because organizations are capable of fixing problems that they could not imagine that they had to face (Wynn et al., 2009). Sometimes companies do not have the capacity to learn through the validation process, and they remain stuck in a business model that is not able to mature or reach the market successfully, which is certainly a pity.

Figure 2: Rationality behind a business model

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Nowadays, according to Reuver, Bouwman and Haaker (2013), the most prominent and popular tool for practitioners to design business models is the Business Model Canvas (Osterwalder et al., 2009). Business Model Canvas (BMC) is based on nine building blocks (figure 3) that covers according to its developer the four main areas of a business: customers, offer, infrastructure and financial viability. Planellas and Miguni (2015) state that the BMC allows to analyse the equilibrium between the nine blocks, giving a holistic business idea. A new business could be the result of introducing a single innovation in any of the nine blocks, such as a new revenue model, introducing a new partner or a new type of customer relationship.

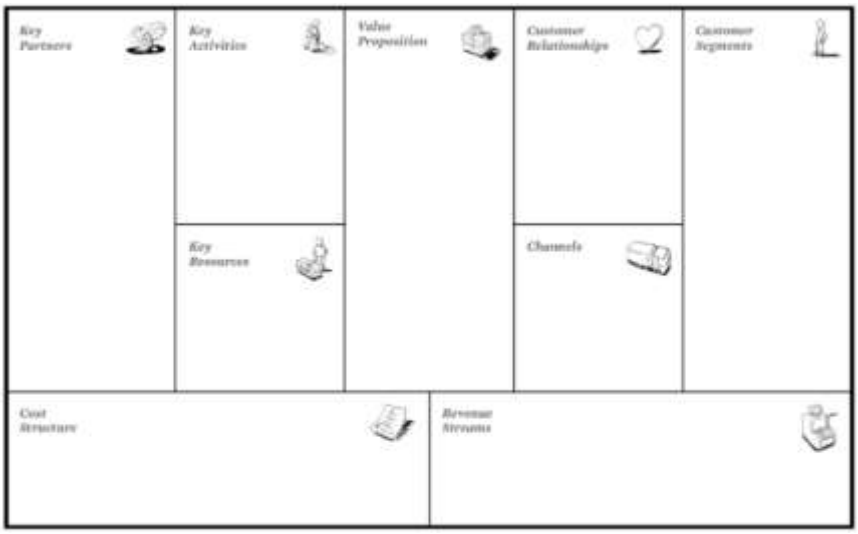

Figure 3: Business Model Canvas Structure (Osterwalder et al. 2009)

In general terms, most business models focus their attention on just one firm. However, it is also important to draw attention to the whole set of activities performed by the third parties (partners, suppliers, customers). Without these actors, the focal firm would not be capable to run its business, as shown by Zott and Amit (2010). Any business model should define the entire ecosystem of activities creating, delivering and capturing value. It means that it is necessary to describe accurately the actors needed, the activities carried out by each of them, the connection among actors (the sequence of activities), and finally the type of value captured by each actor. The reader cannot forget that everything happening within the value chain of a business model will affect the rest of firms involved in it although it is not under their control.

At this stage, it is important to highlight that a business model is not a business plan. Many times these concepts create confusions among readers. In fact, a business plan tries to demonstrate the business model, estimating the financial viability of a business, paying special attention to the cash flow, profits or loses. It is also important not to confuse strategy and business models. Casadesus-Masanell and Ricard (2010) explain that strategy refers to the choice of how the company interacts with competitors in the market place, while the business model is the logic by which the company creates value for its customers and stakeholders. However, it is true that, according to Demil et al. (2015), business models lie at the intersection of strategy and entrepreneurship, reinforcing the connection between both fields, suggesting a more central place for customers and emphasising the importance of the pilot implementations.

3.2 Public Value and Business Models

The concept of public value was originally described by Moore (1995), where the author states that the public sector should have the role to create public value as the private sector should have the role to create private value. This particular type of value describes the contribution of organizations to society. It is supposed that this value addresses citizens and other stakeholders concerns, as it could be environmental protection, security and safety matters, social inclusion, energy poverty, equity, quality of life, etc. Public value is created when the goods and services offered to civil society are greater than the cost of producing them. Public authorities should consider the benefits and costs of public services beyond the private paradigm, where every action is assessed just by its profit.

In many cases, public institutions have to finance the public value production and delivery through public taxes, because the process is not sustainable by itself. In other cases, donors finance it. For this reason, public value is usually measured by non-quantitative variables. But this does not mean that these measurements are subjective or ambiguous. In order to deliver this public value, cities need to have

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democratic legitimacy, which will imply having citizens' support and operational capacity (resources in terms of budget, infrastructure and knowledge), as presented in the strategic triangle (figure 4) proposed by Moore (1995):

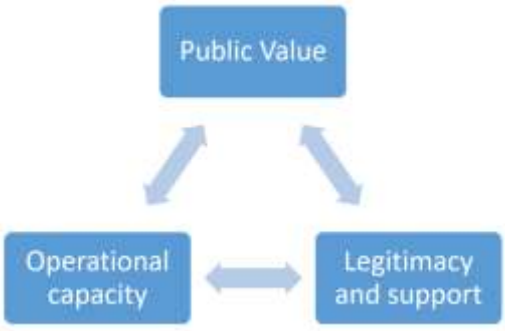

Figure 4: Strategic triangle for producing public value (Moore, 1995)

As a society, we cannot neglect the production and delivery of public value. Public administrations should conceptualize how they articulate their activities or resources for offering public services as private enterprises do through business models. In this regard and according to Williams & Lewis (2008), public managers should use private sector tools for ensuring a holistic and accurate analysis. Duggan & Moon (2008) remark that business models are strategic tools that can help public administrations on managing their activities and resources through which they offer public service to their citizens, fulfilling their democratic mandate. According Pardo-Bosch, Cervera & Ysa (2019), using business models, public organizations understand the logic of how they offer value, to whom they offer it, and how they can sustain it over the long term. They can use it because the value proposition - a business model's central element - does not necessarily have to be defined by profit, it can be defined just by social and environmental benefits. In fact, as shown by Seelos & Mair (2005) and Yunus, Moingeon, & Lehmann-Ortega (2010) other nonprofit organizations or social enterprises use business models to analyze their services production.

On its transition from a traditional city to a smart one, the Municipality needs to use tools for articulating the logic of how it creates value for and with its citizens and companies in the long term, as an essential part of its global strategy. This is the only way through which the Municipality will be capable of integrating the improvement of very different public services such as energy use, healthcare, mobility, or education among others in a global and well-articulated systemic vision (Lataifa, 2015).

3.3 Innovation and Business Models

There is a broad consensus about the fact that innovation is central for organizations (public and private) success, as well as a driver of economic and social progress on a national level, as it increases productivity and efficiency. Many governments view innovation as an essential axis of growth and sustainable strategy, especially in our current context, where they are facing many challenges including the economic downturn, climate change, and the scarcity of resources (Doradova et al., 2013). Innovation comes from *innovare*, which in Latin means action or effect of becoming new or renewing. OCDE (2005), in its Oslo manual, states that "an innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations". Just those innovations that are feasible, desirable and viable will be consolidated in open market.

The introduction of an innovation, which is the result of research and development processes, represents an improvement of performance and allows organizations to achieve a competitive advantage. Porter (1990) states that the innovation process can be neither understood nor separated from the strategic and competitive environment of the organization. Although innovate is risky − more than many other activities developed in enterprises − since it usually needs many resources used in activities carried out without previous experience and several times it fails on its objective. Nevertheless, innovation is key for ensuring a sustainable future.

While many organizations pay a lot of attention, dedicating important resources and assets, to explore new ideas and technologies, they often miss the opportunity to change, modify, and improve the business model they use to introduce these new technologies to the market (Chesbrough, 2010). Today more than ever, innovation must include business models, rather than just technology (Chesbrough, 2007). In fact,

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Chesbrough (2010) states that a great business model supporting a mediocre technology could be more successful than a great technology exploited via a mediocre business model. According to Skarzynski and Gibson (2008), some of the most relevant innovations in the business arena come from business model innovation.

Business model innovation could be understood as the implementation of a new business model in an existing industry, by introducing any effective variation in any business model element which would mean to apply a new way to create, deliver or capture value that provides advantages in comparison to competitors. Borrowing words from Mitchell and Coles (2003), we could also state that: "When a company makes business model replacements that provide product or service offerings to customers and end-users that were not previously available, we refer to those replacements as business model innovations." Figure 5 presents the different components of the business model that could be modified creating a business model innovation.

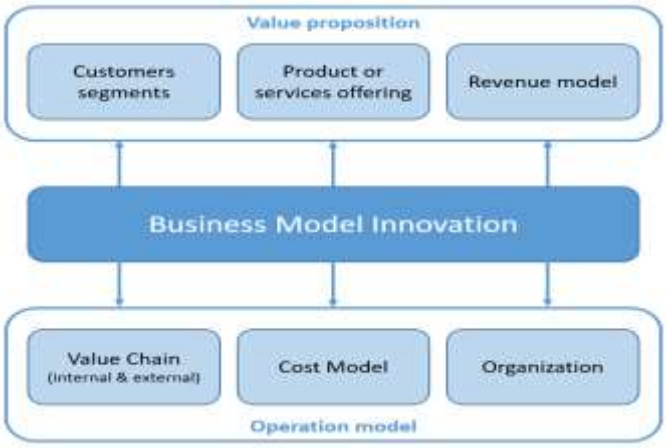

Figure 5: Possible targets of business model innovation

Source: Adapted from Lindgardt et al., (2009)

There are different drivers of business model innovation. Public authorities need to respond to market conditions, especially in high changing environments. They must be dynamic. One the most relevant drivers of public services innovation, according to Christensen, Johnson and Kagerman (2008), is the chance to serve a large group of potential citizens who are not attended because existing solutions are too expensive or complicated for them. This is a clear example of product democratization.

3.4 Business Model tools for strategizing a smart city

As the reader can see along this section, any public manager willing to develop essential smart services needs to know two significant things: the chain of actors that produces services for their citizens; and inside this chain, the logic of how his/her Municipality creates, delivers and captures its part of value.

In this research project, the team led by ESADE Business School has used the following tools in order to describe and understand the selected pilot interventions: the Value Creation Ecosystem (VCE), and the City Model Canvas (CMC).

3.4.1 Value Creation Ecosystems (VCE)

Pfeffer and Salancik (1978) and Johanson and Matsson (1992) state that companies (public and private) must work with other companies, establishing solid value chains (Cristopher, 2016), in order to produce products and/or services because they are not capable of carrying out all the needed activities by themselves. Each actor increases the value of the product and/or services along the value chain, and just for that, each actor can capture part of that value (Lepak et al. 2007), which in many cases, and according to Agandoña (2011), goes beyond economic value. Urzmetzer (2016) explains that the relationship established by the actors participating in the value chain is based on coopetition, which is the particular combination of cooperation and competition.

In order to build up the ecosystems that develop smart city services, the authors propose to use a tool that they call Value Creation Ecosystem (figure 6). This tool is based on the theory presented in Shapiro (2001), where nodes (actors) are connected to a network. Each actor can be connected to as many nodes as

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necessary. For each relation of a node A (actor A) with a node B (actor B), two links are generated: one from actor A to actor B (in blue in figure 6) which indicates the value that actor A creates for actor B, and another one from actor B to actor A (in yellow in figure 6) that shows the value that A captures from its relation with B (this would represent the payback).

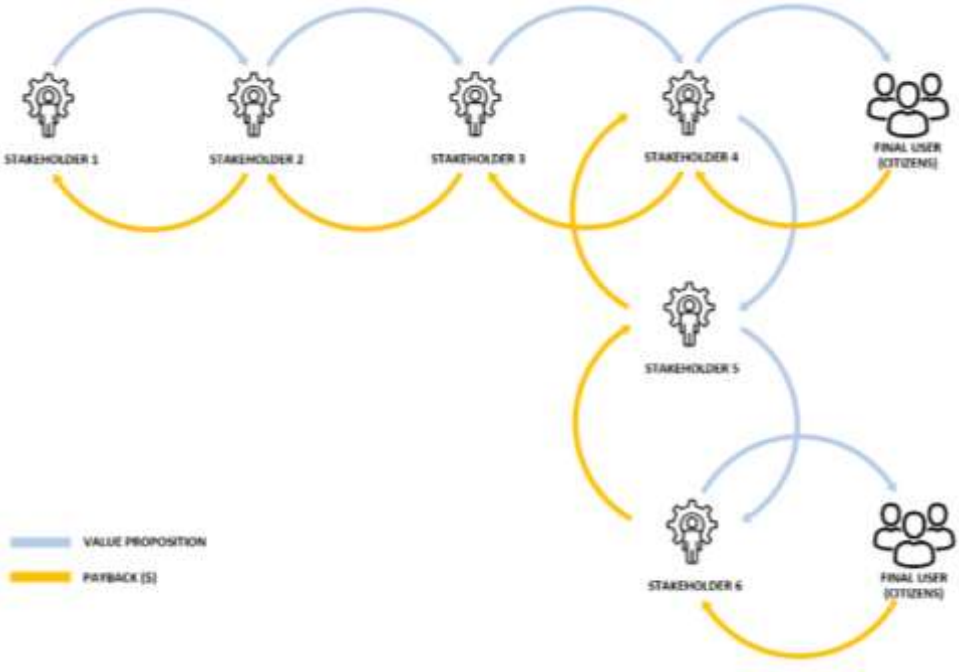

Figure 6: Value Creation Ecosystem

Drawing the value chain is a key activity for explaining the following ideas:

- The actors needed along the value chain.
- The value delivered and captured by each actor and its impact on the whole ecosystem of value creation.
- The interdependences created among actors.
- The actor (final user) that receives the whole value at the end of the chain.

3.4.2 City Model Canvas (CMC)

According to Timeus, Vinaixa and Pardo-Bosch (2020), the City Model Canvas is a framework that city councils can use to articulate how they expect to create and deliver value in an economically, environmentally and socially sustainable way through smart services. The CMC (figure 7) is based on Business Model Canvas (BMC), replacing several blocks of that canvas for other ones more related to public services and introducing a triple bottom line, where cities must assess the sustainability of their services. Using it when cities define strategies for their future services, public managers will be capable of assessing from a holistic perspective the net balance of their policies and actions.

This tool emphasizes that the transition from a traditional city to a smart one should be based on solving environmental and social problems rather than just addressing economic challenges, which, obviously, also have to be taken into account. This is important to ensure that smart services actually serve to alleviate a particular need of the population and are not just being implemented to follow a trend or satisfy corporate interests.

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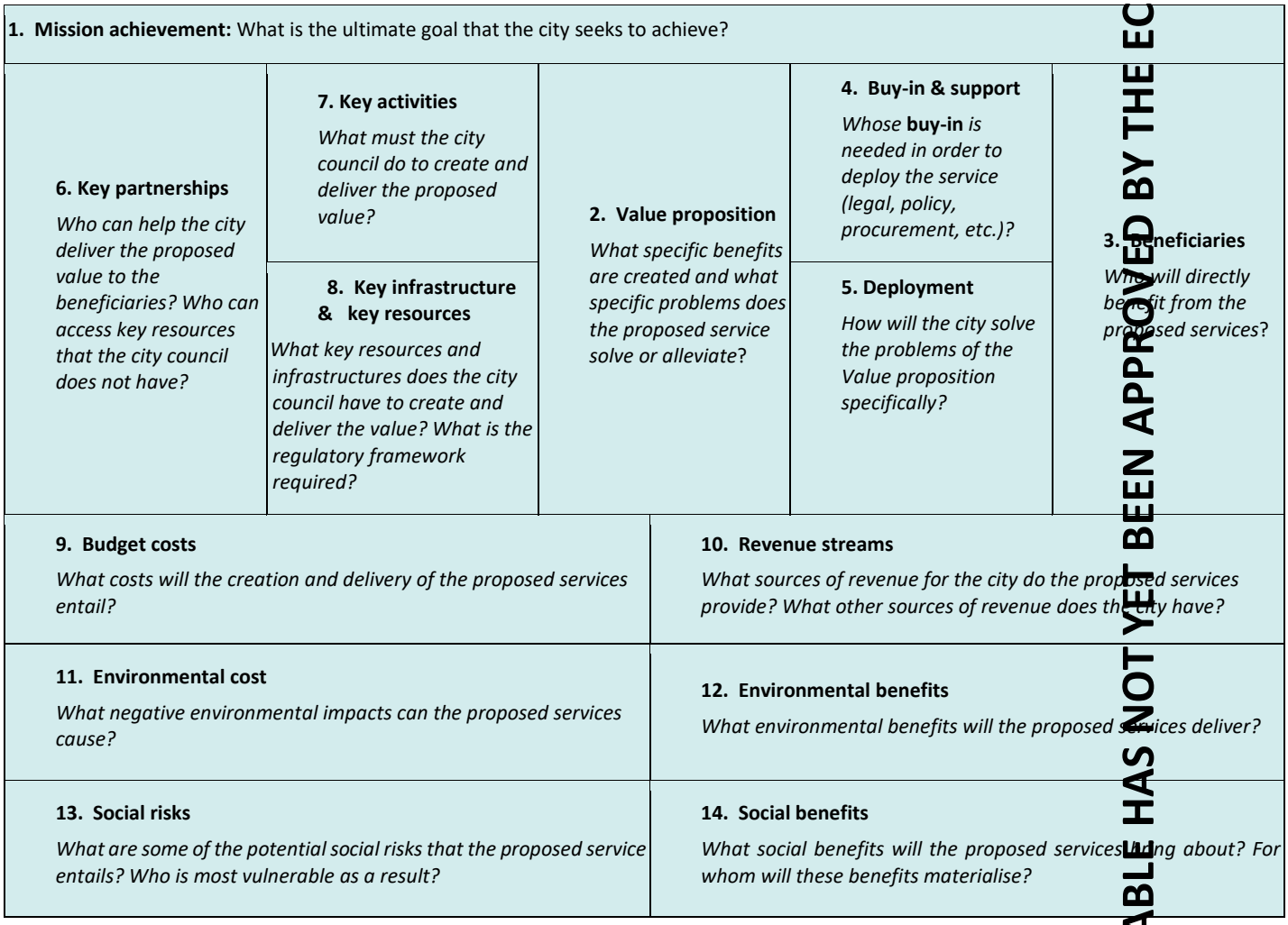

Figure 7: City Model Canvas (Timeus, Vinaixa and Pardo-Bosch, 2020)

CMC is composed of fourteen blocks (B), divided into four main areas: value proposition, which is composed of Mission Statement (B1) and Value Proposition (B2); delivering value, which is composed of Beneficiaries (B3) and Buy-in & support (B4); producing value, which is composed of Deployment (B5), Key partnerships (B6), Key activities (B7) and Key infrastructure & key resources (B8); and triple bottom line, which is composed of Budget costs (B9), Revenue streams (B10), Environmental cost (B11), Environmental benefits (B12), Social risks (B13), and Social benefits (B14).

Mission Statement. It is a short declaration of the overall aim that the city wants to reach through its City Business Model.

Value Proposition. It states what benefits are expected from the new smart service.

Beneficiaries. It categorizes who is positioned to benefit directly from the value proposition.

Buy-in & support. It identifies the individuals, groups or entities (such as unions, NGOs or other governmental organisations) whose acceptance of the proposed project is necessary for its successful implementation.

Deployment. It presents the actions/projects through which the Municipality will deliver the value preposition.

Key partnerships: It enumerates the partners that will enable the city to produce the value, offering best opportunities to access more resources and capabilities.

Key activities. It describes the most important things or actions that city must do to make its business model work.

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Key infrastructure & key resources. It describes the most important assets required to make a business model work. It can be tangible (physical, human, financial, etc.) or intangible (intellectual), but all of them are essential to create, deliver and capture value.

Budget costs. It describes all costs incurred to operate a business model.

Revenue streams. It represents all the source of income that city generates from its business model. If the value proposition is attractive for beneficiaries, they will be willing to pay the price of acquisition.

Environmental cost. It identifies the negative impacts induced by the value proposition, or those generated during its production and delivering.

Environmental benefits. It identifies the positive impacts generated or induced by the value proposition.

Social risks. It refers to negative costs that the smart city strategy can have on a city's residents and communities.

Social benefits. It refers to indirect positive impacts of the smart city strategy implemented through the value proposition.

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4. Palencia's business models for smart city services

4.1 City description (mySMARTLife project DoA)

The city of Palencia (figure 8) is located in the Autonomous Community of Castilla y León (Spain). Palencia has a population of 82,169 inhabitants and has a major industry in the automotive sector and agricultural production, but it is mainly a municipality related to the service sector. It is the greenest city, per square meter and inhabitant in Spain and it is also proud of its historical and cultural background as being the settlement of the first University in Spain.

Palencia is a dynamic city. It has been nationally and internationally awarded (i.e. Google Digital City 2012 or Spanish most Sustainable City 2010). Palencia is co-founder of RECI Network (Red Española de Ciudades Inteligentes) and it is betting heavily on the energy efficiency, renewable energy and intelligent transport. At the same time, Palencia is a member of Smart City Valladolid y Palencia, which involves public administrations, multiple companies, research centres, universities, associations and everyone who wants to improve an initiative whose objective is to give, drive, favour and promote the union of Valladolid-Palencia as main beneficiary and promoter of innovative actions in different technological fields.

Figure 8: The city of Palencia (Spain)

4.2 District heating with biomass in public and private buildings

4.2.1 Description of the action

Initially, this action consisted in the construction of a public District Heating (co-financed by EDUSI funds and the Municipality). Originally three public buildings were going to be connected to the system and it was expected to extend the network once it was in service towards two more public buildings and private residential buildings. The city council signed a collaboration agreement with Palencia ECO Energías S.L for the exploitation of the DH under an ESCO model (private or private/public).

The definition of the action has changed during the previous months and finally Palencia ECO Energías S.L. will be the owner and the constructor of the private DH. The DH includes a biomass boiler plant (30 MW) to supply thermal energy for DHW and heating to 6,000 dwellings which will be combined with a thermal solar plant to cover partially the energy consumed by the DH installations.

The DH project will be implemented in two phases: The first phase deploying in one year wants to give Heating and current Domestic Hot Water service on the first term of 2021 to *Campo de la Juventud* and *Santiago* neighbourhoods (around 3,500 dwellings, 1st phase) and *Pan y Guindas*, city centre and the second phase on the first term of 2022, *San Juanillo* neighbourhoods (around 2,500 dwellings, 2nd phase). The Municipality will connect two of the public buildings originally identified (Public Library and Local Police Building, located in *Campo de la Juventud*) using the EDUSI (Sustainable and Integrated Urban Development Strategy) with a financing by the European Regional Development fund (ERDF) of 50% and Palencia Municipality of 50%, already provisioned for this action.

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4.2.2 Intervention's value chain

The construction of a District Heating (DH) is a very complex intervention that requires the participation of different actors as can be seen in the Value Creation Ecosystem presented in the figure 9. In the case of Palencia, the project pivots around two main actors: the Municipality and Palencia ECO Energías.

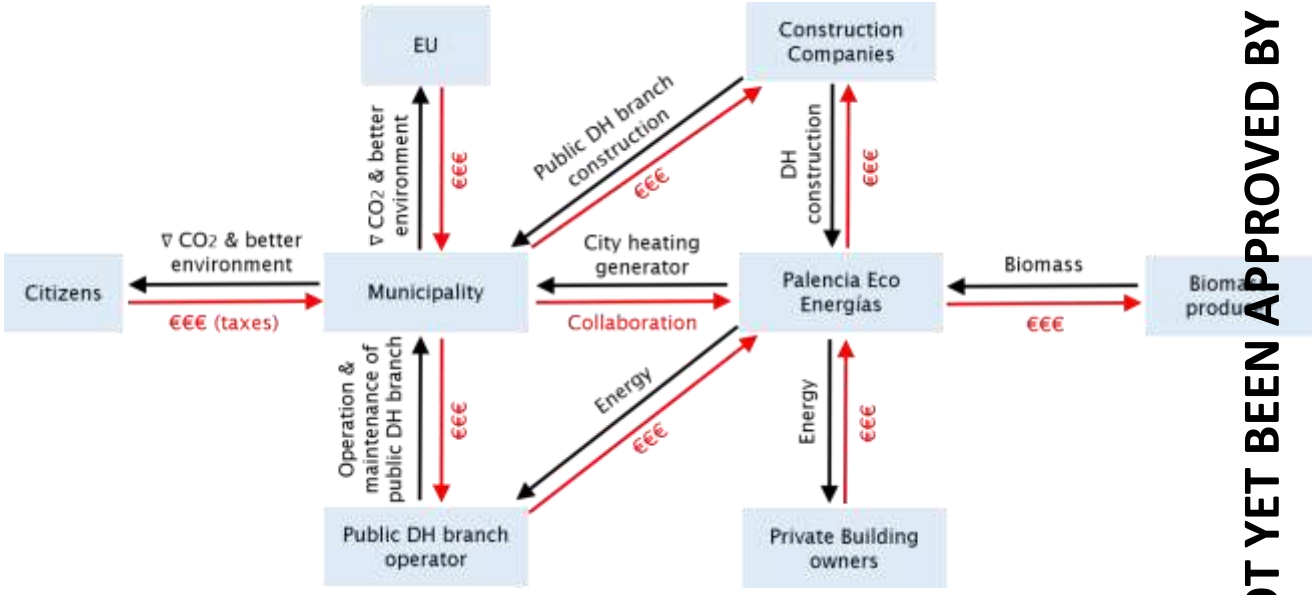

Figure 9: VCE of Palencia's DH intervention

These actors collaborate to build a DH that will serve public and private buildings. The Municipality, through a construction company, will build a DH branch to serve public buildings, meanwhile Palencia Eco Energías will build the boiler and the branch of the DH that will serve private buildings. The Municipality will receive money from the EU to reduce the city CO_2 emissions and to improve the environment and the air quality, to do that, they will use part of the taxes paid by citizens, who will be the ultimate beneficiaries of the intervention.

Palencia ECO Energías will use thermal and biomass energy to provide heating and domestic hot water to private building owner and to the DH branch operator. Both actors will pay an open market price for that service. The biomass will be bought to local producers. Palencia ECO Energías could be the DH branch operator but this is something that will be decided through a public tender. This operator will distribute energy to public buildings and maintenance this branch of the DH according to the conditions stablished in the public tender.

4.2.3 City Business Model

The Municipality has defined a business model based on sustainable development that is presented through the City Model Canvas in figure 10. The city wants to reduce CO_2 emissions replacing diesel and natural gas boilers by biomass in three municipal buildings —local police station, public library, and social services equipment— and 3,500 dwellings.

The value proposition is centered on improving the thermal comfort and decreasing energy costs of public and private buildings, which increase, for sure, the social acceptance of this solution. The DH will consume green energy. Moreover, the DH intervention will contribute to reducing the energy consumption and CO_2 emissions by 20% and increasing the use of RES in 20%, which are the European 2020 objectives. Beyond that, in the economic sphere, the DH will create a network of local suppliers and producers of biomass due to the propagation of these type of projects.

Originally the beneficiary was just the Municipality since three public buildings were going to be connected to the system but the city council signed a collaboration agreement with Palencia ECO Energías for the exploitation of the DH under an ESCO model and it is expected to extend the network to 3,500 dwellings in private residential buildings, so the owners and tenants of these dwellings with fuel or gas boiler collective heating system will be beneficiaries, too.

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The success of the intervention depends on the buy-in of dwellings owners. The main concerns are usually related to high up-front costs. It is also fundamental to have companies willing to operate this service as ESCOs.

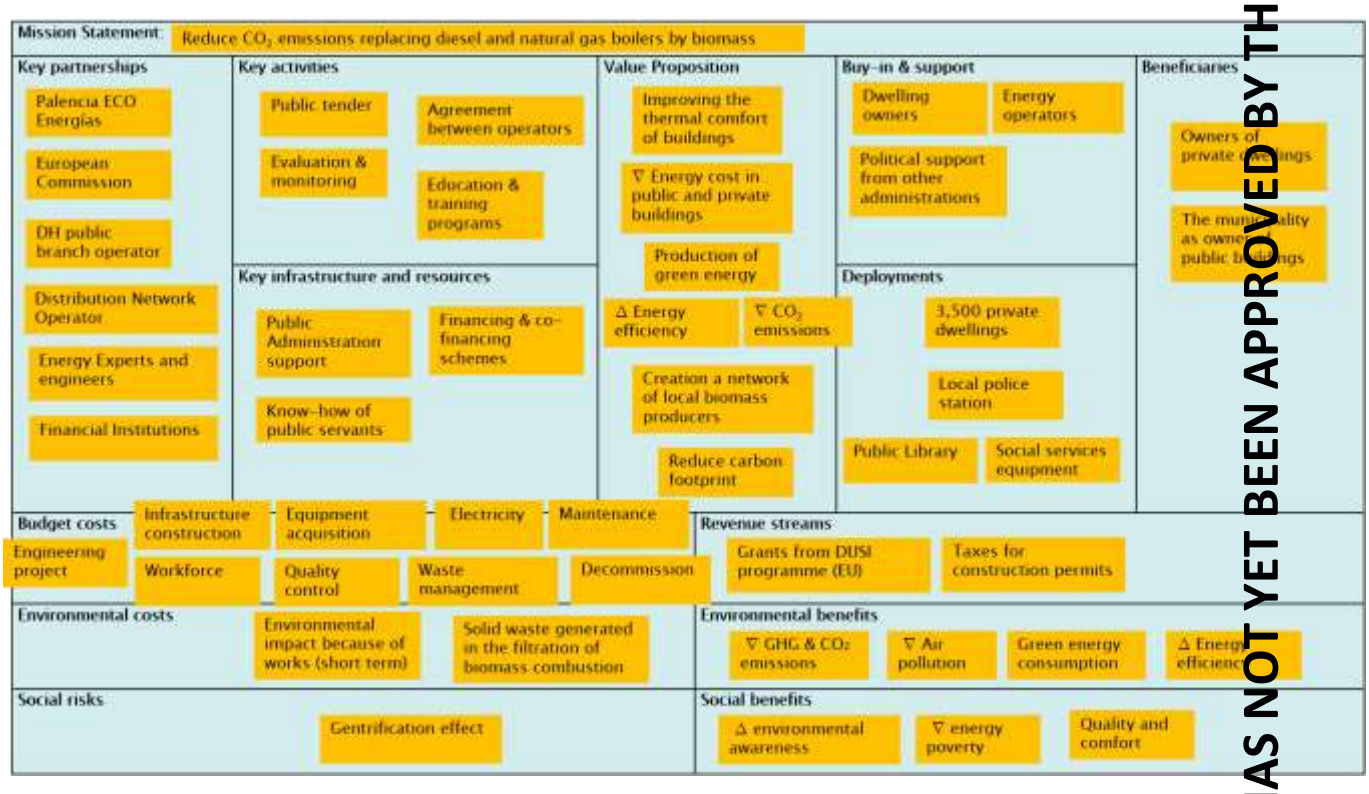

Figure 10: CMC of Palencia's DH intervention

Regarding the deployment, as it has been already mentioned, the DH construction and operation are divided into two branches. Palencia ECO Energías is in charge of building and operating a DH that initially will serve 3,500 private dwellings —with the possibility to expand that network— and the energy production center. While the Municipality is in charge to build the branch that connects the local police station, the public library, and a social services equipment the general DH. Therefore, Palencia ECO Energías, as the promoter of the construction, operation, and maintenance of the DH, is the key partner for the development of this project. As usual, also the EU is a key partner, acting as a main financial supporter. The Municipality needs the know-how of energy experts and engineers, and the collaboration of financial institutions that could help owners to get funds to pay the initial investments.

This project requires, according to Palencia's Municipality four main key activities. Two public tenders are necessary, one for the construction of the public branch of the DH and another for deciding who will manage it. If the winner is not Palencia Eco Energías, it will be necessary to build an agreement between the winner and the company who is building and operating the main part of the DH. Once the project runs, evaluation and monitoring of buildings —tenants and owners' energy consumption— will help to understand if the performance is according to the previous expectations. In parallel, the Municipality is launching educational and training programs for citizens, technicians, operators…which aim is to ensure that people are ready to understand the intervention and to benefit as much as possible from it.

Regarding the key resources and infrastructures, the support of different levels of public administration (regional, national, and supranational) is fundamental. The Municipality has defined a financing and funding schemes that guarantee that the intervention will be finished according to its interests. Palencia counts with the essential contribution of professionals with large experience, which know-how contributes to define the solution that has to be implemented according to the needs of each street. The project implies an intervention on the urban subsoil and public technicians are the ones who must establish the guidelines to minimize affectations in the network of other companies during construction period.

The main costs of the intervention can be divided as usual into two big blocks: project and construction costs, and operation costs. In the first block, the Municipality includes the engineering project, with its planning, the construction of the infrastructure, the acquisition of equipment, waste management cost and

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quality control cost. While in the second block there are electricity prices, maintenance cost (materials/consumables), labour costs, tax (fee per year), and insurance costs (fee per year). Finally, there will be a decommission cost at the end of the DH's lifetime.

The Municipality has received funds form the EU (EDUSI programme) and Palencia ECO Energías will be paid for each ton of CO_2 avoided (grants from Clima Project). Private owners willing to be connected to the DH will have to pay taxes for the building permits. Moreover, the Municipality also believes that there will be a reduction in the municipal budget allocated for fuel property.

During the construction of the DH (short period of time) there is an extra generation of greenhouse gas (GHG) emitted and sound pollution. The major impacts during the operation of the DH are related to the biomass. On one hand, the operator has to treat the solid waste generated in the filtration of biomass combustion gas, and on the other the biomass transport from its origin to the biomass plant generates energy consumption and GHG emissions. However, the environmental benefits are majuscule. This Dh will improve the energy efficiency of the city and will reduce the CO_2 and GHG emissions. Moreover, it will make possible the use of biomass, which is a renewable and indigenous energy source, and cogeneration, with the consequent improvement in global energy efficiency.

The improvements mentioned before will increase the value of the dwellings, situation that could generate a possible effect of gentrification. This is something that the Municipality should tackle beforehand with public policies. In terms of social benefits, the city should reduce the energy poverty due to the reduction of household's energy bills, as well as reduce the social differences offering buildings with most quality and comfort.

4.3 Electric vehicles for municipal services fleet and public charging stations

4.3.1 Description of the action

The action consists in the implementation of eleven EV in the Municipality of Palencia to replace combustion vehicles from the municipal fleet. The vehicles acquired consist of seven e-vans for municipal services (gardens maintenance, public works and municipal sports) and four motorcycles for the Local Police. Finally, the implementation of these EV has been completed with the installation of seven indoor charging points of 3 kW for the charging of the vans, and other four indoor charging points 3 kW for the Local Police motorcycles.

This action has been completed on September of 2019 using the EDUSI (Sustainable and Integrated Urban Development Strategy) with a financing by the European Regional Development Fund (ERDF) of 50% and Palencia Municipality of 50%.

Moreover, this intervention incorporates the installation of public EV charging stations. Nowadays there are thirteen public stations operated by a private entity. However, the idea of the Municipality is to increase the network in order to guarantee the availability, accessibility and reduction of range anxiety.

4.3.2 Intervention's value chain

The deployment of EVs and public charging stations (PCSs) is still in an early stage and there is a long path to go. PCSs network is key in supporting the EV major adoption. Due to financial constraints, there are not many companies willing to install these stations in cities that are not considered as big capitals. This is the reason why nowadays municipalities have to play a central role in the value chain if they want to develop a robust network in their cities. Palencia's Municipality has understood what is needed and is playing a central role in the Value Creation Ecosystem as it is shown in figure 11.

The Municipality is leading by example the project. It is acquiring EVs, which are delivered by a company that has a strong commitment to Palencia, where it has a factory. The manufacturer through a concessionaire is in charge of the maintenance of the EVs, taking especial care with the batteries. Moreover, the municipality acquires charging stations that are installed and operated by a private operator, that runs these stations through a concession. The municipality is paying the charging stations operator (CSO) for this public service. The CSO offers the possibility to EVs' owners to charge in public spaces their vehicles and it is paid by EVs' owners according to the energy consumed during the recharge. The energy is offered by a classical energy provider. The CSO could acquire other stations at its own risk and responsibility. EV's owners, at least nowadays, have some advantages offered by the municipality as gratitude for reducing CO_2 emissions and improving the air quality and the environment.

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Palencia is promoting a long-term strategy, and therefore it also considers in the value chain network those companies that will decommission EVs in the coming years.

The Municipality is financing part of its activity in this ecosystem with its own resources, but it is also receiving funds from the EU, which is incentivizing the actions that try to generate a positive environmental impact, as it is in this case.

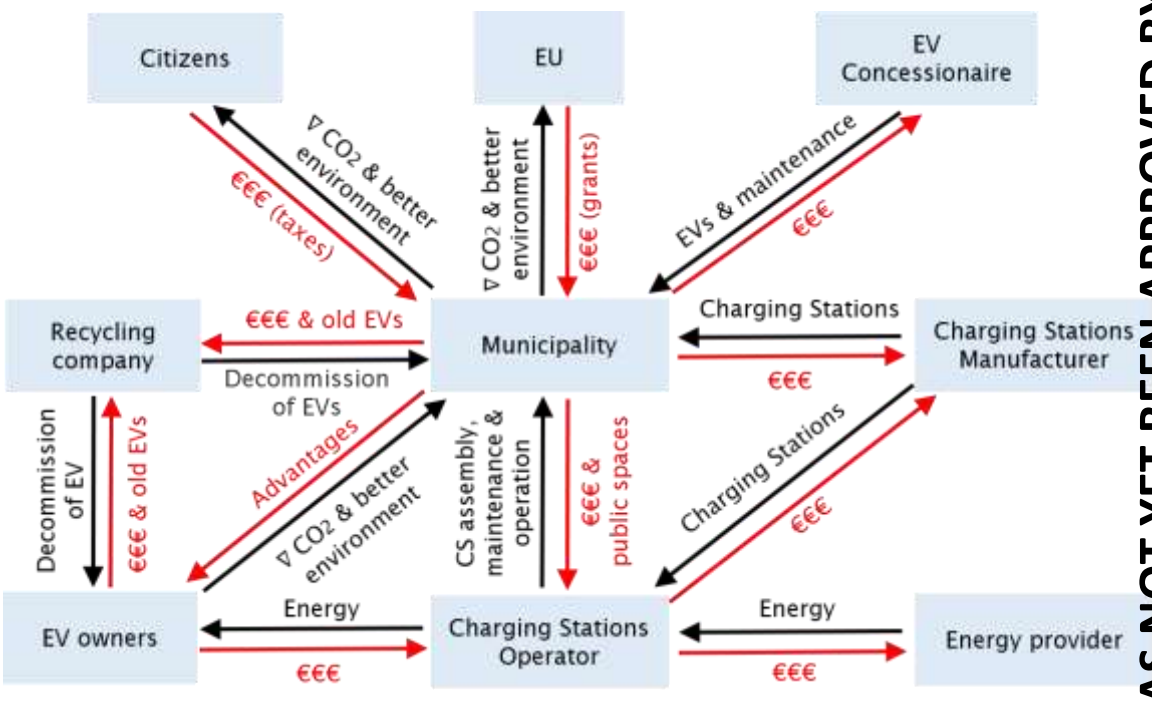

Figure 11: VCE of Palencia's EV intervention

4.3.3 City Business Model

Palencia has built an interesting city business model, which is presented in figure 12, to ensure the deployment of this project. The main objective of the Municipality is to contribute to convince key stakeholders and citizens of the benefits of EVs for the city and to contribute to the transformation of the vehicle manufacturing industry in the region.

Palencia offers the replacement of current vehicles fleet that run on diesel and gasoline by electric vehicles, in which carbon footprint is much lower. Doing so, the city reduces GHG emissions to meet the commitment with the Covenant of Mayors. Moreover, with the replacement of traditional vehicles by electric ones, the Municipality will reduce its investment in maintenance. The installation of Public Charging Stations (PCS) guarantees the availability, the accessibility, and it reduces the range anxiety of those that do not have private charging points. Finally, as part of its value proposition, the Municipality is developing a car-sharing platform for EVs.

There are different beneficiaries of this intervention, starting by the Municipality itself. The EV's owners will be also considered as other stakeholders because they benefited from charging its vehicles whenever they need it. Dynamizing the ecosystem, the usage of the EVs will increase and hence the usage of public stations, therefore the operator of these points can be classified as a potential beneficiary, as well as manufacturers. The City Model Canvas cannot forget the citizens, who will live in a better city, and the entrepreneurs, who could create new business models around EV maintenance and development.

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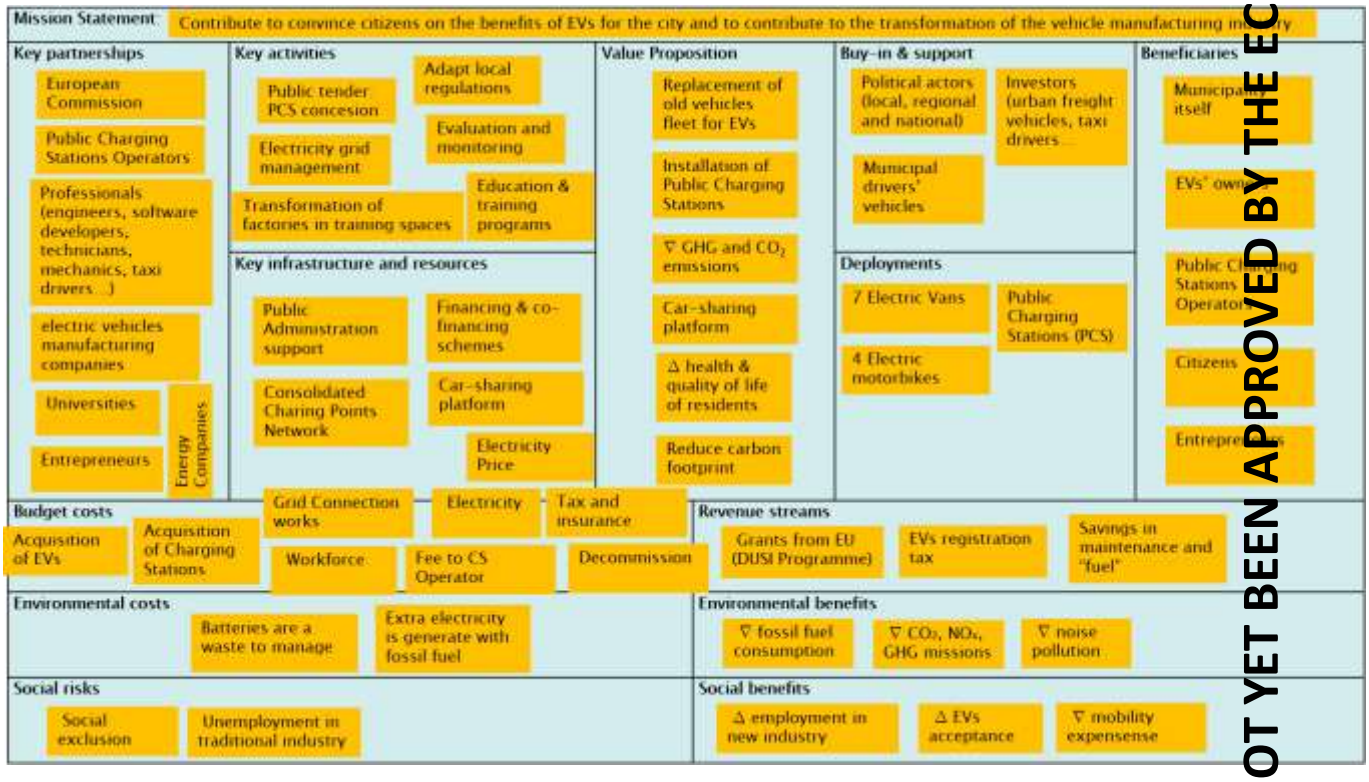

Figure 12: CMC of Palencia's EV intervention

The implementation of EV needs the political actors' (central, regional, and local administration) support. It is also fundamental to have the support of potential investors (urban freight vehicles, taxi drivers, private buses with provincial routes). The drivers of municipal vehicles are important players because they are those who use this new type of vehicles, and if they present resistance, the implementation will be done much more slowly.

As it has been already mentioned, the Municipality bought eleven electric vehicles (seven vans and four motorcycles) in 2019 to integrate them in the municipality fleet. As part of this strategy, the Municipality is incentivizing the deployment of PCS in different neighbourhoods, and it wants to increase the number in the following years as a part of its replication plan.

The Municipality, as it has been shown in the VCE, needs different actors to deliver an efficient electric mobility into the whole city. In that, the EU, the charging stations operators (CSO), professionals (engineers, software developers, technicians, mechanics, taxi drivers…), universities (new degrees, and researchers), SME,s, electric vehicles manufacturing companies, car-sharing entrepreneurs and companies, energy companies, and recycling companies can be considered as key partners without which it would be difficult to guarantee the success of the project.

There are some essential activities that the Municipality should do to guarantee that the ecosystem is dynamic and runs properly. In that sense, the Municipality should adapt the local regulation to current needs. A good starting point would be to remove the obligation to those hotels, restaurants, and services interested in installing an electric charger to declare themselves as energy managers forcing them to pay some taxes. To prepare a strategic plan for the transformation of the factory plant of vehicles on technical training space, and financing for non-lose competitiveness in a market with an increasing demand for electric cars. Promoting the use of electric car-sharing. Information campaigns focused on the economic benefits of the EV in comparison with conventional cars for professional (taxi drivers, delivery companies). Evaluation and monitoring of energy consumption of EV municipal fleet and publish data. A rapid growth of the units of this type of vehicle can arise a problem in the electricity grid, so managing it properly and effectively is an asset.

Palencia has important resources that help to deploy the intervention. The public administration support, the financing and funding schemes, and the consolidated charging points network in the city are key. The car-sharing platform is another interesting resource.

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In terms of budget cost, in the deployment phase, the Municipality has to afford the E-vehicle cost and its battery cost, the charging points, and the grid connections works. During the operation, it has to afford the energy to recharge the EVs, the workforce, and, beyond the tax and insurance costs, it will pay the fee to the CSO. In the disposal phase, it will be necessary to cover the cost of scrapping value of vehicle and the battery recycling.

The revenues of the intervention can be divided into three main blocks: European Regional Development Fund from the European Commission, EVs registration tax and the reduction of municipal budget allocated to the purchase of gasoline and fuel.

The batteries of EVs are one of the major problems in terms of environmental impacts and they will be a waste to be managed, although they are recyclable. EVs usage will increase electricity consumption and some electric power plants use fossil fuels to produce the extra energy required for EV vehicles. However, in terms of environmental impact, the benefits of EVs are huge because these vehicles consume less energy than conventional vehicles, they do not emit GHG, NOx particles, or noise and their batteries are completely recyclable.

Nowadays, EVs are more expensive than a standard traditional vehicle, and it could imply levels of social exclusion because low-income cannot afford this new typology of vehicles. A big growth of the EV could affect the business network around the fuel combustion vehicles and increase unemployment. On the other side, EV car sharing will provide a cheaper model of mobility and reduce the expenses of car that families have currently. Taxi drivers as delivery companies will increase its acceptance due to the lower cost of maintenance and operation of EVs that benefit citizens with a cleaner air. Introduction of EVs at the local factory will ensure employment at this plan.

4.4 Smart public lighting

4.4.1 Description of the action

The Municipality began to replace traditional street lighting for LED lighting with a light management control system in 2013. Palencia was a pioneer city in Spain and commissioned an ESCO, which was made up of Philips and Clece, to manage a quarter of all public lighting (4,000 points of light). The savings in all areas were spectacular. At an economic level, the Municipality saved EUR 2,000,000, 60% of the energy consumed, which represented 756,000 kWh/year. With these results, the city met the 2020 agenda and the covenant of mayors targets, reducing CO_2 emissions by 20%. The Municipality acquired the ESCO's know-how and nowadays it manages itself the 4,0000 lampposts infrastructure.

In 2015, with its own funds, the Municipality replaced another 2,000 light points located in an industrial area of the city. Since 2017, through the DUSI program, which will spend EUR 900,000, Palencia is replacing another 1,067 points. The last 556 lampposts are currently being replaced, costing this part of the intervention EUR 493,000. In total, at the end of the DUSI programme, therefore, 7,000 points will be replaced, which represents 60% of the total number of lampposts operating in Palencia.

4.4.2 Intervention's value chain

Although Palencia has used different value chains over the last few years to provide public lighting, figure 13 presents the current ecosystem, in which the Municipality plays a central role.

Nowadays, as it has been already said, the city is receiving funding from the EU to replace the traditional lamppost for smart ones. The EU wants to reduce CO_2 emissions and to improve the air quality around Europe and public lighting is one of its most relevant targets. Palencia through a public tender is buying smart lamppost with very well-defined characteristics to private manufacturers. The city commissioned to a construction company the decommissioning of the traditional lamppost and the installation of the smart ones. The city, thanks to the in-house resources and technician's know-how, is operating the public lighting services across the city. The saving achieved in terms of energy consumption is transformed into a reduction of energy bills.

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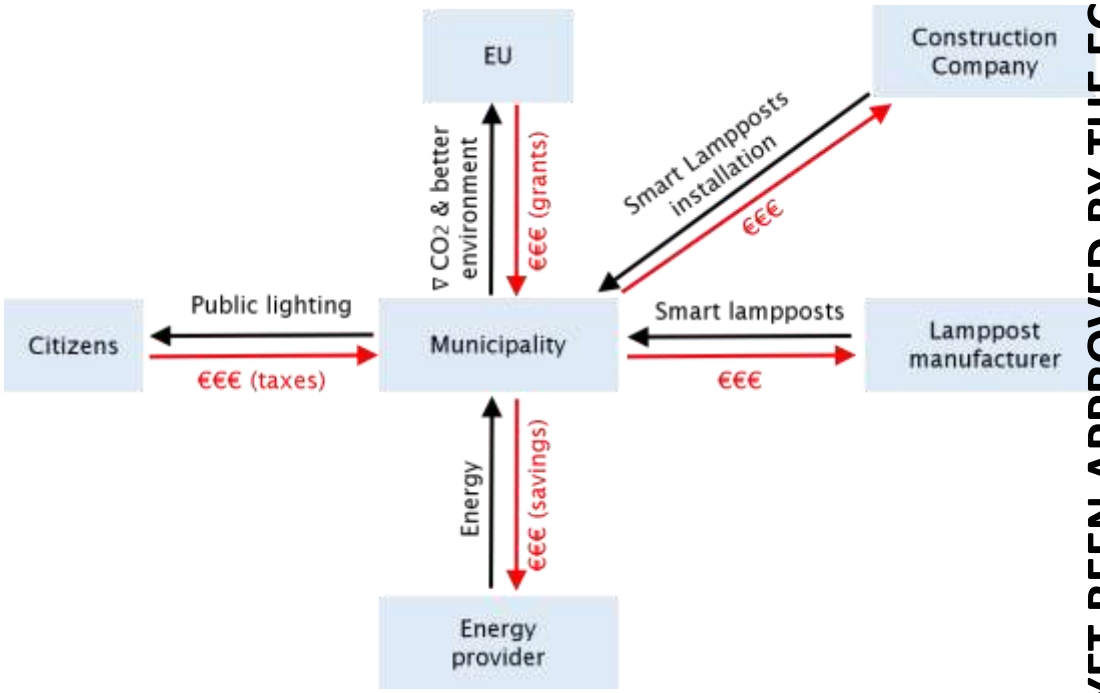

Figure 13: VCE of Palencia's smart lighting intervention

4.4.3 City Business Model

The City Model Canvas presented in figure 14 describes how the Municipality is organizing its resources to create, deliver, and capture value through the installation of smart lamppost across the city. The main objective of the administration is to reduce the energy consumption and CO_2 emissions while generating economic savings due to this reduction. The value proposition is centred on these concepts, but it also emphasizes that the new lamppost will offer better public lighting because they are capable to offer a cleaner light when it is needed, modifying intensity as appropriate, and focusing the desired points, which result in the reduction of light pollution.

The main beneficiaries are the citizens. One of the reasons is that intervention improves the safety of public spaces because municipal technicians can control the correct operation of each installation and perform point-to-point control of the luminaries, being able to increase levels at the points of greatest security. The dynamization of this business sector will also benefit local electrical installation companies and LED lamppost suppliers.

The intervention will be a success if it has the buy-in and support of the neighbourhood associations that could otherwise act as blockers for data protection reasons and for the inconvenience generated during the implementation.

As it has been presented in the introduction, the replacement of 60% of the Palencia`s lamppost has been divided into three phases. In 2013, 4,000 smart lampposts were installed across the city; in 2015, 2,000 smart lampposts were deployed in an industrial area; and the last 1,067 are being installed since 2017.

Once again, the EU is the main financial partner, which means that it is playing a key role in the stakeholders' map. Other financial institutions are key partners, too. Beyond these actors, the Municipality should consider and recognize the role of different types of professionals (engineers, energy experts…), construction, and installation SMEs and technology suppliers. Without all of them it would be very difficult to achieve the desired results.

As it happens in many public services, the public tender for commissioning services or buying materials is key. In this case, especially considering that the deployment has been dived in different phases, is fundamental to the integration of new LED lampposts in Street Lighting Palencia's Control System. The assessment and evaluation of the behaviour and consumption of the new lamppost are essential to achieve the levels of energy saving expected by public authorities.

Regarding the key resources and infrastructures, the support of different levels of public administration (regional, national, and supranational) is fundamental. The Municipality has defined a financing and funding

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schemes that guarantee that the intervention will be finished according to its interests. Palencia counts with the essential contribution of professionals with large experience, whose know-how contributes to defining the solution to implement according to the needs of the neighbourhood.

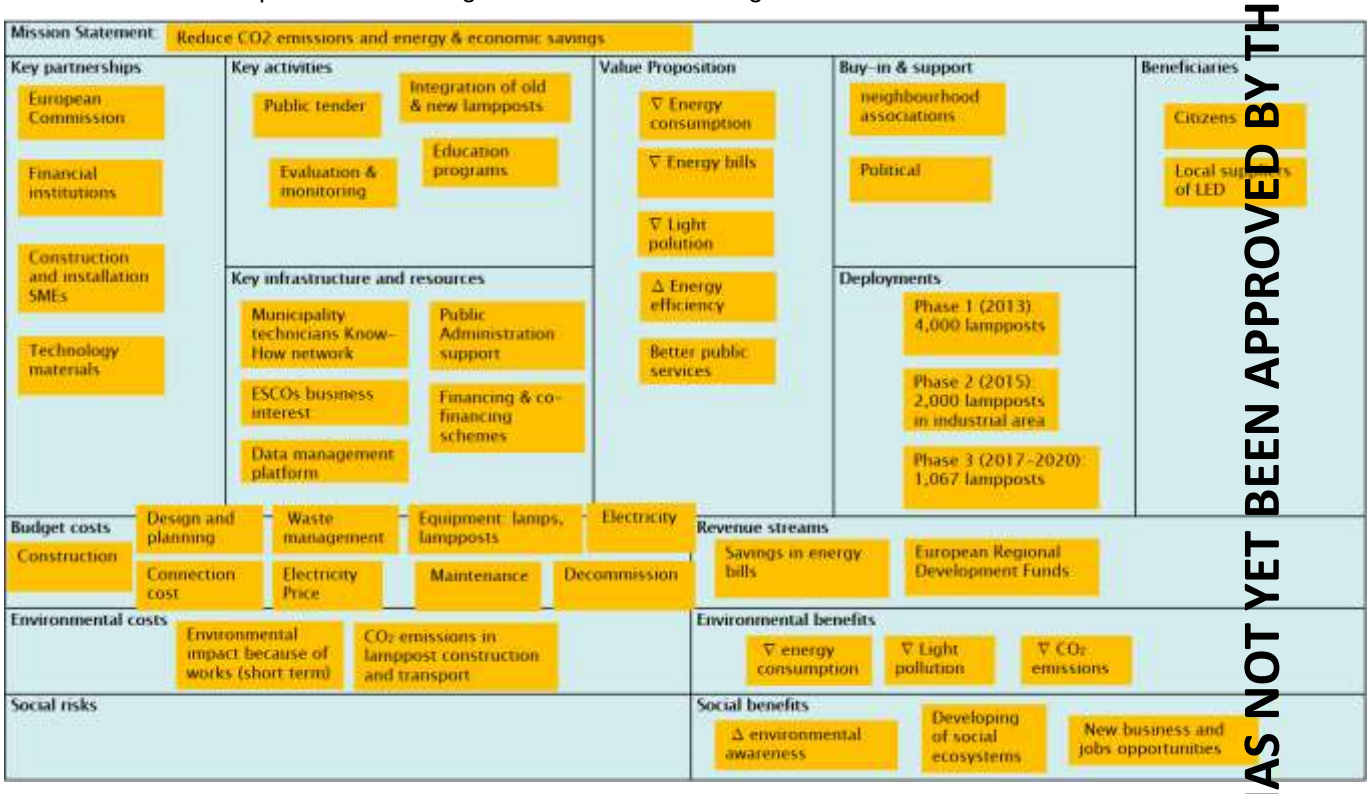

Figure 14: CMC of Palencia's smart lighting intervention

The main costs of the intervention can be divided as usual into two big blocks: Acquisition and installation costs, and operation costs. In the first block, the Municipality includes design and planning cost, construction costs, infrastructures and connection cost, electricity installation cost, equipment cost: lamps, lamppost, street LED lamps remote management, and Philips luminaire control system service, waste management cost, quality control cost. While in the second block there are electricity prices, maintenance cost (materials/consumables), labour costs, tax (fee per year), and insurance costs (Fee per year). Finally, there will be a decommission cost at the end of the lifetime of each lamppost. The operation of these new smart lampposts should offer a reduction of municipal budget allocated for electricity. Beyond the savings, the Municipality has already received funds from the EU to finance this project.

The deployment of the lamppost could generate a short-term impact. In that sense, the Municipality is aware that this phase causes an increase in energy consumption, GHG emissions, and sound pollution. Moreover, the replacement of traditional lamppost requires the treatment of solid waste generated in old sodium or mercury vapor lamps. However, the benefits in the medium and long term are much bigger than short term costs, and they can be summarized with three ideas: less energy consumption, less emission of CO_2, and less light pollution under the operation phase.

Using much more efficient technology can lead to an increase in light levels, which would lead to greater light brightness and aspects related to visual perception and well-being. It is necessary to calculate the lighting needs of the street, for example, if they serve pedestrians, traffic, or gardens. Moreover, the intervention contributes to increase environmental awareness of citizens, to increase the smart ecosystem development, to reduce potentially dangerous places and to create business and jobs opportunities.

4.5 Final general remarks

Palencia is developing very interesting interventions in terms of its transition from a traditional city to a smart one. The three interventions analysed in this deliverable are perfectly aligned with the main axes of mySMARTLife project: energy efficiency in the built environment, reduction of CO_2 and GHG emissions, and deployment of data management technologies. The Municipality stands by the private sector, building

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close collaboration with companies, and dynamizing, directly and indirectly, the economy of the entire region, which is a strategic issue for its long-term sustainability.

The DH intervention a clear example of private and public entities working together, protecting their legitimate interests, while benefitting inhabitants, which is always the main interest of the public authorities. Public lighting intervention was also made under this principle, and it was the key element of the success of the first phase of the project, building a solid foundation for the following ones. Both interventions are based on the principals of Energy Saving Agreements (ESA), which are the contracts where there is a sharing risk between public and private organizations.

Palencia, on its commitment to Sustainable Development Goals, is also supporting the implementation of EVs, leading by an example with the aim of helping an important industry for historical reasons in its region. Implementing a public electric fleet is an interesting strategy, but what will be key to overcome the existing barriers is the deployment of public charging stations hand in hand with private operators, which nowadays are receiving a fee from the Municipality, as an engagement measure, for running the charging points because otherwise it will be impossible for them to be profitable with the reduced number of EVs that are active in Palencia and its surroundings.

In general terms, value chains are complex, and many stakeholders participate in it, which evidences how difficult is to deliver a smart service into the hands of end-users. However, the municipality is managing the structures and the projects properly. A part of the value proposition of these interventions, the analysis reveals two interesting points: beyond the grants received form supra-regional institution (national government or EU), the long-term economic viability, in general terms, is based on savings; and the diaphanous and clear idea of each cost structure that the Municipality has, which is a guarantee to balance the P&L of each project and thus their scalability in other areas of the city. Regarding social and environmental impacts, the ratio between cost and benefits is clearly favourable to benefits in both cases.

Finally, it is interesting to highlight that Palencia is already considering the decommission of each project, creating the right ecosystem to do it properly and with the funds required. This should be an example for many big cities worldwide.

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5. Bydgoszcz's business models for smart city services

5.1 City description (mySMARTLife Project DoA)

Bydgoszcz (figure 14) with 359,428 inhabitants and an area of 175 km^2 is the eighth largest city in Poland. Its competences derive from the Self-Government Act: managing technical infrastructure, ensuring social infrastructure, ensuring safety and public order and taking care of spatial and environmental issues.

The city is committed to achieve GHG emission reduction, increase RES and energy efficiency. The city developed documents on climate policy (e.g. SEAP), joined Covenant of Mayors. The vision indicates that Bydgoszcz would like to be an energy sustainable city by 2020, a leader in exploiting low-emission technologies and enhancing climate protection. In 2012 the Energy Manager position started to function in the Municipality. In 2016 the city set up smart city task group which aim at elaborating and implementing the smart city strategy. Some smart solutions have already been implemented in Bydgoszcz.

Figure 15: The city of Bydgoszcz (Poland)

5.2 E-mobility (public charging stations)

5.2.1 Description of the action

Bydgoszcz has ambitious targets to be a sustainable and efficient city with well-developed public transport network. E-buses and e-bikes as well as a good charging infrastructure are perceived as key elements of this strategy. The Municipality has been implementing several sustainable investments and projects which highly improve mobility in the city (ITS system, new tram line which connect the important areas in the city, city bikes, new bus lines which connect Bydgoszcz with outskirts and neighbourhood communes, etc.). However, there is still an important problem: environmental pollution caused by the emission of exhaust gases from motor vehicles into the atmosphere. The introduction of electric vehicles would be a solution.

Bydgoszcz is working on the first E-mobility Strategy for the City of Bydgoszcz, which should be finished by the end of 2020 —if Covid-19 crisis allow it—. The mission statement of Bydgoszcz is to reduce the city greenhouse gas emissions, improve air quality and increase the urban healthiness. Part of the strategy is the planning of EV charging station within the city. The proposal is not to build the charging points but to lease the ground to the future charging point operator who will tender an e-mobility service provider. Right now, there are eighteen charging points in Bydgoszcz that are private. The achievement of these objectives will have a positive impact on increasing urban healthiness, which entails many economic, environmental and social benefits.

Bydgoszcz starts the EV mobility Strategy and plans to install two-hundred charging points by 2022 (by the hands of the future CPO). The plan was also to buy e-buses fleet, yet the region did not receive the EU co-financing and the purchase plans have been put on hold.

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5.2.2 Intervention's value chain

Bydgoszcz needs to articulate a network of organizations to offer in the whole city a consistent service to EV users. Figure 16 present the Value Creation Ecosystem of this intervention where it is possible to understand the linkages between organizations.

The Municipality is the project owner of the intervention and its main catalyser. Bydgoszcz City will tender the service for the management of the charging stations to private operators. The private operators of the public parking will act as CPOs for the case of the EV charging stations business model. These charging stations operators will manage the relation with the EV owners (e-cars) and the suppliers (energy, charging stations manufactures, and other type of suppliers such as ICT services). Regarding EV owners, they will pay for the parking space fare prices to the operators.

The intervention is possible thanks to the co-financing from the National Fund of Environmental Protection and Water Management – but for that co-financing the works on e-mobility would not have been started.

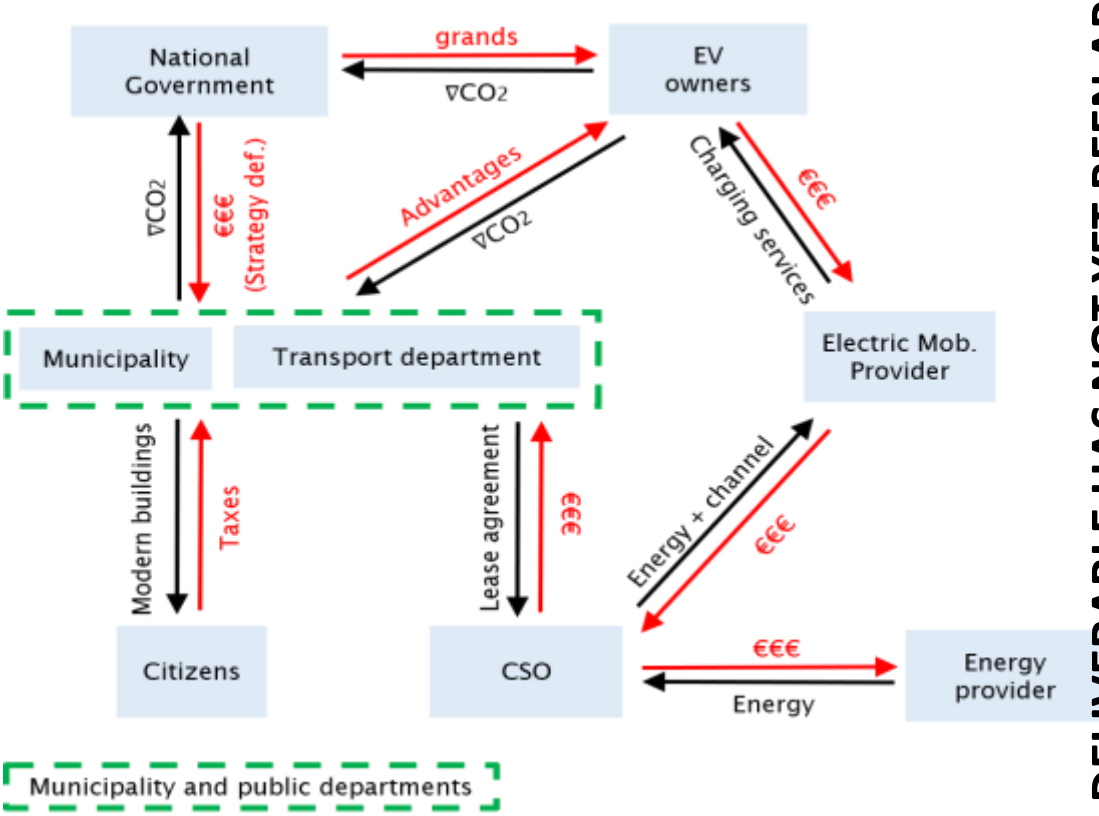

Figure 16: VCE of Bydgoszcz's EV intervention

5.2.3 City Business Model

The implementation of a reliable EV charging stations network faces many challenges. In this section, authors explain, through the City Model Canvas (CMC), which is presented in figure 17, how the Municipality plans to organize its resource to do it successfully in a way that is economically viable, socially inclusive and environmentally sustainable.

As it has been announced in the introduction, Bydgoszcz City aims to reduce the pollution, increase the air quality and increase the urban healthiness. The value proposition of the business model is to promote and facilitate the use of EVs facilitating charging stations, thus promoting sustainable transport. The city is at the beginning of the process as there are only sixty e-cars registered in the city communication department (privately-owned). The new infrastructure will allow for better use of the available transport routes and the possibility of inventorying the existing infrastructure.

The direct beneficiaries of the intervention are property owners, property managers, citizens that own an e-car. These owners will benefit from more spaces to park and charge their vehicles in an efficient way. Obviously, taking into account the mission statement, the business model has indirect beneficiaries, such

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as citizens who will benefit from the reduction of greenhouse gas emissions and the increase of urban healthiness.

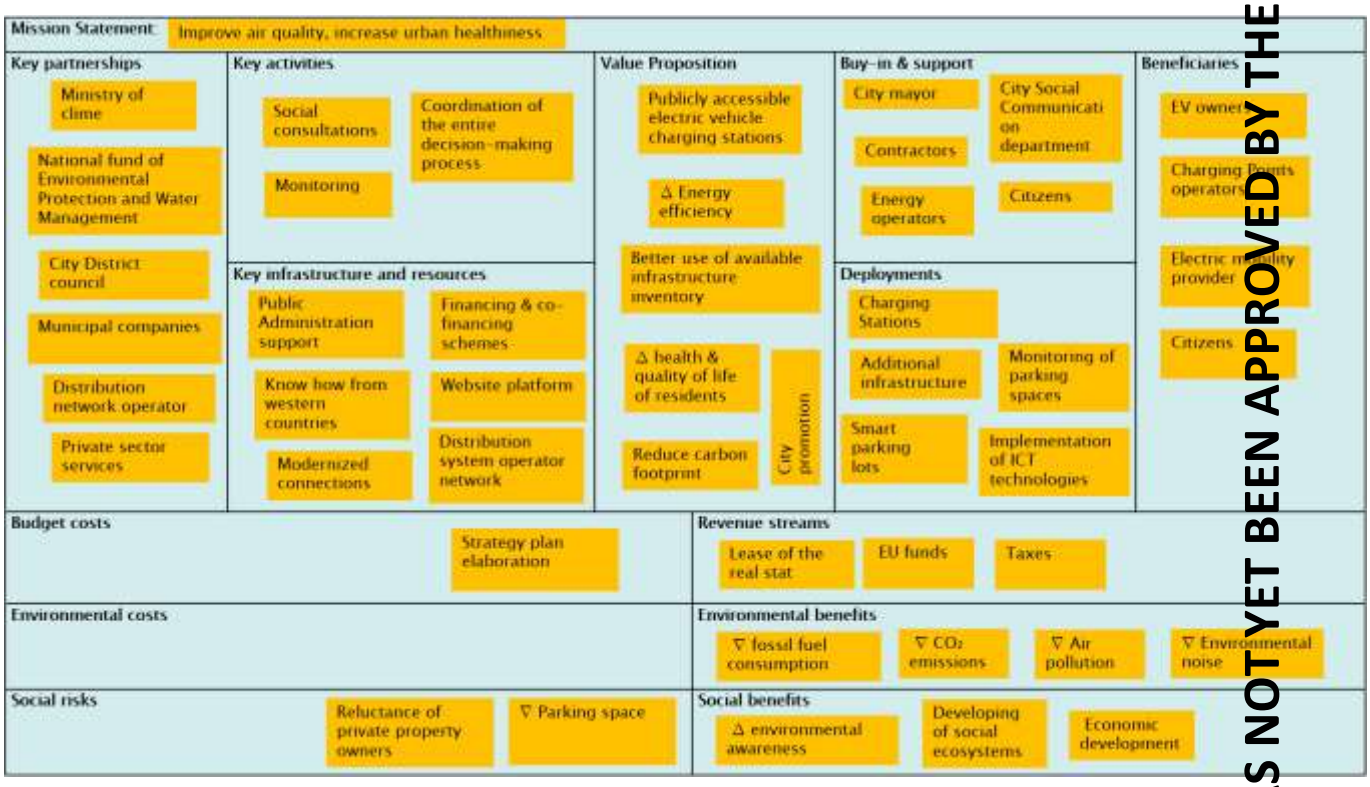

Figure 17: CMC of Bydgoszcz's EV intervention

The delivering value of the intervention and possible replications need the political and citizens' buy-in. The intervention has already the buy-in of the politicians, because it fits in the goals of the City Strategy and SEAP aims.

Finally, the delivering value of the business model implies the elaboration of the first E-mobility Strategy in Bydgoszcz and later the implementation of the smart charging stations.

The producing value of the business model implies different stakeholders. The stakeholder structure is classified by those who: i) promote the charging stations for EVs – EU, National Fund of Environmental Protection and Water Management and Bydgoszcz Municipality; ii) finance the charging stations for EVs – Municipality and National Fund; and iii) produce and deliver value – the Municipality, Distribution Network Operator, municipal companies, private parking operators, and different companies suppliers of products and services such as EV manufacturers or charging stations manufacturers.

The producing value involves different activities. The first one is the public tender design to run the charging stations in public parking. As mentioned, this service is planned. Then the construction of additional small infrastructure, smart parking lots with monitoring of parking spaces and implementation of advanced ICT technologies will ensue.

Besides these activities, the business model relies on key resources and infrastructures. The most important one is the public administration support. This support is mainly linked to the financing of the public service and the introduction of intervention results in new public tenders. Another important resource for the business model is the cooperation with the distributor system network operator.

Finally, the sustainability of the business model focuses on the triple bottom line: cost/revenue, environmental costs/benefits, and social risks/benefits. In that sense, the sources of revenue streams will manly come from leasing the ground to the CPO. However, the Municipality will try to get funding from EU, too. The definition and the implementation of the E-mobility Strategy represent the main cost of the intervention.

The business model presents important environmental benefits such as the reduction of emissions (CO2, PM, NOx, etc.) that influence directly the urban healthiness of Bydgoszcz and the citizens' quality of life; the

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reduction of fossil fuel consumption due to an increase of EVs; and the decrease of the environmental noise, which also affects daily life of citizens. Regarding environmental costs, the increase of the number of EVs will be linked with the consumption of electricity, which also has an environmental impact but in the case of Bydgoszcz, the EV numbers for now are rather low.

Finally, there are important social benefits. The main ones are the urban healthiness and the improvement of citizens' well-being. Obviously, the intervention contributes to the smart ecosystem development and the scale-up of the solution could imply an economic development for the city in terms of job creation, attraction of companies and start-ups, investors, etc.

5.3 Smart lighting system

5.3.1 Description of the action

The lighting fittings are being replaced with LEDs and equipped with individual controllers. The lighting cabinets and their control are modernized, and new lighting are built. The open LonWorks standard was used for system communication, enabling control via the power line. The main impact on the reduction of energy consumption is the use of energy-saving LED light sources and the reduction of lighting intensity at night. The old lamp replacement is carried out on a yearly basis depending on the budget and needs.

The main goal is a 67% reduction in CO2 emissions compared to the state before modernization. Other goals are to reduce electricity consumption and to achieve the savings.

Nowadays, the intelligent lighting system that operates in the city of Bydgoszcz consists of 10,000 lighting fittings controlled and powered from 183 lighting cabinets. The first phase of modernization of lighting began in 2015 and the new system is still developing and since then is carried out yearly. The new lighting is built in accordance with previous standards and it is connected to the system. Obtaining financing and loans is a necessary resource for the modernization.

The main purpose at beginning of the project of lighting modernization was to ensure safety for road users (pedestrians, cyclists, vehicle drivers), to reduce air emissions and to save electricity. The main assumption of the project was to maximize economic and ecological effects and energy, so it was decided to use the existing infrastructure. Concrete poles and lighting circuits were not replaced. This allowed to significantly reduce the cost of the entire project. The luminaires were replaced and each lighting point was equipped with individual GLC controller. Old lighting cabinets have been closed down and replaced with new ones with an intelligent lighting control system. The GLC controller enables control and management of the light source and obtaining parameters such as energy and reactive and active power, cos φ, THD. The flexible and distributed network structure increases the functionality and reliability of the system. Direct supervision over the construction and operation of the lighting system lies in the hands of engineers from ZDMiKP (*Zarząd Dróg Miejskich i Komunikacji Publicznej* – City Roads and Public Transportation Board), who manage the roads on behalf of the Municipality of Bydgoszcz. The process was started in 2015 since the National Fund of the Environmental Protection and Water Management introduced the SOWA grant for co-financing the replacement of the old lamps with LEDs. From that moment on, the process of old lamps replacement started together with energy efficiency introduction to the city policy (Energy Management Office was created).

5.3.2 Intervention's value chain

ZDMiKP, which is the public company of roads and public transportation, is the responsible for implementation of the action and acts on behalf of the City Government and oversees the public lights and roads in the city. The network of organizations created around ZDMiKP to implement this complex intervention is presented in figure 18.

ZDMiKP publishes a tender in which a company is selected to carry out the lighting works. The infrastructure for the new lamps was built in 2015 together with a CMS. The contractor of that system was Energa (one of Poland's four largest energy companies and one of the three largest electricity suppliers in Poland whose core activities include the generation, distribution, and trading in electricity and heat, as well as gas trading). The company was selected in a public tender. The VCE figure, shows that Energa is responsible for cooperation with manufacturers of lighting control system (Apanet Green System company – who was subcontracted by Energa) and manufacturers of lighting poles (Philips). Apanet Green System, which provided the control devices, control system and application of the master CMS (Central Management Software) system played a large role. APANET is still supervising the system and provides technical and substantive support to ZDMiKP employees.

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The lighting system was co-financed by the National Fund of Environmental Protection and Water Management in 2015, which is offered by the National Government and by the Municipality through its ordinary budget.

Apanet Green System has been dealing with the implementation of solutions optimizing lighting control in a sustainable and intelligent way since 2003. Apanet can boast of many projects of intelligent lighting control systems, including those in: Paris, Vilnius or Bydgoszcz. The company manufactures its own controllers in Poland according to the ideas of Smart Grid and Smart City, bringing significant savings and complete security to the user. Most importantly, the company uses solutions based on an open standard. In addition, the open standard system allows its further expansion and integrated development with additional sensors such as humidity, temperature and air pressure as well as noise sensors.

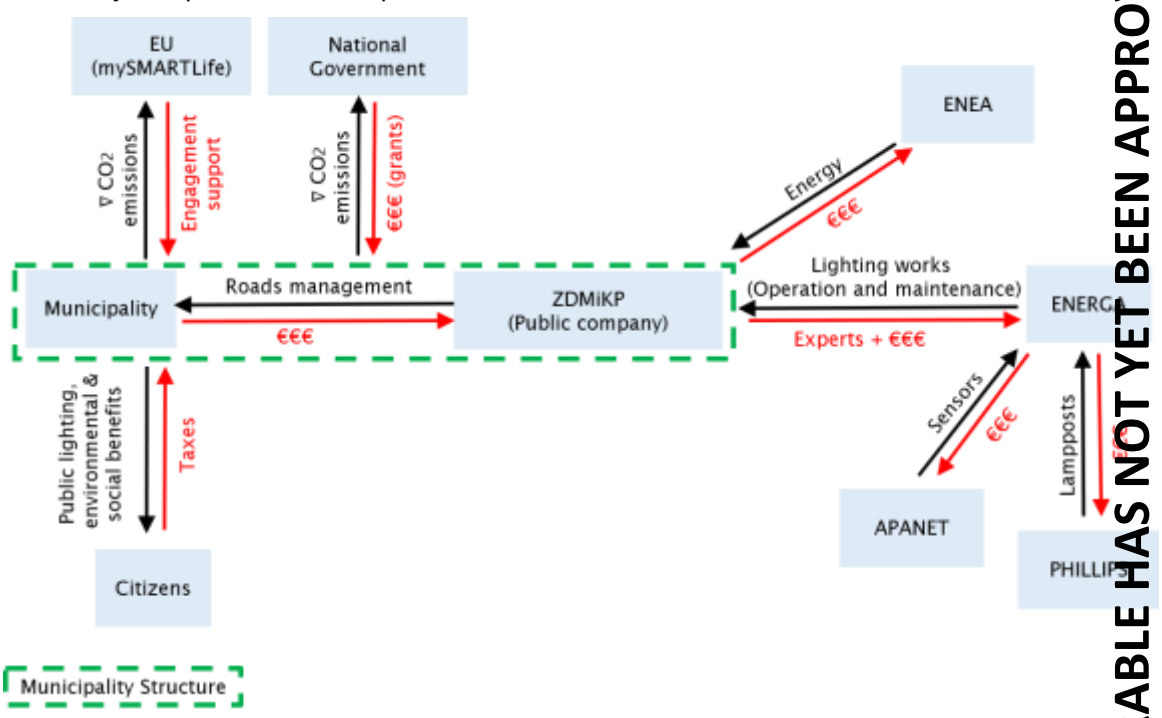

Figure 18: VCE of Bydgoszcz's smart lighting intervention

Another important partner is the seller and distributor of electricity, who provides the energy necessary to power the lighting system (ENEA – selected via tender). Another co-operator are municipal lighting maintenance technicians - a company selected as part of a public tender that provides the necessary repairs.

5.3.3 City Business Model

The replacement of the traditional lighting system by the new one is based on the ambition of improving energy efficiency, reducing CO_2 emissions, and improving the safety of road users. As figure 19 shows, it is funded on a solid business model.

The value proposition of the business model is the reduction of electricity consumption at the level of 60% compared to the state before modernization, improvement of ecological efficiency, promotion of intelligent lighting control systems, and improving the health and quality of life of residents.

The beneficiaries of the interventions are the participants of the road and pedestrian traffic, the citizens and the passers-by. The decision as to carry out the intervention depends on the Director of ZDMiKP and the City Mayor with the cooperation of the experts (environmental supervision). In 2015 the process did not involve the citizens at all. Now are also the residents who can co-decide on the places of their construction. The city's authorities receive the applications of residents who have influence on the location of new lamps.

Finally, the deployment for the delivering value of the intervention depends on the implementation of the public lighting actions. As mentioned before, the modernisation of the lamps in the City of Bydgoszcz started in 2015 - modernization of lighting (fittings, control system), intelligent individual luminaire controllers, intelligent lighting cabinet controllers, network analysers, energy management system. From that year on,

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the old lamps are replaced and modernised yearly depending on the budget – a new contractor is chosen in a tender.

The partnership cooperation on the intervention is built among those entities that promote the smart lighting – EU and the Municipality, those that fund the interventions – Municipal budget (with co-financing in 2015, and only City budget from 2016 onwards), the National Fund for Environmental Protection and Water Management in 2015 and, those who produce and deliver the value: City Roads and Public Transportation Board in Bydgoszcz, Municipality, the contractor, architects, Energy Management Office, construction and IT companies.

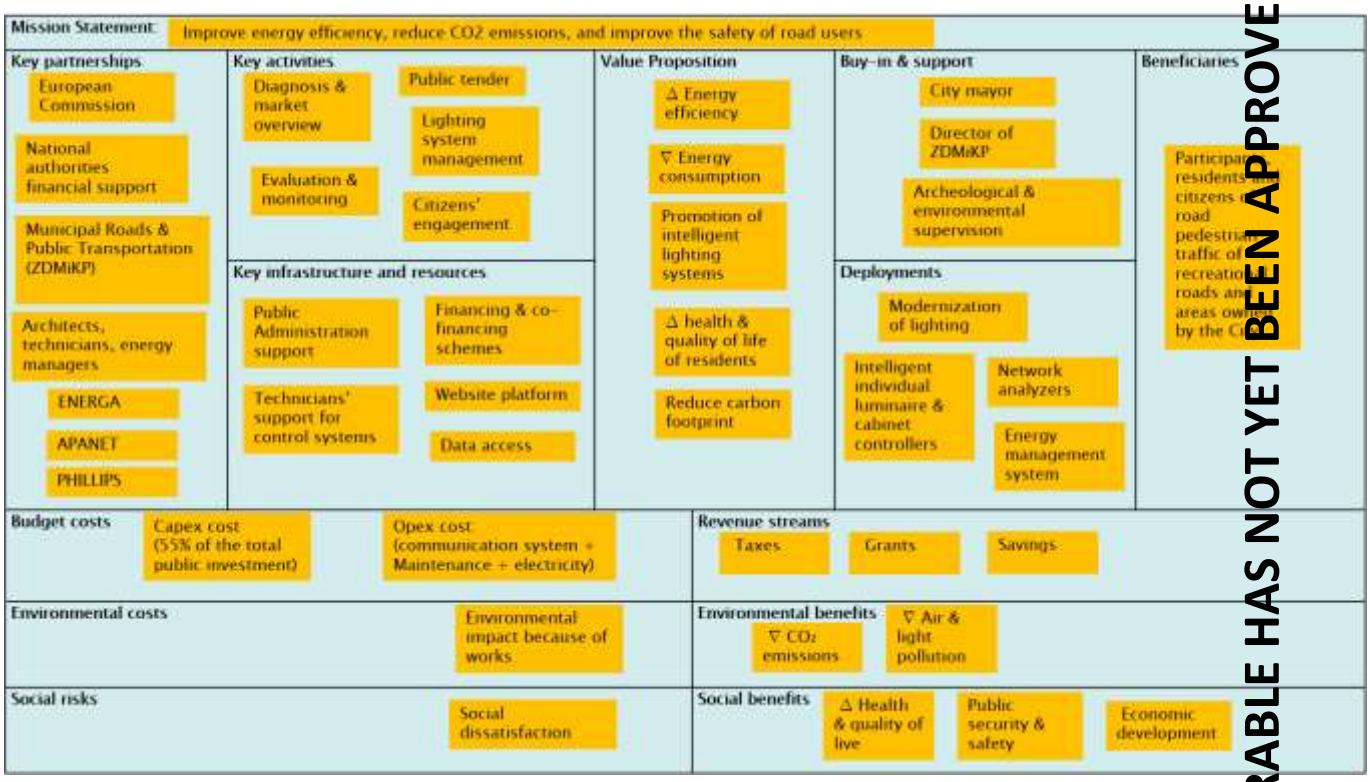

Figure 19: CMC of Bydgoszcz's smart lighting intervention

The business model involves the following activities: the diagnosis, market overview, preparation of the public tender for construction works, lighting system management (maintenance, operation), evaluation (reporting CO_2 emission reduction) and monitoring.

The business model relies on the key resources - support for public administration, financing and co-financing schemes, support of technicians of a company producing lighting control systems, and infrastructure, namely: a web platform to supervise the lighting system and create access to data on electricity consumption.

In terms of capex costs, the total investment value amounted to PLN 20,140,170.82 gross. Co-financing was obtained in the form of 45% (PLN 9,063,077.00) from the National Fund for Environmental Protection and Water Management. The second source of financing was the city's budget, which is funded by, among others, city residents. The city of Bydgoszcz is just learning and developing social partnership. Since its construction in 2015, the city budget is the sole financial contributor for another 1,232 lighting fittings and nineteen lighting cabinets have been attached to it.

Beyond the capex costs, the budget costs are related to operating expenses for the proper functioning of the service (costs for system communication, costs for maintaining lighting in constant efficiency, opex costs for the purchase of electricity and distribution of electricity). The sources of revenues are: taxes from the citizens and the possible savings from reduction of electricity consumption and the lower costs of the infrastructure maintenance, in fact, the city's budget saves hundreds of thousands of zlotys annually, which can be allocated to the further development of lighting or other areas of activity, e.g. sport, culture, etc.

One of the conditions for co-financing was to reduce CO2 emissions by a minimum of 40% as a result of the project (reduction of 2,449 Mg of carbon dioxide per year). Accordingly, the investor was obliged to

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summarize each completed year of use with a report on reducing CO2 emissions. CO2 reduction was calculated on the basis of the current CO2 emission factor for electricity. As a result of multiplication of reduced energy in megawatt hours and CO2 emission factor (kg CO2 / MWh), the value of CO2 emission reduction in kilograms was obtained.

The base electricity consumption was 4,112.29 MWh. The base CO2 emission was 3,660 Mg/year, and the expected environmental effect was to reduce carbon dioxide emissions by 2,449 Mg / year.

Table 4: CO_2 emission reduction from 2016 to 2019

Period	Reduction		
	CO_2 emission [Mg]	CO_2 emission versus the state before modernisation [%]	Emission indicator [Mg CO_2/MWh
1/01/2016 – 31/12/2016	2,391	65	0.8100
1.01.2017 - 31.12/2017	2,300	63	0.8060
1/01/2018 – 31/12/2018	2,383	65	0.8140
1/01/2019 – 31/12/2019	2,369	65	0.7920
TOTAL	**9,443**		

As it can be seen from the table above, the lighting system with a large supply ensures the required reduction of CO_2 emissions of 40%. In just four years, 9.443 tonnes of CO_2 have been avoided, which is a spectacular success, so the environmental benefits are high in terms of energy consumption and CO_2 emissions, however it is also important to highlight that thanks to the modernization there is less air pollution, significant reduction of light pollution, improvement and development of the social ecosystem, better standard of living and health, business benefits (new jobs, new business opportunities and innovative solutions), better lighting parameters of roads and recreational areas used by residents, public security and safety.

Although, some citizens were not satisfied at the beginning of the project because the correct direction of the light beam does not light private areas (courtyards, driveways, pavements) that were previously lighted as a result of light pollution (courtyards, driveways, pavements) were also partly illuminated, the new lighting system increases the quality of life of the residents and the prestige of the city, making Bydgoszcz an attractive place to live or to do business.

5.4 PV in public buildings

5.4.1 Description of the action

Promoting RES in the City of Bydgoszcz has been possible since the Energy Management Office was established within the Municipality structure in 2015. The mission of Bydgoszcz RES installation smart intervention is to reduce the city's greenhouse emissions through promoting and enhancing renewable energies and savings. The Energy Manager together with other departments' representatives define the need to introduce photovoltaics in the public buildings – the decision was to install most PVs on schools. They belong to the city, they are the easiest to be measured, controlled and analysed in terms of energy data. The chosen intervention for this analysis is the installation of PVs on eleven school roofs. The intervention target consists in the installation of RES panels on eleven public schools in Bydgoszcz with total minimal electricity production of 172,91 MWh/year. Tender to choose the contractor closes in June 2020. The intervention contractor signed the contract in June 2020 and the works are planned to be finished in October 2020. This intervention is a part of a bigger city plan for introducing photovoltaics in public schools and thus minimising the energy costs by 25 %, i.e. EUR 90,000 per year. The full cost of the intervention is estimated to EUR 380,000.

5.4.2 Intervention's value chain

At the urban level, governments try to improve the energy efficiency of buildings and to increase the renewable energy sources. In Bydgoszcz, the structure designed to develop this type of intervention is simple but very well strategized as it is shown in the Value Creation Ecosystem (figure 20).

The Municipality acts as the RES project promoter of the intervention through the Energy Management office. The Municipality's Energy Management Office is the municipal department with the right expertise to lead and control the interventions. It constructs the tendering (cooperates with Investment dept. and other departments necessary for the action to be implemented). The Energy Office cooperates with the Energy Supplier and the PV manufacturer.

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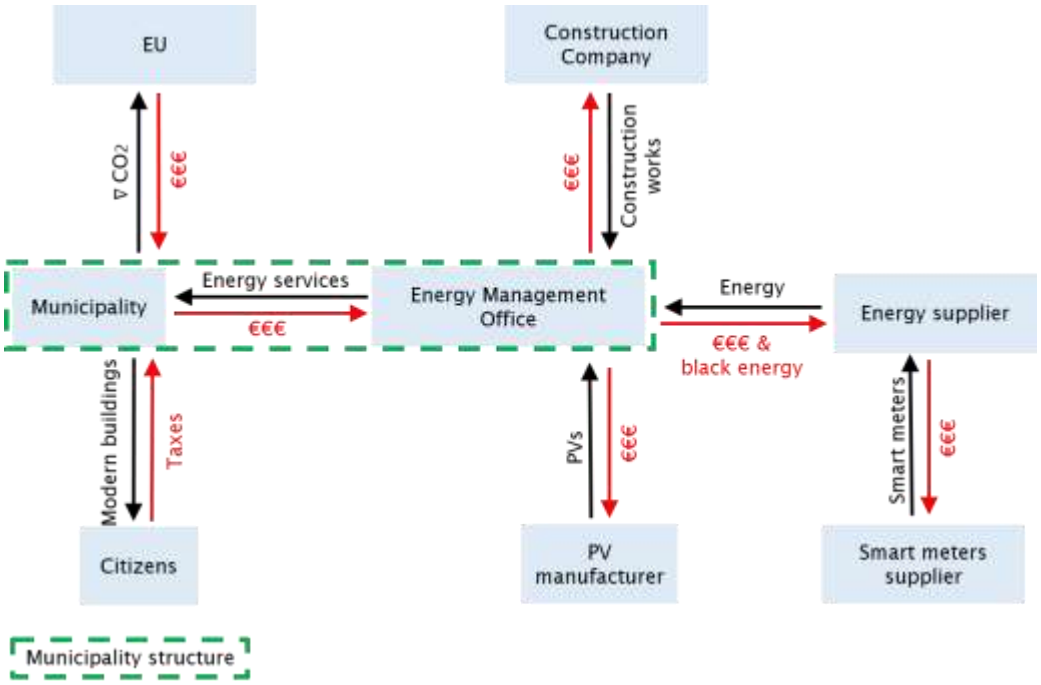

Figure 20: VCE of Bydgoszcz's PV intervention in public schools

The energy supplier will receive solar energy from the PV panels installed in public buildings (schools). It will treat this energy that will be resent to greed. Moreover, the energy supplier will provide green energy to Municipality schools. The energy supplier will be paid both for recollecting energy from and providing energy to the schools.

Leading by example, the Municipality will offer to its citizens, especially to public schools' users, better buildings. The intervention will be co-financed by the Municipality, because of its commitment to sustainable development and the EU. It is key to get economic resources from the EU to carry out these interventions that will contribute to achieve the SECAP objectives.

5.4.3 City Business Model

The study of the city business model through the City Model Canvas (figure 21) reflects the logic of how the city is going to produce and deliver public value in a way that is economically viable, socially inclusive, and environmentally sustainable (triple bottom line). The city mission statement is energy saving and promoting RES, installing it on school building stock of Bydgoszcz that are chosen according to the technical capacity of the roof. The value proposition of the business model is to reduce energy consumption, increase green energy production and to use the existing infrastructure in a more efficient way. The direct beneficiaries of the intervention are the school directors and local decision makers (Municipality). The intervention has as well indirect beneficiaries of the specific needs that the value proposition addresses. These beneficiaries are the citizens of Bydgoszcz that learn about renewable energy sectors.

The delivering value of the business model for direct and indirect beneficiaries needs the buy-in and support of the Mayor and school headmasters. It is the Municipality that is also essential for the business model and the co-financing from the Marshal Office.

The deployment actions that are under analysis here are: photovoltaic panels, energy management system and intelligent energy metres.

The value generation of the business model implies multiple and varied stakeholders. The stakeholder structure is classified by those who: i) promote RES – the EU (Marshal Office) and Municipality; ii) finance the RES – the EU (Marshal Office) and Municipality; iii) produce and deliver value – architects, energy managers, construction companies, municipal companies, schools.

In addition to school masters' engagement activities, the intervention activities comprise: public tender for the purchase of the service (design, consulting services, open tender for the implementation of PV systems), operation of devices during use (20 years), education and training programs for residents, technicians, data evaluation monitoring, knowledge acquired as new added value for future projects, involvement of

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educational institutions, including youth education, generating savings through self-consumption of the object.

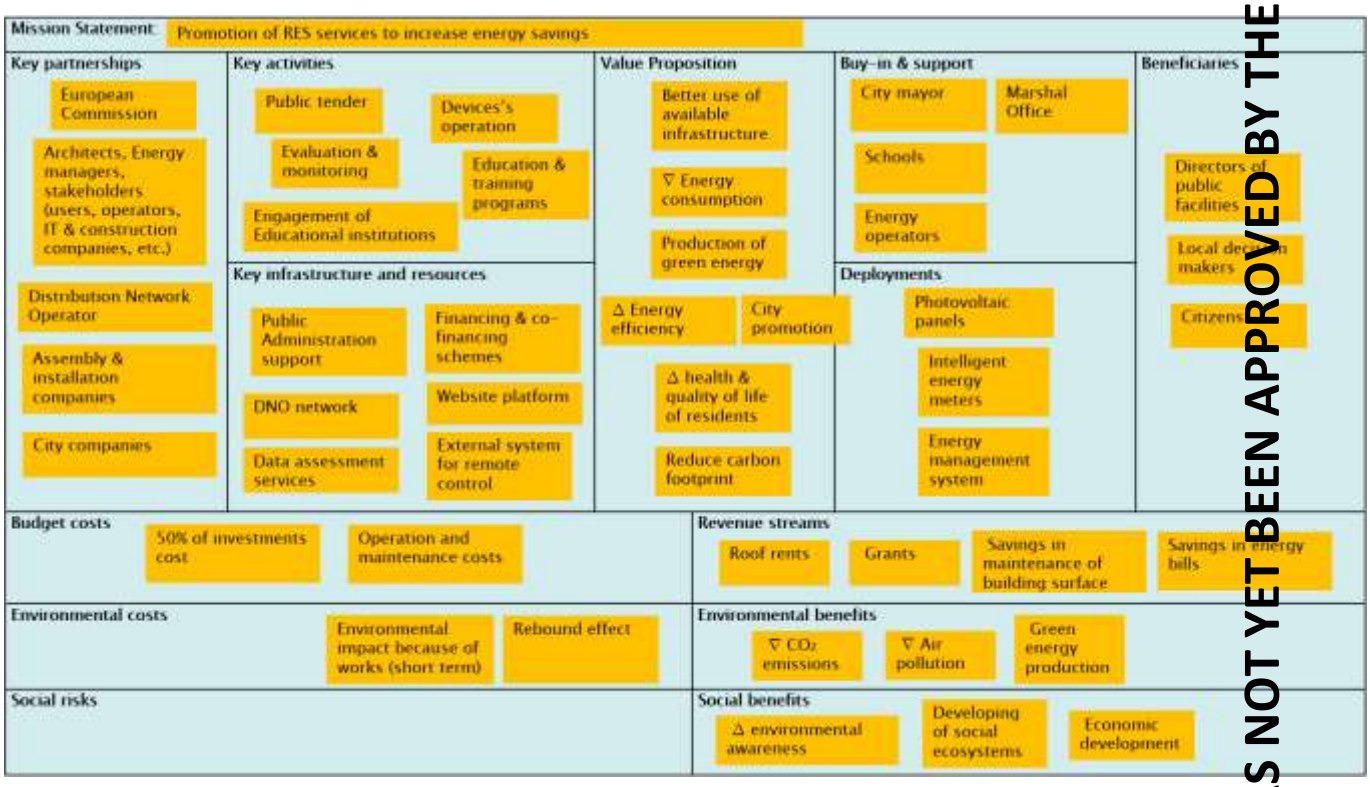

Figure 21: CMC of Bydgoszcz's PV intervention in public schools

Finally, to produce value the model relies on key resources and infrastructure. Obviously, the most important resource is the public administration support, mainly offering funding to the schools and installing RES together with connecting them to Energy management system. The intervention relies on use of the DNO network (ENEA Operator for discount billing), external systems for remote monitoring, support for public administration, financing and co-financing schemes and for the infrastructure - www platform and the service of accessing energy data connected with the Municipal platform, assessment of services and creation of new energy services.

The sustainability of the business model focuses on the triple bottom line: cost/revenue; environmental costs/benefits; social risks/benefits. The Municipality has two type of revenue streams, the EU grant (Marshal Office) and municipal budget (reduced costs of maintaining the building). For possible, future revenue the Municipality considers possible renting of rooms. Regarding budget costs, there 50% cost co-financed from the Marshal Office and 50% from the municipal budget. The full cost of the intervention is estimated at EUR 380,000.

The environmental impacts are highly positive. The most important environmental impact is the decreasing of CO2 due to optimization, energy efficiency and production of renewable energies (green energy). Finally, the social impacts are also quite high. We can highlight the followings ones: increasing the ecological awareness of the inhabitants, improving and developing social ecosystem, better standard of living and health, business benefits (new jobs, new business opportunities and innovative solutions), building awareness and long-term relationships with users of schools and municipal companies, building a positive image among residents. There are not social risks associated to this intervention.

5.5 Final general remark

Bydgoszcz, on its transition, from a traditional city to a smart one, is becoming one of the references of eastern Europe thanks to its commitment to sustainable development and due to its great job on deploying interventions like those analysed in this deliverable, which aim is the reduction of energy consumption, improving the efficiency of the infrastructures and reducing their GHG and CO2 emissions, at the same time that increase the renewable energy source in the city.

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As a dynamic entity, the Municipality, through its different public companies, is playing different —all of them very interesting— roles in each intervention. The E-mobility intervention is an example of close collaboration between public and private organizations. The municipality is creating the right environment to deploy EV public charging infrastructures that are operated towards a lease agreement by a private enterprise being EVs' owners. Shearing the leading role and saving resources, the Municipality is able to offer other benefits to its inhabitants.

In the other two interventions, the smart lighting system and the installation of PV in public buildings, the Municipality is leading the intervention, although, in the case of the smart lamppost, it has also involved a private company with an important role in the operation and maintenance of the infrastructure. Regarding the PV panels intervention in public schools, the Municipality is using its building to lead by an example, showing the usefulness of this type of technology for supplying green energy with the aim of incentivizing the scale-up of the intervention in other building of the city.

The Bydgoszcz's interventions have clear value propositions and objectives. They are characterized by having a compact, but very well thought value chain structure. With this structure, the Municipality minimizes dysfunctions in the network and it can guarantee efficient public services. The tipple bottom line of each city business model revels that the benefits overcome the costs, and the key role played by EU funds, although there are some types of potential revenues.

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6. Rijeka's business models for smart city services

6.1 City description (mySMARTLife project DoA)

The city of Rijeka (figure 22) is the third largest city in Croatia with a population of 128,624 inhabitants. It is located on Kvarner Bay, an inlet of the Adriatic Sea and situated on an area of 44 km². Rijeka is an industrial, administrative, cultural and university centre of the region which serves about 400,000 inhabitants.

Over the last decade, Rijeka has merged activities and applied a more responsible administration approach to urban development projects, particularly with regard to the plans for switching over to renewable energy sources in public transportation, energy efficiency growth in the field of construction works as well as in information management and as regards the indicators of energy efficiency measures after the provision of new ICT infrastructure. Rijeka approved the SEAP in 2010, and in 2013.

Rijeka has not yet engaged a process of implementing a nearly zero or low energy districts plan, but among the key goals for the next 10 years are: energy efficiency of all buildings owned by the City; usage of renewable energy sources and solar energy in all buildings; restoration of the public transportation system by giving up diesel buses and introducing CNG buses; installation of LED public lighting is foreseen.

Today the vision of the city is the transformation of the urban area, environment and economy through the widespread development and adoption of modern ICTs. The aim is to stimulate innovation, create jobs, empower citizen engagement and improve the quality of city life for all citizens, businesses and visitors.

Figure 22: The city of Rijeka (Croatia)

6.2 Smart metering and smart data management

6.2.1 Description of the action

The monitoring of energy resources is an important issue in order to provide insight into consumption dynamics (importance for the city in terms of maintenance and planning); further promotion of the savings and the reduction of the emissions. The city of Rijeka is installing 40 smart meters in public buildings by year 2021; and plans to install other 110 smart meters to achieve the final number of 150. The first sensors will be installed in 26 buildings. The data will be processed, managed and stored by the Municipality through the Rijeka Data Center. Thanks to the data collected, the tenants of public buildings will be able to understand how their energy behaviour is and how they can reduce their energy bills.

The City of Rijeka uses for various useful purposes such as: effective maintenance of public owned buildings, new investments (like retrofitting), application for project funding (EU, national grants), drafting of strategic documents and papers, dissemination of data towards scholars, experts and institutions, open data platform for private entrepreneurship, raising awareness on energy consumption for citizens and promotion for energy renewal and ISGE data system.

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6.2.2 Intervention's value chain

The data measurement is carried out in public buildings used by citizens for various purposes, such as culture, recreation and sport, and education, and the whole value chain of the intervention is presented in figure 23. The Value Creation Ecosystem shows that the City of Rijeka assigned its ICT department to be in charge of collecting the information obtained from smart measuring, as well as data processing. As it was mentioned above, the smart meters are installed in 26 buildings owned by the Municipality, who manage them and the data collected, sharing it with its companies. The utilities supplied and measured are electricity consumption and production (HEP), gas (Energo), and water (ViK).

The actions are funded firstly from an early EU funded project, and later funding was resumed by the city. It can be thus divided between EU, the national budget, the City budget (public procurement), and in a small part, attributed to the membership fees obtained by the occupants which use and rent spaces. These are citizens who use these facilities for business purposes, or activities in their free time.

There are several actors identified in this chain, and some have a twofold role. As explained, the City needs information on energy consumption from its buildings. The smart meters are installed in 26 public buildings, and the equipment maintenance provider is the energy provider Energo, which is financed by the City on an annual contract for this service. Energo also acts as a goods provider for these users, providing gas for households and heating energy, as well as public lighting. The building`s relation to Energo is informing them about the status of equipment. The data collected by measuring in public buildings is directly sent to the City`s server and processed for further use. The City of Rijeka has a multiple role in this process. It acts as a mediator between the actors depicted in the model above. It is the user and owner of data obtained by measurements, one of the financiers for the activity and the driver of the activity procured, as well as the owner of the facilities provided for citizen`s activities.

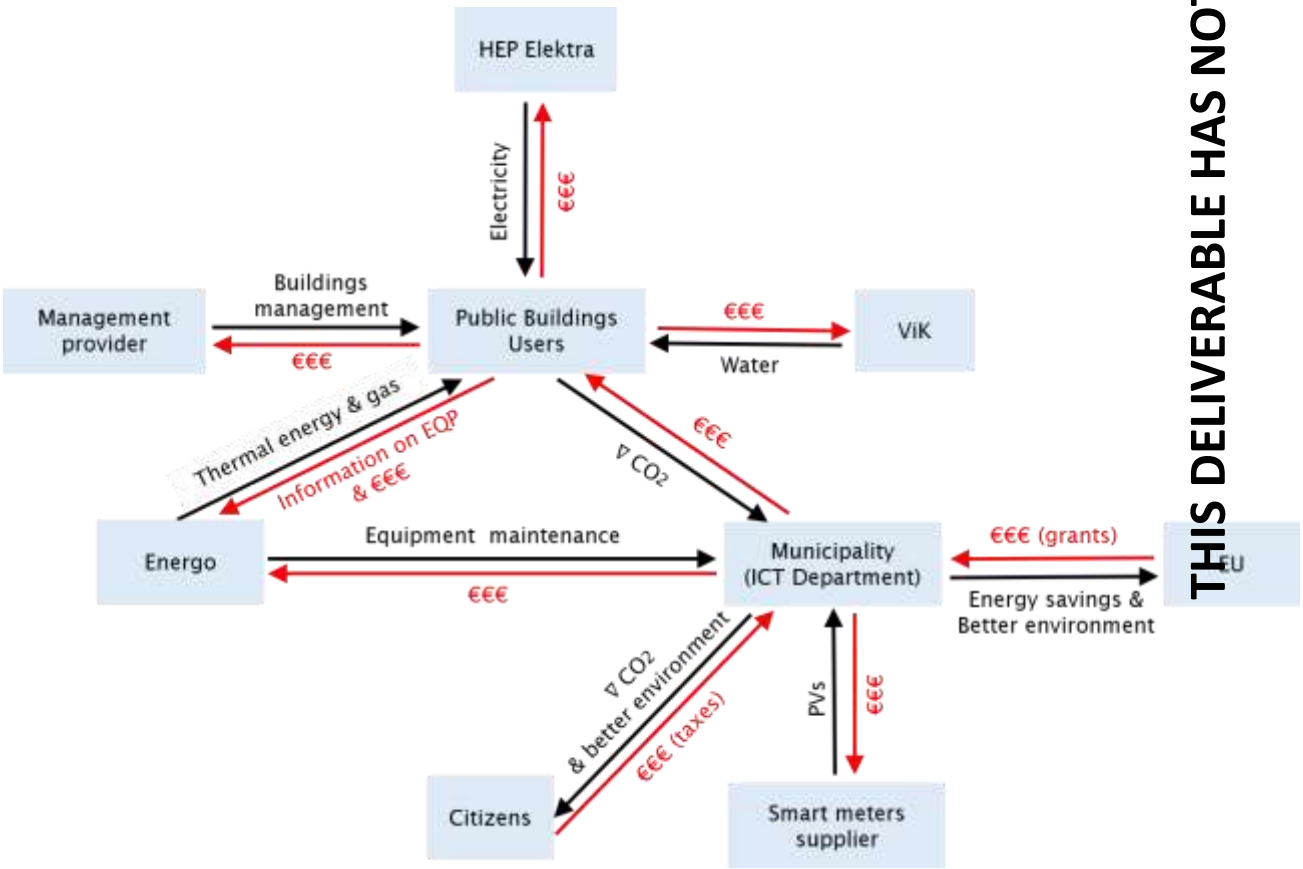

Figure 23: VCE of Rijeka's smart meters and data management intervention in public buildings

The end users in this case can be identified as the City, for collecting information on energy savings needed for budget planning of maintenance and investments, and the citizens who obtain a clear demonstration on energy savings. The data collected is immediately shared with the national ISGE system – the information system for energy management. Continuous energy management means the strategic planning of energy

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usage and sustainable management of energy resources in buildings owned or used by a city, county, the government or budget and non-budget beneficiaries, as well as public authorities.

6.2.3 City Business Model

The main objective of this smart intervention is to provide insight into consumption dynamics and to promote savings respectively in reduction of emissions. The rationality built by the Municipality to deploy this project is shown in figure 24, where the City Model Canvas is presented.

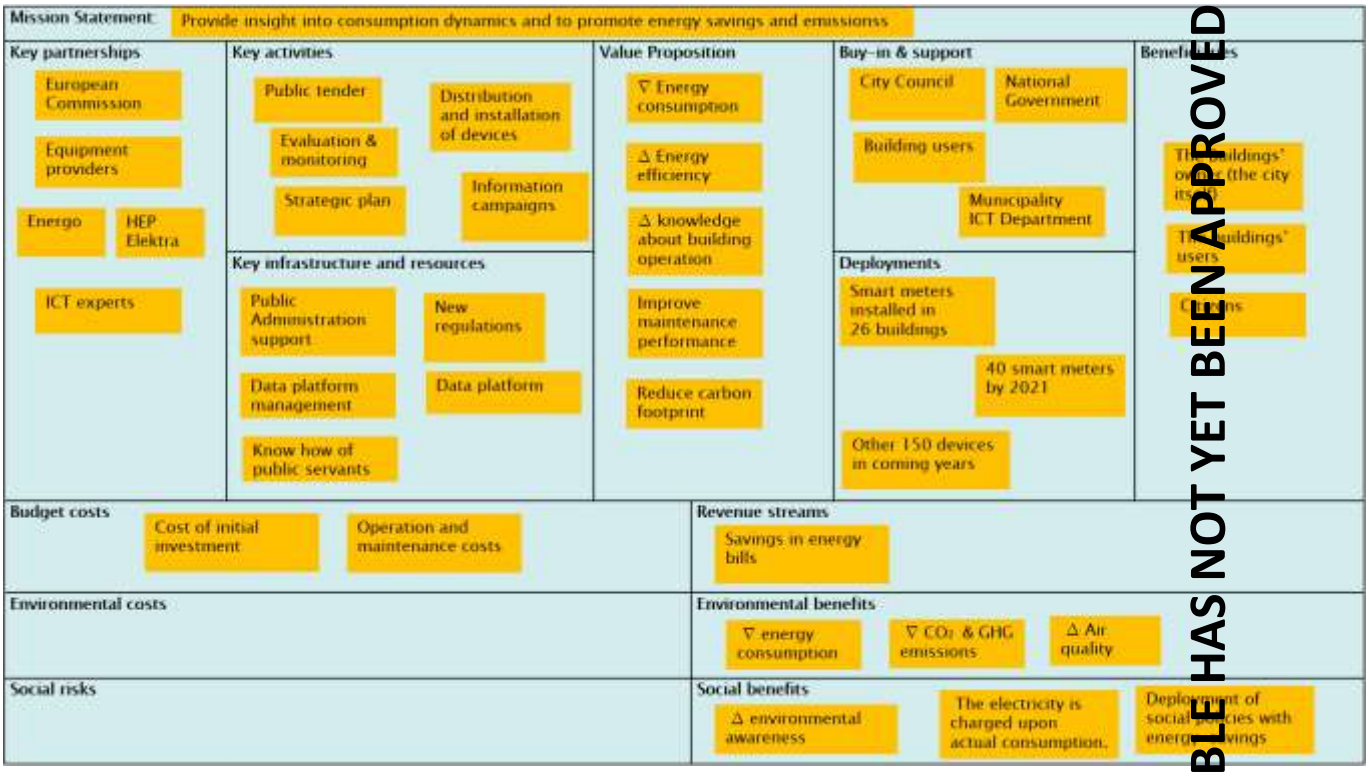

Figure 24: CMC of Rijeka's smart meters and data management intervention in public buildings

Beyond the main purpose, the city understand that the key value of smart metering can be found in the area of infrastructure maintenance, as well as in making decisions on interventions in the existing and construction of new infrastructure. On the other side smart metering fit in the concept of smart city strategic policies of the City of Rijeka because it involves data management that contextually converted to information and knowledge about the system being observed.

The beneficiaries of this intervention are three. The city of Rijeka, being the owner of the buildings, is the most benefited actor jointly with the users of the infrastructure with the smart metering installed.

This intervention needs the political buy-in at different levels. The City Council must include it in the city budget and the state must develop an evolutive legislative framework and co-finance the deployment of smart meters. Without the economic support of the central administration it will be difficult to increase properly the coverage of devices. The building users support is also important to avoid possible blocker actions.

The Municipality plans to install 150 devices, and the initial idea was to deploy them by 2021, but after the impact of COVID-19 crisis and in the situation where there is no co-financing by the state, the City of Rijeka is rescheduling the deployment of the project. By 2021 it will deploy another 40 smart meters and the next ones will be installed depending on the pandemic evolution.

The Municipality will collaborate with different organizations, as it was shown in figure 23, to deliver the value to the final user. Energo (the public provider of thermal energy, gas and public lighting) and HEP Elektra (Croatian national provider of electricity) will be two of the most important ones. EU will be another important actor in this ecosystem, providing part of the economic resources to deploy the smart meters. The equipment providers for an obvious reason are also key stakeholders that will be involved in the intervention. Finally, ICT experts

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Regarding key activities, beyond the traditional ones, this project needs a clear strategic plan as a first step, a well-defined public procurement and the distribution and installation of smart meters. It is also important to develop an information campaign to disseminate the project across the city. Assessment and monitoring buildings behaviours are essential to understand how to take advantage of the devices installed.

Although, there is not a legal obligation for smart metering system implementation in public (or any other) buildings, and there is no national subsidies that supports/refunds smart metering system implementation, new regulations encourage energy savings and the fight against climate change. Data platform and its management and the know-how of public servants are other two important resources that the Municipality has.

The cost of one smart meter based on the last procurement is about EUR 7,200, which includes equipment, works and testing (the first seven rows in table 5). The system management and control cost approximately 13,500€/year and the database management 10,000€/year.

There is not a direct income related to this intervention, however, smart meters in public buildings will help to reduce the public expenses for the electricity. A ROI analyses must be conducted for revealing a precise capital return period. The smart meters, besides the savings, may indicate on issues not identified by now, which will need new approaches (in energy management, organisation system etc.). In the long-term, smart meters will contribute not only to city/municipal cost reduction, but also on (positive) impact on the environment. Moreover, unspent/saved funds may be redirected in other priority fields, depending on active polices.

The smart meters system has positive impact on the environment, including air and GHG emission. Using it on conscious and proper way, the system can reduce the consumption, and by that lower the GHG emissions, as well as improve air quality. In fact, the usage of the smart meters can reduce energy consumption, by:

Accepting new behaviour standards regarding electricity consumption (remote control of electricity system)

Revealing discrepancies in everyday consumption which can be removed or neutralized by management intervention.

Table 5: Cost of smart meter

Cost Breakdown	Cost (€)	Units	Liftime (years)
Central unit WMG type	2,362	1	10
Active antenna type 868 AAO	715	1	5
Wireless M-Bus PulseReader	250	3	5
Wireless M-Bus PulseRepeater	551	3	5
Zener battery	350		5
Assembly and installation	2,000		10
Parameterization, testing and commissioning	1,000		10
TOTAL	**7,228**		

The purchase of the system devices and maintenance causes initial investments, and that may result in difficulties because a similar price will be charged to equal units with a diverse level of income.

Considering the wide range of potential consumers, the smart meter system is equitable: the electricity is charged upon actual consumption. From the perspective of the city-owned buildings, those gaps can be overcome by on-time planning, while in the private sector it will depend on smart system providers, payment options, and subsidy policy.

Smart meters are part of the smart and sustainable concept, and they are one more path to make citizens become ‘smarter’. They certainly promote a sustainable, rational, and healthier life, in relation to themselves and to nature and community. By this action, the city of Rijeka may establish a flag-ship concept that can be followed by other individuals, institutions, organizations, or cities of Croatia.

6.3 Smart Public lighting

6.3.1 Description of the action

Smart public lighting is one of the key interventions from the Rijeka SEAP objectives. Concretely, Rijeka wants to replace old luminaries with ones that are energy efficiency and environmentally adequate, as well as manage the intensity of the public lighting infrastructure.

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6.3.2 Intervention's value chain

The City of Rijeka is the owner of the complete public lighting network and infrastructure installed in the city. The City is the owner of 15,668 lightning bodies installed in the city (Rijeka EEAP 2020-2022). Figure 25 identifies the stakeholders' structure and their main relations of exchange to offer the smart public lighting.

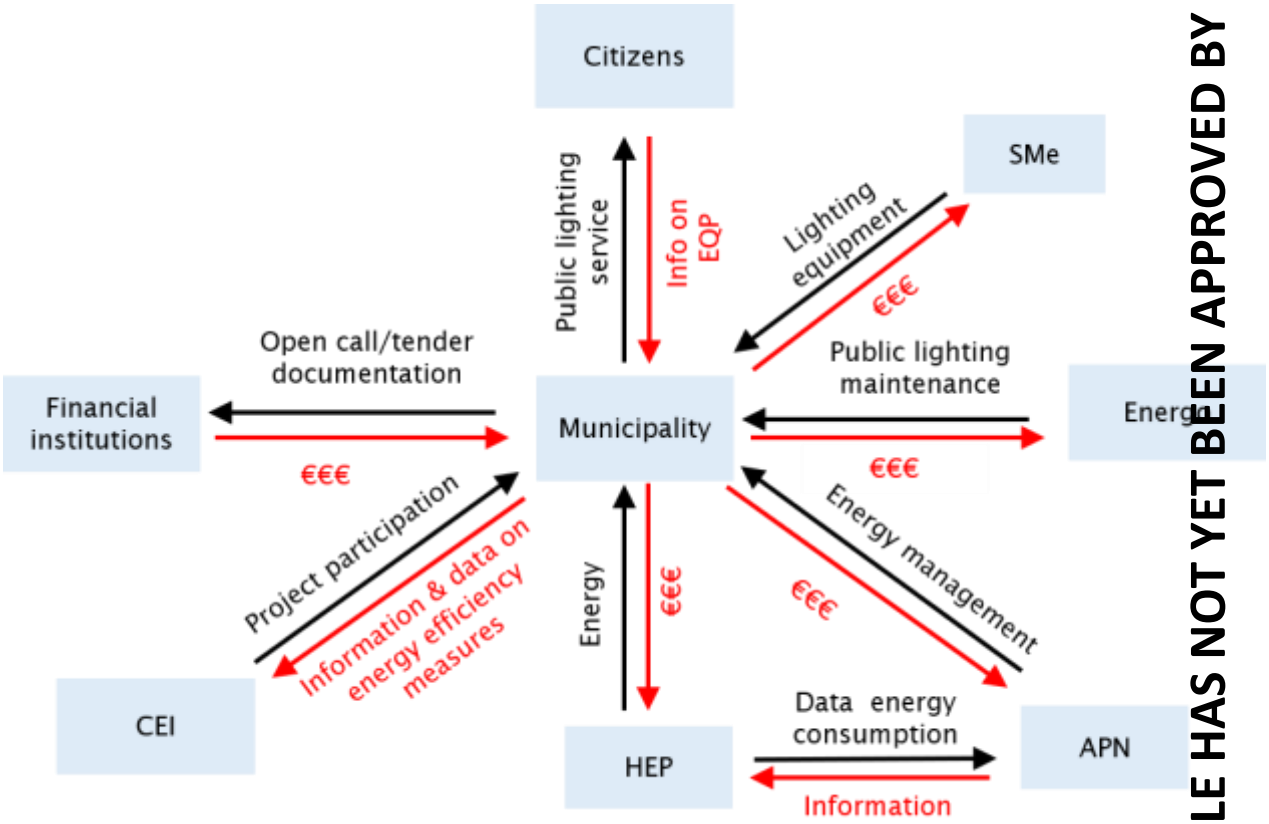

Figure 25: VCE of Rijeka's smart public lighting intervention

At the beginning of 2017, the City of Rijeka installed the first smart lighting in Mihanovićeva Street with a light temperature of 3000 K. Post installation, during the test period, information was gathered in order to be used it in project design of the reconstruction of public lighting in the City of Rijeka. In the meantime, the new Law on Protection from Light Pollution entered into force on April 1, 2019. City of Rijeka is now waiting for the legislator to adopt the ordinances that accompany law after which the city will be able to start preparing project documentation.

On behalf of the City of Rijeka, Energo Ltd. manages public lighting system with the aim of:

- Increasing the quality of illumination
- Increasing energy efficiency
- Reducing light pollution and CO2 emission
- Reducing costs of electricity, maintenance

Rijeka pays Energo for the maintenance service. Energo also provides the GIS light application which contains the complete information on installed infrastructure in the public lighting network.The City directly procures public lighting equipment from SMEs, who in return, pay income taxes in their main office. Citizens who receive the service of public lighting can contribute with their suggestions on the need for repairs and increasing the efficiency of lighting equipment, for instance, if the light is shielded by trees or shrubbery, damaged etc.

The City of Rijeka is the main financier of the public lighting network, but can secure finances from other sources as well. As depicted above, the City responds to open calls and tenders financed by the EU, the Fund for Energy efficiency and environment protection, and the Croatian Bank for Reconstruction and Development.

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The electric energy provider is HEP d.o.o., the company that has the monopoly on electric energy in the country, with other providers having a smaller share in the market. HEP as the distributor, shares the data on energy consumption with APN. APN is a state agency whose scope of work includes systematic energy management. Electricity supplier (HEP) enters data on electricity consumption in the public lighting system of the City of Rijeka into the ISGE system. The City of Rijeka, as a user of the ISGE system, has access to consolidated data on electricity consumption.

The City of Rijeka then also shares the data with CEI. CEI (Center for Monitoring Business Activities in the Energy Sector and Investments) coordinates System for measuring and verifying energy savings (SMV). City of Rijeka enters in the application data on measures and implementation of measures in the field of energy efficiency and CEI conducts analysis on the basis of consolidated data. Government policies also take this data and analysis into account.

6.3.3 City Business Model

As observed in next figure 26, the mission achievement of the intervention is to reduce light pollution, energy consumption and gas emission, as well as to upgrade the possibilities of remote control, management and data collection.

The City of Rijeka has specific activities planned in the Rijeka SEAP (Sustainable Energy Action Plan) that are identified in the value proposition such as: replacement of old luminaires with ones that are energy efficient and environmentally adequate, using control remote management for different issues such as management of the intensity of public lighting.

The beneficiaries of the intervention are citizens from the municipality, as well as equipment providers and those who benefit from data collection because of smart metering installed.

The buy-in is focused in the City Council, who has to approve budget items and fix purchase costs in a public procurement (services, works or equipment). Also, the strategy and intervention must follow strictly the legislative framework which falls within state competences. The Republic of Croatia has a law on protection of light pollution from January 1st 2012, and the Law on energy efficiency from November 5th 2014. This law commits to maintain and reconstruct public lighting in a way that reduces energy consumption, and in compliance with the Law on the protection against light pollution. Also, when reconstructing public lighting systems, European (Croatian) provisions on illumination of roads for vehicles and pedestrians must be respected: EN13201.

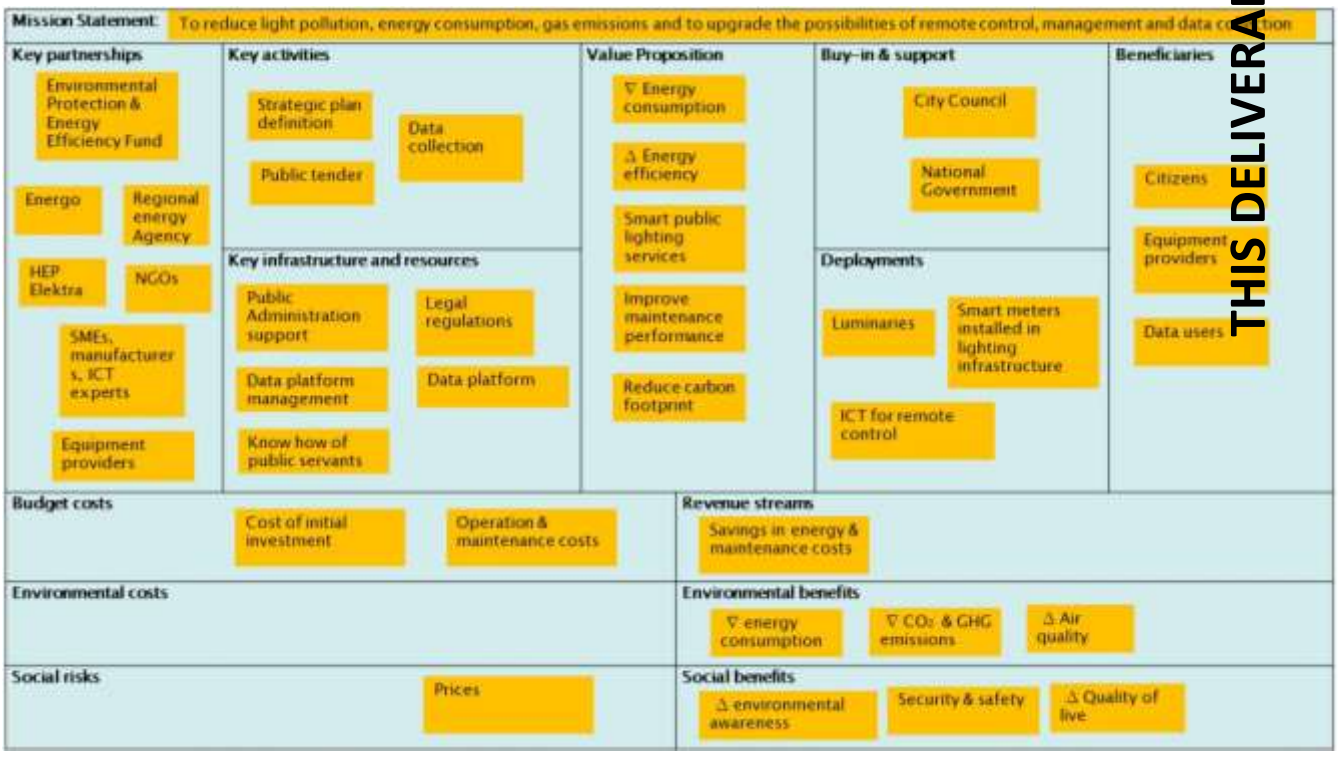

Figure 26: CMC of Rijeka's smart public lighting intervention

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At the moment, there is no possibility of state funding. In this situation, where there is no co-financing by the state and at a time when the COVID-19 pandemic is having consequences on the financial situation of the city of Rijeka, it can be assumed that the interventions in public lighting interventions will not be first on the list of funding priorities.

To this end, the State should be considered as a key stakeholder regarding funding issues through the Environmental Protection and Energy Efficiency Fund. Furthermore, there are other stakeholders need to define the strategy and later kick off of the intervention such as Energo (public provider of thermal energy, gas and public lighting); HEP ELEKTRA (Croatian national provider of electricity, Rijeka subsidiary); REA Kvarner (Regional Energy Agency); SMEs (manufacturers, ICT experts, smart meters providers) and NGOs.

Regarding key activities, the light pollution and energy efficiency is already incorporated in all the relevant strategic documents on the city level (as a first step) and data collection within the public lighting still have to be incorporated in strategic documents. The budget for the project development and implementation has to be insured and approved by the City Council and following activity in public procurement must be designed.

As mentioned, the possibilities of co-financing investments in public lighting are limited. In the past the situation was more favourable because of the then existing national program for public lighting by the fund for environmental protection and energy efficiency. Also, there is always the possibility that the national program will be started again and enable new investments. To this end, the public administration support at a national level is a key resources for the business model.

Finally, the triple bottom line focus on budget and revenue streams and environmental and social costs and benefits. Table 6 shows the cost breakdown for the project lifetime (15 years).

Table 6: Costs of smart public lighting intervention

Cost breakdown	Costs	Unit	Specific lifetime of the component (years)
High pressure sodium lamp 70W	6	€	7
High pressure sodium lamp 150W	7	€	7
250W high pressure sodium lamp	8	€	7
Electromagnetic preamp for 70W sodium lamp	7	€	8
Electromagnetic preamp for a 150W sodium lamp	11	€	8
Electromagnetic preamp for sodium bulb 250W	13	€	8
70-400 W sodium lamp bulb	3	€	7
FRA Fuse 6-10 A	3	€	7
Circuit breaker 10 A, 230 V, AC, 1P	2	€	7
Road lamp with 70W high-pressure sodium source	167	€	25
Road lamp with 150W high-pressure sodium source	208	€	25
Park lamp with 70W high-pressure sodium source	257	€	25
Park lamp with 150W high-pressure sodium source	257	€	25

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Road LED lamp, 83 W, with multi-stage light control	382	€	25
Park LED lamp, 53 Watt	472	€	25
10 kV overvoltage protection for LED lamp	10	€	7
LED flashlight preamp	52	€	8
Management and maintenance of the public lightning	500 000	€/year	1

The revenue streams are based on energy costs savings and operation and maintenance costs saving too. For instance, the existing public lighting is reconstructed with the new led technology that has the possibility of reducing energy in late hours of the evening, and the return of the investment can be expected in 8-14 years. This assessment includes savings in electricity and maintenance during the lifespan of the equipment. On the other hand, the same lamps are used but with integrated smart management, and the period for the return of the investment will be 5 years shorter.

This intervention directly and positively will affect the reduction of electricity consumption, and along with that, on global increase in air quality (less energy produced in thermo-energy plants). This action also has an effect on the reduction of light pollution – the influence of lighting on a person's biorhythm is decreased, and the animal and plant life in urban surroundings.

This activity positively affects the increase in security and the improvement of the quality of life of the local community in several aspects. With the realisation of smart lighting the city can effect: traffic safety because of the better illumination of streets which results in a reduced number of traffic accidents; the increase of safety of citizens from petty thefts and night attacks; the reduction of light pollution in night which ensures better sleep; a more normal biorhythm of birds inhabiting the city; the reduction of greenhouse and other harmful gas emissions in the atmosphere, which affects positively the local community's health; and the global reduction of man's influence on climate change. On the other site, the purchase of the system devices and maintenance causes initial investments, and that may result with difficulties (similar price will be charged to equal units with diverse level of income).

6.4 Final general remarks

Rijeka is developing an interesting intervention to monitor public buildings energy consumption. Its deployment will represent an extra asset for those buildings and will increase the potentiality of the city in terms of energy efficiency and CO_2 and GHG emissions reduction. Given its complementary nature, this action seams sustainable in a long-term scenario. In fact, its benefits overcome its costs, which are, in general terms, just economics. Regarding smart public lighting, it seems clear that the intervention paybacks are quite reasonable for a public policy investment in such strategic area. On the other site, as mentioned for this case, there is an strong need to have the financial support from the National government in order to keep on with the intervention.

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7. Public Procurement Innovation

7.1 The basics of public procurement innovation

Public procurement has the purpose of fulfilling the needs and demands of any public administration. Actually, Edquist and Zabala-Iturriagagoitia (2012) stats that public procurement can be defined as purchasing goods and services or the combinations of the two by public sector organizations. This buying mechanism is involved in 13% of the GDP in the EU and in the OECD countries (Tammi, Saastamoinen & Reijonen, 2020). According to Erridge and McIlroy (2002), it bases the achievement of quality and value for money on a fear competition between suppliers.

That said, there are important challenges that must be faced to direct this capital towards more innovative, ecological, and sustainable initiatives. In fact, the main priorities for public procurement according to the European Commission (2018) are:

- Fostering innovative, green, and social procurement as 55% of procurement procedures within EU countries are provided for those having the lowest price rather than higher quality, sustainability or innovation.
- Professionalizing public buyers as they often lack the required business skills, technical knowledge, or procedural understanding.
- Increasing access to the procurement market to small- and medium-sized enterprises.
- Improving transparency, integrity, and data.
- Boosting the digital transformation of procurement as only four European Union countries provided digital technologies for all the main steps of the procurement process.
- Enhancing the cooperation between authorities as only 11% of procedures are carried out through cooperative procurement.

Nowadays, over half of the global population lives in urban areas. It is estimated that this percentage will grow by 15% over the following 30 years (2050). Population growth means that the needs of public services are increasing, and the resources are limited to achieve the same or even better results because societies are every day more demanding (Pardo-Bosch, Aguado & Pino, 2019). According to Nordic Healthcare Group (2015), public authorities could utilize the procurement process to drive innovation (figure 25), develop new solutions, and ultimately secure improved “outcomes per dollar spent”, as Michael Porter declares. Increasing the effectiveness and efficiency of the services, public bodies will be able to solve the need with their limited resources with at least the same results, and this can only happen to incentivize and supporting innovative processes.

However, many organizations go through conflict situations when balancing the efficiency and cost-effectiveness with innovation. Moreover, regulations and control mechanisms in public procurement limit buyers' freedom of action and public spending are often subject to rigid rules and a demand for traceability and accountability, which pose major challenges for policymakers who want to invest in innovation (Obwegeser & Müller, 2018).

Figure 27: Holistic overview of new public procurement approach

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Experts stand that public procurement innovation is the solution because it is a label for demand-driven development and purchasing of innovative solutions to meet the needs of the public sector's end user (Suhonen et al. 2019). It can help the public administration to move from resource and output-driven service procurement practices towards procuring outcomes and value (figure 27). In that sense, the value can be defined as the subjective measure of stakeholders' utility, taking into account the merge of quality and cost of the service. One must, however, be careful with the definitions because "innovative public procurement" could refer to an innovative procurement process which is distinct from the outcome-oriented meanings of the definition presented above (Rolfstam, 2012; and Suhonen et al., 2019).

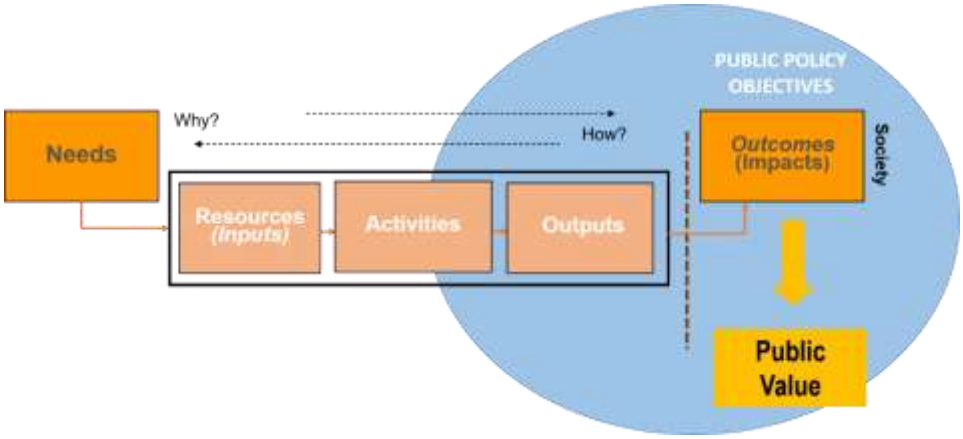

Figure 28: From outputs to outcomes toward public procurement innovation (Ysa, 2016)

Since 2014, the European Commission is promoting public procurement innovation. The Directive 2014/24/UE established the bases to launch this buying instrument that tries to establish a dialogue with the market to face public problems that cannot be solved with traditional instruments. Each municipality, which is the closes administration to citizens, has a powerful tool to provide solutions to real problems and to support secondary goals and policy initiatives, e.g. green and sustainable procurement and support for small and mediums sized enterprises (Obwegeser & Müller, 2018).

The new public procurement model is funded on the following principles: services based on the value and services focused on citizens. These principals encourage authorities to buy outcomes instead of products; it develops a partnership with suppliers and completes all needs of the municipality offering a comprehensive service. Furthermore, the partnership between buyer and supplier enables the provide fast answers to complex changes although public bodies are characterized by their rigid and inflexible structures. Obviously, this scheme is not compatible with economic saving in the short term, but it fixes the basis to achieve sustainable services in the long term. Table 6 summarizes the principle benefits of PPI.

Table 7: Benefits of Public Procurement Innovation (Bria et al., 2015)

Benefits of Public Procurement Innovation for…		
Citizens	**Municipalities**	**Industry**
Improves public services by including innovative goods or services that better and more efficiently serve the needs of all city residents	Promotes a cultural change within the Administration, shifting it towards more innovative practices and attaining economic and technical efficiency.	Supports innovative companies and SMEs that promote the City Council's values on social, environmental and technological matters, driving development and internationalisation, as they build on access to the local public market as their first flagship customer.

Historically, public services offered toward a public procurement presents problem, which are the result of the misalignment of interests between suppliers, public administrations, and citizens (beneficiaries). The new models require a high implication of both sides (buyers and suppliers) from the beginning. The buyer must start the process defining precisely the needs and challenges to be solved and offering the industry the possibility of explaining how they could solve it although the proposed solution be just an idea or prototype (Bria et al., 2015). With this approach, the buyer is creating an ecosystem of partners that work

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together to offer a public service with new and better ideas. In conclusion, it shifts the paradigm of public procurement, moving from very detailed tenders to an open call.

Buyers (in our case municipalities) are in charge of the definition of the contract: objectives, structure, roles, and competences of every partner. Once the supplier is decided, the implementation, monitoring, evaluation, and redesign is shared by partners. The public sector becomes a key element of innovation in public procurement processes and a key agent in the development and trend of the market. The role of the private sector (industry) in the new model is to participate as an active stakeholder in the entire process. Finally, although there is a shared risk with suppliers in the new model, the public sector constitutes itself as the guarantor of the service in the eyes of the citizens and therefore, ultimate responsible for achieving the established objectives.

Despite optimism about the transformative potential of PPI, uptake remains low, hampered by lack of technical capabilities of procuring organizations, poor coordination, and inadequate incentive structures, amongst other barriers (Uyarra et al., 2020). In order to overcome the barriers, figure 29 presents the twelve steps that any administration could follow for developing with theoretical guarantees a public procurement innovation process when offering new o renewed public services.

Figure 29: 12 steps to develop a public procurement innovation with guarantees (Pardo-Bosch, 2020).

7.2 Public procurement process: the Finnish experience

7.2.1 Business Finland

Business Finland is a Finnish government organization for innovation funding and trade, travel and investment promotion. The organization employs 600 experts who work in 40 offices globally and in 16 regional offices around Finland.

Business Finland creates new growth by helping businesses go global and by supporting and funding innovations. Business Finland was created on in 2018 by the merger of two organizations: Finpro, which offered services for internationalization, investments and tourism promotion, and Tekes, which offered funding for innovation activities.

In 2018 Business Finland granted a total of 565 M€ of funding of which 451 M€ was directed for companies and 114 M€ for research.

One practical example of Projects Funded by Business Finland is project of renewal energy for residential and office buildings (Shemeikka et al.,2015). This project presented a solution for district heating and -chilled "nearly zero energy" building by taking into account the dense urban structure which gives the new possibilities for utilization of renewable energies (see figure 30). The energy-efficient building design solution developed within this project is named as SunZEB. The solution is based on the regional district heating and cooling. It allows cooling energy recycling back to the district heating network at the regional level as a renewable energy. It also makes integrated heat and cold distribution system possible on building level, as

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the same device produces both heat and cooling services. Renewable solar energy yield for recycling allows large glass surfaces in building. High-quality solar architecture together with the building services produces high-quality indoor conditions to users of building. The developed energy-efficient design solutions for block of flats and office that provide bright and comfortable interiors with high-quality indoor conditions for users (indoor air class S2).

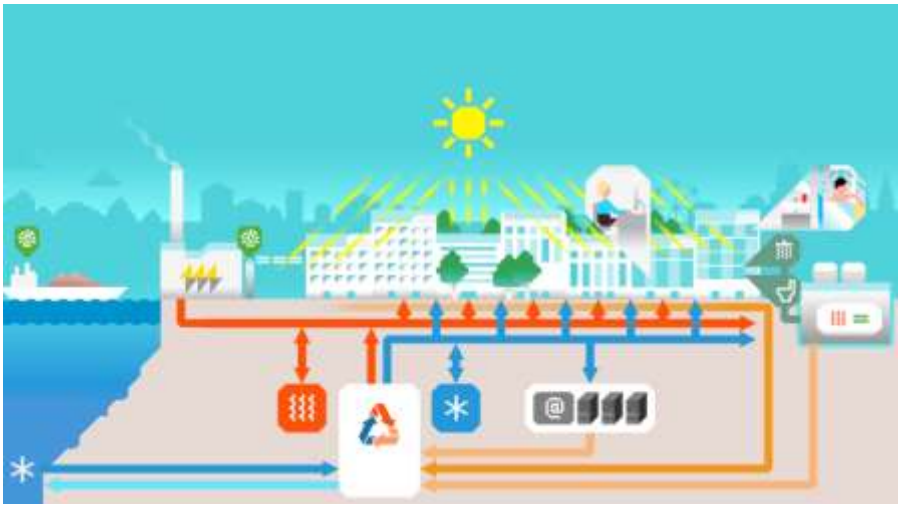

Figure 30. Integrated district heating and cooling system of a dense city structure enabling recycling energy flows for different purposes (Helen Oy)

Life cycle costs of SunZEB - solution in the block house are around 0.2 €/n-m²/a, which are 0.017 € /m², month higher than in corresponding reference building. Corresponding additional investment costs of SunZEB - the solution is about 130-150 €/m² in case of additional apartment building. The emissions of SunZEB solutions were compared at energy system level to the emissions of buildings which are built according today's building requirements. Active solar thermal energy installed in these buildings produced an equivalent amount of renewable energy as in SunZEB solutions. The results can be generalized to the rest of the respective combined heat and power production utilizing cities.

The first apartment building built according to the SunZeb concept was handed over to the residents in April 2020 and is part of the monitoring program of Kalasatama district in mySMARTLife Helsinki demonstration.

7.2.2 Example of supporting public procurement - KEINO

KEINO is a network-based consortium, whose founding members responsible for the operation and co-development are Motiva Ltd, the Association of Finnish Local and Regional Authorities, VTT Technical Research Centre of Finland Ltd, The Finnish Funding Agency for Innovation – Business Finland, the Finnish Environment Institute SYKE, Hansel Ltd, KL-Kuntahankinnat Ltd and the Finnish Innovation Fund Sitra.

The centre's main objectives for 2018–2021 are that the number of innovative and sustainable procurements in Finland increases, public procurement is recognized and actively used as a management tool, contracting entities openly disseminate information on their own experiences and learn from one another. The value of the Finnish public sector's procurements is approximately 35 billion€ annually, or on average 16% of the country's GDP.

An example of the public procurement interventions in Keino is the procurement of electric vehicles for carsharing in city of Lappeenranta, Finland. The purpose of the procurement was to decrease the CO2 emissions of the municipal vehicles, advance the development of e-vehicle related infrastructure in the city, collect user feedback from the users of shared e-vehicles and to make the carsharing service as interesting as possible for several user groups. The objective of city of Lappeenranta is to decrease CO2 emissions by 40% from 2007 level by 2021 and 80% by 2029. Emissions of traffic represent 40% of CO2 emissions, thus decreasing the environmental impact of traffic is essential to reach the climate objectives. (Keino)

The procurement process is well described on Keino website along with the objectives of the procurement, terms of the contract and also the benefits, results and impacts of the procurement. Possible next steps are discussed regarding the procurement.

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8. Conclusions

The analysis of the follower cities interventions through a business methodological approach, already tested in D1.6 Key aspects of City's Business Models of mySMARTlife EU project, confirms us again some interesting general ideas:

- Cities are key players in fighting climate change. They are cause of the problem because they are responsible for 70% of global energy-related greenhouse gas emissions according to the UN, but are also part of the solution to reduce these emissions.
- The description and analysis of the intervention through the VCE and CMC business tools point out the importance of using useful and comprehensive frameworks among cities to underline similarities and differences among them to scale-up successful interventions and help to set up next political agendas.
- In this path, we would like to highlight some common patters identified in most of the interventions according to the business tools presented:
    - The value proposition of all interventions highlights an important decrease in energy consumption due to an increase of energy efficiency and RES production in some of them. There is a clear impact in reducing cities' carbon footprint as well as providing other environmental benefits for citizens such as the decrease of air pollution or GHG and CO_2 emissions. On the other site, there are also important social benefits linked to the value proposition. We find an increase of quality of life of citizens, more specifically for the case of DH which entails also a decrease in fuel poverty. But also, it is very important to highlight the economic development linked to EV and smart public lighting interventions, which offer the creation of new businesses and job creation in new industries.
    - Furthermore, value propositions imply a better use of public resources in different manners, such as optimizing cost of energy resources (all interventions), utility of available infrastructure in the city (EV and PV) or improve operation and maintenance activities (PL and smart meters).
    - The delivering of the public value clearly identifies a common need in all interventions: the political buy-in. Although it is an obvious aspect from city business models, we believe that is interesting to pinpoint for several reasons. On the first place, the political buy-in represents the bottleneck to overcome these types of interventions. And on the second, there should be an alignment of interest among geographical political levels (municipal, regional, national) to set up a common strategy and offer funding and financing schemes.
    - Regarding the producing of public value, we find important aspects to highlight. First of all, the importance of public-private collaborations to develop and implement the interventions through public tenders. Furthermore, it is important to underline the figure of ESCO, for example in DH or smart public lighting (PAL), because these companies clearly operate under an energy savings business model logic.
    - Secondly, it seems crucial the public administration financial support at all levels. Although not all interventions have been co-financed – reason to put on hold the intervention -, almost all of them (i.e. DH and EV in PAL, smart public lighting and PV in BYD or smart meters in RIJ) present some type of co-financing between the Municipality and the EU through H2020, EDUSI, ERDF, or the nation or region. This co-financing is important to set up the initiatives testing with pilots as well as covering initial high upfront costs and public procurement.
- Finally, we must highlight the importance of PPI for cities when purchasing outcomes. The example of Finland through the KEINO network-based consortium show interesting cases where success, measured by economic, environmental and social benefits and impacts come from a clear alignment between municipalities', citizens' and companies' interest.

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