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Deliverable due date: M36 – November 2019

D1.9 Innovative business models. Making things happen
WP1, Task 1.2

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.

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Date	Version	Author	Comment
25/09/2019	1	ENG, ENH, ESA, NAN, HEN	Following the guidelines provided by ESA; HEL, ENG, NAN and ENH provided texts regarding the following section: 4.2, 4.4, 5.3, 4.3, 4.5, 6.3 and 6.4. The version form HEN & NAN were very complete interim version. ESA: Information from ENG, ENH, NAN and HEN gathered and preparation of section 3.
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14/11/2019	3	ESA, VHH	VHH provided the final version of section 6.2 ESA preparation of first final version.
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Table of Content

1. Executive Summary 11
2. Introduction 12
2.1 Purpose and target group 12
2.2 Contributions of partners 13
2.3 Relation to other activities in the project 14
3. Business Model Innovation 15
3.1 Cities Public Service Delivery 15
3.2 Business Models 18
3.3 Innovation and Business Models 20
3.4 A theoretical framework for analysing Business Models Innovation 22
3.4.1 Types of Innovation 22
3.4.2 Degree of Innovation 24
3.4.3 Holistic approach for the next sections 25
4. Nantes' best practices 26
4.1 Introduction 26
4.2 Retrofitting in individual houses (action 3) 26
4.2.1 Action description 26
Value proposition 27
Customers/beneficiaries segment 27
Partners involved 27
4.2.2 Business innovation 28
Considering that the result is the combination of several works and services, which improve the efficiency of energy savings, this solution is an incremental innovation. 28
4.2.3 Financing instruments 28
4.2.4 Innovation drivers, main barriers and weaknesses 28
4.2.5 Takeaways 29
4.3 Digital Boilers (Action 7) 29
4.3.1 Action description 29
Value proposition 29
Customers/beneficiaries segment 30
Partners involved 30
4.3.2 Business model innovation 30
4.3.3 Financing instruments 31

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

4.3.4 Innovation drivers, main barriers and weaknesses 32
4.4 Lighting optimization: gradation, rem management (action 18) 33
4.4.1 Action description....33
Value proposition....33
Customers/beneficiaries segment....35
Partners involved....35
4.4.2 Business innovation....36
4.4.3 Financing instruments....36
4.4.4 Innovation drivers, main barriers and weaknesses 36
4.4.5 Takeaways....36
4.5 Citizen solar projects – Support to citizen project of renewables (action 38)....37
4.5.1 Action description....37
Value proposition....37
Customers/beneficiaries segment....37
Partners involved....38
4.5.2 Business innovation....38
4.5.3 Financing instruments....38
4.5.4 Innovation drivers, main barriers and weaknesses 40
4.5.5 Takeaways....40
5. Hamburg's best practices....41
5.1 Introduction....41
5.2 Smart Home Assistant (action 3)....41
5.2.1 Action description....41
Value proposition....42
Customers/beneficiaries segment....42
Partners involved....43
5.2.2 Business innovation....43
5.2.3 Financing instruments....43
5.2.4 Innovation drivers, main barriers and weaknesses 43
5.2.5 Takeaways....44
5.3 PV on roof and home battery storage (actions 5 and 7)....45
5.3.1 Action description....45
Value proposition....46
Customers segment 46
Partners involved....46
5.3.2 Business innovation....46
5.3.3 Financing instruments....47

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

5.3.4 Innovation drivers, main barriers and weaknesses 47
5.3.5 Takeaways 48
5.4 Community car sharing (action 23) 48
5.4.1 Action description 48
Value proposition 49
Customers segment 49
Partners involved 50
5.4.2 Business innovation 50
5.4.3 Innovation drivers, main barriers and weaknesses 50
5.4.4 Takeaways 51
6. Helsinki's best practices 52
6.1 Introduction 52
6.2 Viikki Environment House: Field-testing of a new Human Thermal Model (HTM) control concept (part of action 3) 52
6.2.1 Action description 52
Value proposition 53
Customers/beneficiaries segment 53
Partners involved 53
6.2.2 Business innovation 53
6.2.3 Financing instruments 54
6.2.4 Innovation drivers, main barriers and weaknesses 54
6.2.5 Takeaways 54
6.3 Demand management (EV charging points, Solar plant and storage) (action 27) 54
6.3.1 Action description 54
Value proposition 56
Customers/beneficiaries segment 57
Partners involved 58
6.3.2 Business innovation 58
6.3.3 Financing instruments 58
6.3.4 Innovation drivers, main barriers and weaknesses 58
6.3.5 Takeaways 59
6.4 RES-AS-A-SERVICE Business Model development (action 33) 59
6.4.1 Action description 59
Value proposition 61
Customers/beneficiaries segment 61
Partners involved 61
6.4.2 Business innovation 62

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

6.4.3 Financing instruments 62
6.4.4 Innovation drivers, main barriers and weaknesses 62
6.4.5 Takeaways 63
7. Discussion about Business Models Innovation 64
8. Investment mechanisms for innovative business models 70
8.1 Introduction 70
8.2 Private financing schemes 70
8.2.1 Debt financing mechanisms 71
8.2.2 Subordinated debt and mezzanine financing 72
8.2.3 Equity financing 72
8.2.4 Social Impact Bond 73
8.2.5 Green bonds 74
8.2.6 Crowdfunding 74
8.2.7 Leasing on Innovation 75
8.3 The role of public governments 75
8.4 Other type of resources: Energy Performance Contracting (EPC) 77
9. Conclusions 78
10. References 80

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

Table of Figures

Figure 1: Traditional model of public service delivery....15
Figure 2: The smart city cycle....16
Figure 3: Smart City Model of public service delivery....18
Figure 4: The magic triangle of business models....18
Figure 5: Rationality behind a business model....19
Figure 6: Basic features of an innovation....20
Figure 7: Possible targets of business model innovation....21
Figure 8: Basic features of an innovation (Keele et al., 2013)....23
Figure 9: Picture of the project area in Nantes Métropole....26
Figure 10: Set of activities delivering a retrofitting project....27
Figure 11: Intervention area....34
Figure 12: Services offered by Flashnet....35
Figure 13: a) MINàWatt shareholders; b) Investors and invested amounts....39
Figure 14: Energie Partagéne Investissement operational scheme....40
Figure 15: Smart home set from “casenio”....42
Figure 16: Information event at a local community centre of the housing cooperation....44
Figure 17: Viikki Environment House (photo: mySMARTLife project)....52
Figure 18: Battery Energy Storage System (photo: Helen Ltd.)....55
Figure 19: PV panels at the rooftop of Messukeskus, in Pasila, Helsinki (photo: Helen Ltd.)....60

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

Table of Tables

Table 1: Contribution of partners 13
Table 2: Relation to other activities in the project 14
Table 3: Types of devices 33
Table 4: Cost estimation 45
Table 5: Cost estimation/budget 48
Table 6: General characteristics of interventions 64
Table 7: Business model innovation features per intervention 65
Table 8: Structural categories of business model innovations per intervention 68
Table 9: Contribution of partners 70

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

Abbreviations and Acronyms

Acronym	Description
mySMARTLife	Transition of EU cities towards a new concept of Smart Life and Economy
EC	European Commission
BESS	Battery Energy Storage System
BtoC	Business-to-Customer
BACS	Building automation and control system
DHW	Domestic Hot Water
DSM	Demand Side Management
EPC	Energy Performance Contracting
ESCO	Energy Service Companies
EV	Electrical Vehicle
PV	Photovoltaic
RES	Renewable energy services
SME	Small-medium enterprises
VHH	Hamburger Verkehrsverbund

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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 cities in the transition from traditional cities to smart ones. This deliverable, which is part of WP1-Defintion of an innovative Urban Transformation Strategy, is dedicated to study and compare business models innovation in pilot interventions that are taking place in our lighthouse cities, Nantes, Hamburg, and Helsinki.

The comparative analysis among interventions carried out by the authors, clearly supports the idea that innovation goes beyond traditional conceptions just centred in technology. In fact, the analysis shows that innovation can take place in different elements defining a business model: the value proposition, the value chain, the resources used, the channel to deliver products or services, the costumers segments, etc. The analysis also identifies and explains the type and degree of innovation as well as those drivers and barriers that cities and companies are facing to carry out their pilot interventions.

The report is in principle structured in four main parts. The first part, section 3, introduces the reader to innovation and business models and presents a theoretical framework for analysing business models innovation. The second part, sections 4, 5 and 6, describes and analyses best practice models innovation that mySMARTLife project partners are implementing in lighthouse cities in order to identify which elements are innovative, where does the innovation take place and how does the innovation fit in business models. The third part, section 7, presents a discussion about the business models innovation. Finally, the fourth part, section 8, presents some investment mechanisms to tackle one of the main barriers for business models innovation, financing.

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2. Introduction

2.1 Purpose and target group

The main objective of this deliverable is to develop an investigation on innovations in business models and pursue an analysis of the drivers and barriers through the comparison of different case studies related to mySMARTLife project. The research team, led by ESADE Business School, has concentrated its efforts on analysing the most promising interventions in terms of business model innovation according to a common criteria established by the lead partner and the three lighthouse cities. The interventions under analysis are the following ones:

- Retrofitting in individual houses (Nantes – action 3)
- Digital Boilers (Nantes – action 7)
- Lighting Optimisation System (Nantes – action 18)
- Citizens Solar Project (Nantes – action 38)
- Smart Homes Assistant (Hamburg – action 3)
- PV on Roof and Home Battery Storage (Hamburg – actions 5 and 7)
- Community Car Sharing (Hamburg – action 23)
- HTM control concept (Helsinki – part of action 3)
- Demand management (EV charging points, Solar plant, and Storage) (Helsinki – action 27)
- RES as a Services (Helsinki – action 33)

One of the main objectives of the project is to ensure the replicability of some of the products/services implemented in Nantes, Hamburg and Helsinki. Long-term viability depends on ensuring a sustainable business model that helps companies to take advantage of market opportunities. Business models evolve as products/services evolve as well, and just those capable to meet the needs through innovative ideas will survive the fierce competition that exists in smart city industries. This deliverable is useful to understand what works and what does not work in this exciting area of management.

Hence, all entities related to the fields of these selected solutions show a great interest in this deliverable. Beyond them, also cities willing to become smart should consider the main conclusions from each of the interventions to create the right ecosystem in their areas of influence.

In order to ensure an accurate analysis, ESA established a common logic. Each intervention has been analysed through the same systematic approach by one of the involved partners in close collaboration with ESA and the lighthouse cities.

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2.2 Contributions of partners

The following table depicts the main contributions from participants in the development of this deliverable.

Table 1: Contribution of partners

Participant short name	Contributions
ENG	Analysis of the business models innovation for its products following the guidelines of the deliverable and redaction of subsections 4.2 and 4.4.
ENH	Analysis of the business models innovation for its product following the guidelines of the deliverable and redaction of subsection 5.3.
ESA	Overall methodological development, guiding partners when necessary, coordination of the deliverable, reviewing it, and redaction of some sections.
HAM	Analysis of the business models innovation for its product following the guidelines of the deliverable and redaction of subsection 5.2; and coordination of Hamburg pilot partners.
HEL	Coordination of Helsinki pilot partners.
HEN	Analysis of the business models innovation for its product following the guidelines of the deliverable and redaction of subsections 6.3 and 6.4.
NAN	Analysis of the business models innovation for its product following the guidelines of the deliverable and redaction of subsections 4.3 and 4.5; and coordination of Nantes pilot partners.
VHH	Analysis of the business models innovation for its product following the guidelines of the deliverable and redaction of subsection 5.4.
VTT	Analysis of the business models innovation for its product following the guidelines of the deliverable and redaction of subsection 6.2.

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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 2: Relation to other activities in the project

Deliverable Number	Contributions
D1.6	This deliverable has provided an analysis on Value Creation Ecosystems and City Business Models to define how cities create, deliver and capture value for citizens in new smart solutions.
D1.7	This deliverable has found 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 has found out what is the need ecosystem (key drivers) for SMEs, start-ups, and entrepreneurs at a local level to replicate their participation in other areas of the city or other cities.
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.
D6.13	This deliverable will find out what are the innovative funding schemes, opportunities, and best practices to create an investment plan for the implementation of the interventions.
D8.3	This deliverable focuses on the development of market analysis to identify and construct business cases and business models for industrial partners. The objective is to transfer the results from the Exploitation Roadmap of Results into economic feasible business models.
D8.9	This deliverable will focus its attention on the business models of the most promising intervention from the point of view of industrial partners.

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3. Business Model Innovation

3.1 Cities Public Service Delivery

When defining a smart city we need to think far beyond the mere relationship between citizens and service providers. Bearing in mind that this is not a static process, smart cities should not only encourage and enable citizens to become a more active and participative member but also engage with members with all the services on offer, both public and private (Department for Business Innovation & Skills, 2013b). New problems will emerge from the usage of digital technologies, as citizens will have to deal with both soft and hard problems through the lens of digital technologies. In that respect, the Bremen Declaration (2016) highlighted that 'technology should be used as a tool to achieve goals, not as a driver or as a goal in itself. Wise [or Smart] cities use technology to serve the needs of their citizens'. Taking this into account we propose to define a smart city as these efforts on projects related to sustainability and green ICT but in need of a bottom-up view (Walravens and Ballon 2013). In this new governance approach, city governments and local service providers will not be longer the only actors responsible for delivering value to their inhabitants (see figure 1), but instead, they will have become actors among several stakeholders (i.e. large firms, small and medium enterprises, non-profit organizations) in charge of this delivering (Timeus, et al. 2020). In other words, value creation will depend on the engagement of a wide range of stakeholders (Anttiroiko, Valkama & Bailey, 2014). In this service system, the role of the city government would increasingly be one of guiding and overseeing the delivery of services, rather than one of only creating and delivering services to passive consumers (Osborne et al., 2014; 2015).

So far, cities have based their management model covering three axes: their relationship with the public sector, the private sector, and citizens (see figure 1). However, the service model of provision relationship with the private sector has had limited interaction. The city council focused on concessions or public-private partnerships through public tender. The municipality was rather seeking to fill the void when providing goods. Similarly, the constant interaction was oriented towards the public sector, and at their end to citizens.

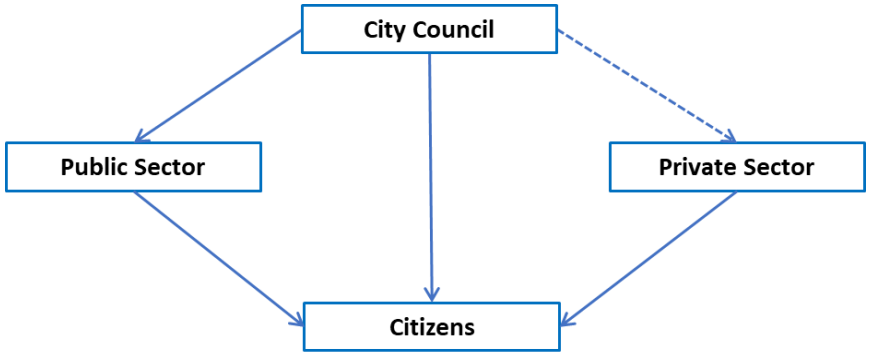

Figure 1: Traditional model of public service delivery
Source: Adapted from Department for Business, Innovation & Skills (2013)

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Meijer and Bolívar (2015) identified three main areas around where smart city revolves: technologies, human resources, and governance. The technological focus refers to the centrality of new solutions (products or services), most of them supported by ICT, aiming to increase the efficiency of infrastructures and to improve the quality of local policies, especially those targeted at environmental sustainability (Angelidou, 2016). Human resources are associated with the importance of education in terms of well-educated population, and knowledge capital is conceived as a driver of urban growth and innovation (Angelidou, 2016). The governance approach highlights the relevance of partnerships and networking among local stakeholders to foster innovation (Torfing, 2016). Providing a smooth transition from the so-called traditional model to the smart city model will require different key players and policy change. In parallel with the document released by the British Department for Business Innovation & Skills (2013), we came across with the following variables (see figure 2): (1) political leadership; (2) promoting change and innovation in the city council; (3) new organizational structure; (4) having access to capital; (5) open data policy, and (6) policies of social inclusiveness.

Figure 2: The smart city cycle

(1) Leadership: The appointment of a new local government with a clear vision represents in most cases the driver for change and innovation. Mayor's leadership to innovation might flourish from five different styles: a transactional style, a transformational style, an interpersonal style, an entrepreneurial style and a network governance style (Lewis, Ricard & Klijn, 2017; Ricard et al., 2017). In all cases, citizens are encouraged to take part in the process of service improvement, and in the development of new approaches and new services. In that respect, cities developing visions that are specific to their needs will require the commitment from the top to drive through change and innovation to achieve quantifiable objectives.

(2) Change and innovation: In this field, public sector can benefit from private sector mechanisms and experience: "skunkworks" with the freedom to try new ideas and ability to manage risk, access to capital -

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internally or externally generated, and a strong focus on measuring outcomes and the ability to scale up are critical for its success.

(3) Organizational Structure: Successful approaches for smart city leadership require a group of people within the organization who can innovate and act entrepreneurially (Department for Business Innovation & Skills 2013a: 44-5). These group can play an active role in seeking out new opportunities, piloting new ideas and approaches, and forging relationships with city stakeholders. These sections of the organization must have strong political support (usually situated in the Mayor's office or in the executive team) and a clear mandate that gives them credibility and focuses their agenda on innovation.

(4) Access to Capital: A strategic factor in the success of governments to innovate is the level of information and confidence required concerning the project, and its wider benefits, before public funds can be committed. However, creative, exciting ideas that are innovative also very often have benefits associated with them that are difficult to establish or estimate. Having a separate body within the organization that is resourced and can test these, or adopts "real options" approaches to identifying radical solutions, provides the operational parts of the organization with the information and confidence necessary to scale up and implement.

(5) Open Data: Open data is seen as a key driver of change (Hielkema and Hongisto 2013; Bakici, Almirall and Wareham, 2013). Leading cities are now consulting citizens on the issues that affect them most and then exploring how information might be brought to bear on the topic. They are examining how to generate more powerful insights and value by using potentially more sensitive datasets (including data on vulnerable groups) to improve their understanding of citizens' needs and to provide better services while respecting data privacy and security. They are also making available large datasets to enable new APIs and services to be developed commercially. Smart cities see ICT and the innovative use of data as fundamental to solving their most complex challenges.

(6) Social Inclusion: Cities also need to engage with all stakeholders to promote awareness and uptake of the e-services on offer. For instance, offering widespread and competitive access to broadband services, or providing access to digital skills training.

The due implementation of these changes requires a new governance and operational structure (see figure 3). In that way, as we have previously mentioned, the role of the local government is now to be considered of high importance. The creation of an innovation unit can highlight this importance. This innovation unit is part of the organizational structure, which directly reports to the mayor. The innovation unit is a multi-sectorial unit offering a smooth transition to the new role played by the public sector in delivering services. It is noteworthy that citizens are now empowered with voice mechanisms. Citizens are now an agent shaping the structure. Their knowledge is modelling not only the public sector and the private but also has the power to the influence city council's decisions. Another characteristic differing from the past governance structure is the role of the private sector. Since the previous model just considered the private sector as provider of goods, the private sector now is essential in the co-design and co-production of services.

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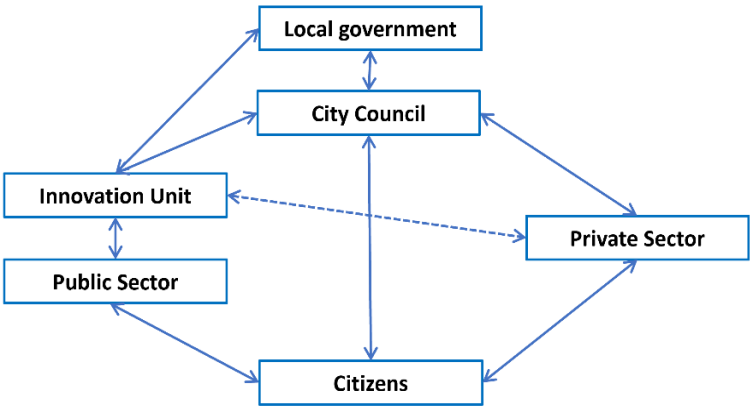

Figure 3: Smart City Model of public service delivery
Source: Adapted from Department for Business, Innovation & Skills (2013)

3.2 Business Models

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 the "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 as 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 4 (Gassmann et al., 2014).

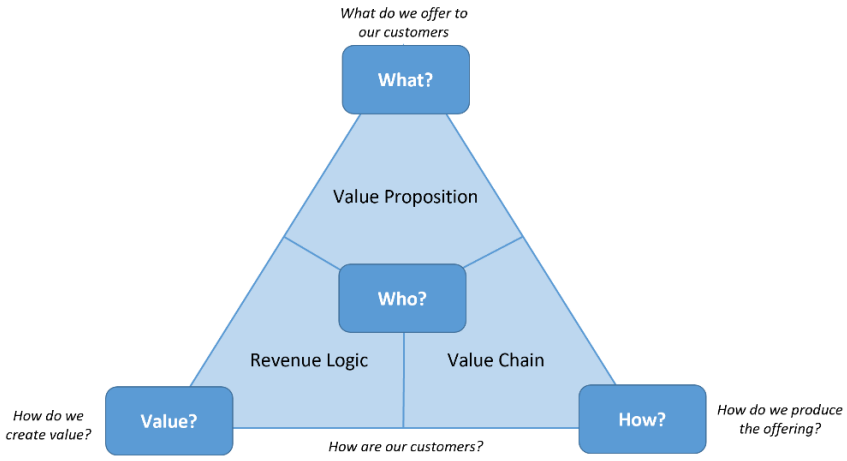

Figure 4: The magic triangle of business models
Source: Adapted from Gassmann et al. (2014)

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According to Osterwalder et al. (2009), a business model is a rationality that explains how a company creates, delivers and captures value (figure 5). Magretta (2002) states that business models are for managers 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.

Figure 5: Rationality behind a business model

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 other lighthouse projects. This increases considerably the chances of success because organizations are capable of fixing problems that they could not imagine they had to face (Wynn et al., 2009). Sometimes companies cannot 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.

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 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. Everything happening within the value chain of a business model will affect the rest of the firms 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 confusion 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

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between both fields, suggesting a more central place for customers and emphasizing the importance of the pilot implementations.

Nowadays, according to De 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). The Business Model Canvas (BMC) bases on nine building blocks that cover according to its developers the four main areas of a business: customers, offer, infrastructure and financial viability. Planellas and Muni (2015) state that the BMC allows us to analyze the equilibrium between the nine blocks, giving a holistic business idea.

3.3 Innovation and Business Models

There is a broad consensus about the fact that innovation is central for business success and competitive advantage at the firm's levels, 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”. According to the manual, there are two minimum requirements for innovation. The first one is that the product, process and/or method must be new or modified/improved by the firm even though it has been adopted by other companies before. The second one is that the novelty must have been implemented and consolidated, and this is something that just will happen when it is feasible, desirable and viable (figure 6).

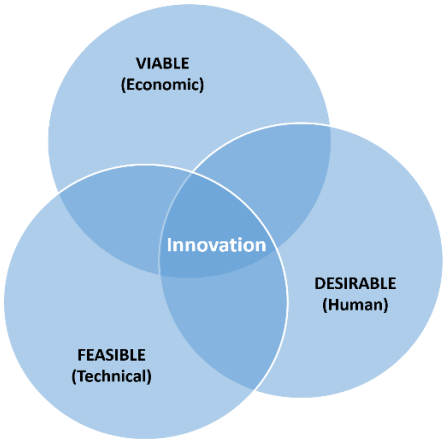

Figure 6: Basic features of an innovation

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The introduction of an innovation, which is the result of research and development processes, represents an improvement of company performance and allows it to achieve a competitive advantage, i.e. to generate a differential feature in front of competitors to reach or increase the market share. 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 of companies.

While many companies 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, 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, which has changed the rules of competition among relevant actors.

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 7 presents the different components of the business model that could be modified creating a business model innovation.

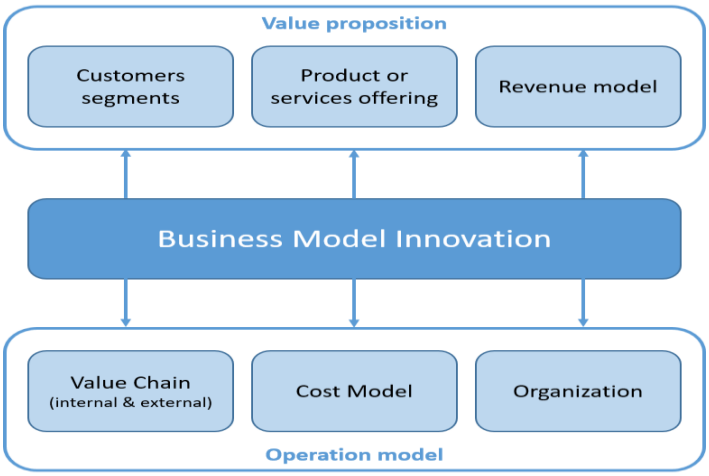

Figure 7: Possible targets of business model innovation
Source: Adapted from Lindgardt et al., (2009)

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There are different drivers of business model innovation. Enterprises need to respond to market conditions, especially in high changing environments. They have to be dynamic. They have to re-design their market approximation. Christensen, Johnson and Kagerman (2008) identify five relevant drivers:

- The chance to serve a large group of potential customers who are not attended because existing solutions are too expensive or complicated for them. This is a clear example of product democratization.
- The opportunity to capitalize a new technology developing a new business model around it, as Apple did by mp3 and iTunes.
- The opportunity to bring a job-to-be-done focus where one does not yet exist.
- The need to defend a market share against disrupters lowering prices.
- The need to respond to a variation on the essence of competition. Markets evolve, and solutions that were accepted yesterday, today are no longer bought.

This process requires a great effort, although it may not seem like it, and must be accompanied by a phase of exploration and validation and ex-post adaptation. Because business model innovation involves a complete set of activities, it is both challenging to execute and difficult to copy (Lindgardt et al., 2009). In fact, as Teece (2010) states, “business models innovation may not seem heroic [but] without it there may be no reward for pioneering individuals, enterprises and nations”.

3.4 A theoretical framework for analysing Business Models Innovation

In order to ensure accuracy in the analysis of the innovative business models implemented in mySMARTLife project, this deliverable has established a theoretical framework based on literature review. This framework divided the analysis into two main sections. First, it analyses what kind (type) of business innovation the companies implement, and then it examines the grade (intensity) of that innovation.

3.4.1 Types of Innovation

One of the most well known tools for diagnosing innovations is called *Ten Types of Innovations* (Keeley et al., 2013). In order to establish the framework, the authors explored the different patterns of important companies introducing innovations. In terms of business innovation, Keeley et al. (2013) established and defined the following three categories of innovation: configuration, offering and experience, and their subsequent classes (figure 8). The definition of the concepts is based on those presented by authors.

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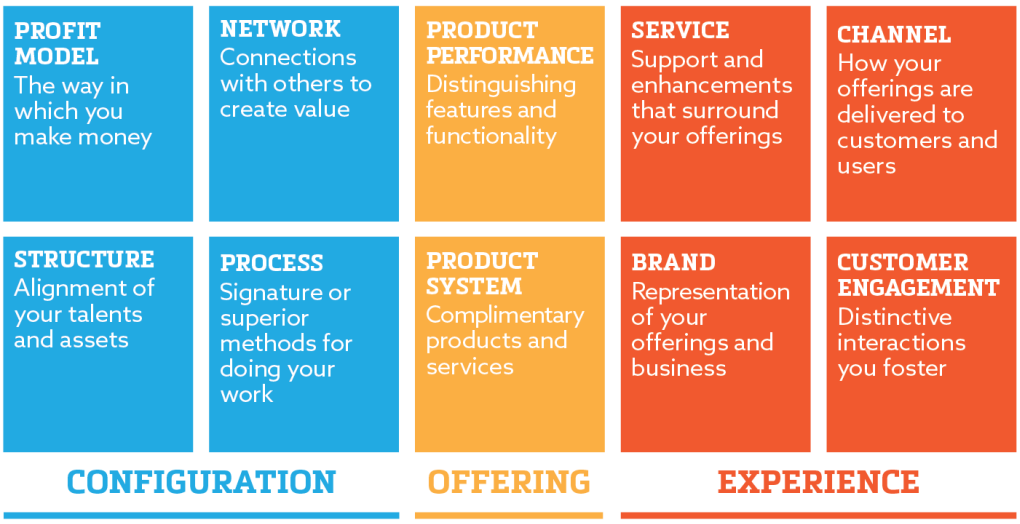

Figure 8: Basic features of an innovation (Keeley et al., 2013)

- **Configuration** is focused on the innermost workings of an enterprise and its business system and comprises four types of innovations: profit model, network, structure and process.
    - Profit model refers to the way a company earns money, the central focus of the business model. Innovative profit models find a new way to convert a company's offers and other sources of value into money. Innovative profit models often challenge the old industry assumptions about what to offer, what to collect or how to raise revenue. This is an important aspect of its power: in most sectors, the dominant profit model often remains accepted for decades.
    - Network refers to how a company connects with others to create value by exploiting its participation in value creation. These innovations mean that a company can capitalize on its strengths by leveraging the skills and resources of others. Network innovations also help executives share risks in the development of new offers and initiative.
    - Structure refers to the way through which a company organizes and aligns its talents and resources that will generate profits. They can include from the best talent management systems to ingenious configurations of capital equipment. These innovations contribute to attracting talent by creating productive work environments or developing a level of performance that competitors cannot achieve.
    - Process considers innovations related to the activities and operations that produce an enterprise's main offerings. In this case, innovating involves a notable change from "business as usual" to enabling the company to use unique capabilities, function efficiently, adapt quickly and create market-leading margins.
- **Offering** is focused on an enterprise's core product or service, or a collection of its products and services and comprises two types of innovations: product performance and product system.

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- Product performance focuses on the products and services offerings in terms of value, features quality, etc. This type of innovation involves both entirely new products and updates that add substantial value to old products. Product performance innovations that deliver long-term competitive advantage are the exception rather than the rule, as it is generally the type of innovation that competitors can copy more easily.
- Product system focuses on how individual products and services connect to create a robust and scalable system. This is fostered through different ways of creating valuable connections between otherwise distinct and disparate offerings such as interoperability, modularity or integration.

- **Experience** is focused on how to improve the users' experience and how to create a great customer-product interaction and comprises four types of innovations: services, channel, brand and customer engagement.
  - Service focuses on improving the utility, performance and apparent value of an offering. They make a product easier to try, use and enjoy.
  - Chanel refers to how a company delivery the value to its customers or users. Its objective goal is to ensure that users can buy what they want, when and how they want it, with minimal friction and cost, and maximum enjoyment.
  - Brand refers to those innovations that ensure that customers and users identify, remember and prefer company offerings to those of competitors or substitutes. Brand innovations can transform commodities into prized products, and give them meaning intent and value to offerings.
  - Customer engagement refers to innovations that seek to understand customers' aspirations and desires for using those insights to develop meaningful connections between them and the company.

Obviously, any business model innovation could combine as many types of novelties as it is able to join in a single transformation.

3.4.2 Degree of Innovation

As it has been already stated, innovation is vital to ensure the long-term success of any firm. Unfortunately, according to Muckersie (2016), there has been a tendency to associate innovation with only the most revolutionary ideas, leaving aside many interesting contributions in the business arena that contribute to modifying the status quo. According to Christensen et al. (2015), experts differentiate disruptive innovations from what are called "sustaining innovations", which encompasses the whole spectrum behind radical transformations: from smallest incremental improvements to breakthroughs, but they all enable firms to increase their performance.

Therefore, and as a summary, it can be stated that, regardless of the scope of the innovation, there are three degrees or levels of innovation: incremental, lateral and disruptive.

- **Incremental innovation** is an innovation base on a series of small upgrades made to the existing business model to improve its competitive advantage, productivity or efficiency**.**

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- **Lateral innovation** is an innovation based on lateral thinking, which provides solutions to problems using unconventional methods, coming at the problem from new directions. They are usually game-changers.
- **Disruptive innovation** is an innovation that represents a change of paradigm, breaking with the pre-established situation and creating a new market and value network, displacing customary market-leading products or services.

3.4.3 Holistic approach for the next sections

In the following sections, this deliverable analyzes the best practices in terms of business models innovation of mySMARTLife project lighthouse cities, Nantes, Hamburg, and Helsinki. In order to offer a holistic vision of the interventions under examination, each case goes beyond the analysis of the above-presented framework. In fact, each case tries to present accurate information in the following fields: 1) action description, which is divided in general description, value proposition, customers/beneficiaries segment, and partners involved; 2) business innovation, which include analysis of the type and degree of innovation; 3) financing instruments; 4) innovation drivers, barriers and weaknesses; and 5) takeaways.

The interventions are presented per each of the city and their order responds to the action number.

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4. Nantes' best practices

4.1 Introduction

Nantes Métropole is an administrative structure that brings together 24 municipalities of the conurbation. The city of Nantes has a total population of 619,240 inhabitants (9,2% of total population in France); thus, is the capital of the Greater West and the 7th largest city in France by its population.

The city benefits from a strong attractiveness and a strong economic dynamism. With 330,000 jobs and just over 180 head offices of companies with more than 100 employees, the Nantes conurbation is the main economic centre in the west of France. Its economic fabric is today diversified: Nantes Métropole is affirming itself both as a metropolis of services (which represent 8 jobs of the 10th) and as a territory of industrial excellence. Indeed, the territory has managed to preserve an important industrial base that is now structured around historical sectors that have been able to adapt and renew themselves (agri-food, shipbuilding), and emerging sectors that have grown more recently (aeronautics, health, marine energies, eco-industries, etc.). Most can rely on dedicated competitiveness clusters to support them in their development and innovation (Nantes Métropole, 2017).

4.2 Retrofitting in individual houses (action 3)

4.2.1 Action description

In mySMARTLife project, several actions on individual houses were deployed. These actions consist of ambitious retrofitting, developing smart thermostat and deploying renewable energy. The concept of energy retrofitting in individual houses comprises in particular, insulation of attics and walls. The aim of this action is to increase renewable and local production combined with reduction of energy consumption. The geographical perimeter of the project is two districts in Nantes and two cities in Nantes Métropole (figure 9). The number of inhabitants in this area is 92,940[1]:

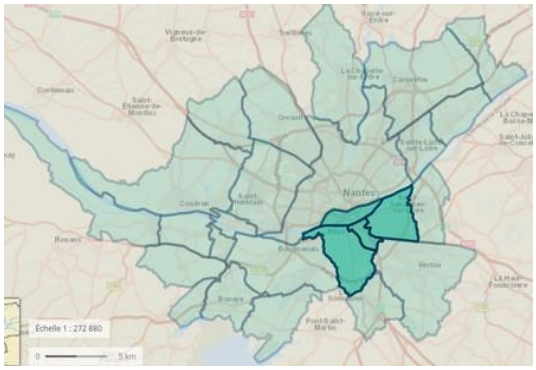

Figure 9: Picture of the project area in Nantes Métropole

[1] Source: www.insee.fr

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The execution period depends on each case on time to obtain consent of owner and funding. The technical audit is done in two weeks, and the works in few months as soon as permits are validated. The setting of each house is special and requires an audit to propose a technical solution (thickness of insulation, type of insulation work: wall, floor, window). The budget is specific for each house. However, the action is structured in a common framework (figure 10).

Figure 10: Set of activities delivering a retrofitting project

Value proposition

The solution provides several benefits for the owner and occupants of the house. The retrofitting of the house decreases the energy consumption and improves the comfort of life in the house. Besides, the installation of hybrid PV panels (thermals and electrical) allows to decrease the electricity consumption and thermal consumption with the production of electricity and thermal energy. Overall, the saving is 70% with the whole project. Thus, the energy bill is significantly reduced.

Customers/beneficiaries segment

The customers of these services are the occupants of the houses, which are also the direct beneficiaries. Indeed, the warm feeling and the thermal comfort is significantly improved with the retrofitting work. Besides, the energy bill is reduced with less consumption and local production (thermal and electrical).

The society is indirectly a beneficiary of this action. The consumption for residential and tertiary building is 45% of final energy consumption in France[2] . And, 67% of the energy in the main residence is used for heating[3]. Decreased the energy consumption in residential building is a way for energy savings.

Partners involved

Several suppliers are involved in this project. . In that sense it is important the remark the important role of some of them like: professional experts in energy and architectural fields, providing solutions for each project/ house ; financial

[2] Source: Bilan de l'énergie 2015, ministère de l'Environnement
[3] Source: CEREN, Les chiffres du bâtiment, 2014, ADEME

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institutions, providing funds and soft loans; construction companies, which carry out the works; and suppliers of products as insulation, PV panels, etc.

4.2.2 Business innovation

This project is offering innovation, more precisely a product system innovation. This offer is a mixture of few technical solutions. ENGIE Home Services, the subsidiary company working on business to consumer (B2C) market propose initially solution (new installation or replacement, maintenance for heating system as boiler). It is a part of energy saving solution. The project added new tasks (as wall insulation and hybrid PV panels) to the core business for ENGIE. They enlarged their business by offering a complete service to customers, which includes technical audits, obtaining permits and the collaboration with partners.

Considering that the result is the combination of several works and services, which improve the efficiency of energy savings, this solution is an incremental innovation.

4.2.3 Financing instruments

Today, individual house owners finance retrofitting works and installation of renewable production in individual houses by themselves. The refinancing takes place via energy savings and the reduction of energy costs. The return on investment time depends on the amount and the type of works. It is not linear.

In France, and in particular in Nantes Métropole, there are several funding possibilities for energy retrofitting of houses. These subsidies can be increased for low-income households. Some funding requires a minimum level of energy savings.

4.2.4 Innovation drivers, main barriers and weaknesses

The energy transition can be forwarded due to energy savings. As an actor on energy transition and working on B2C market, it is key to offer solutions for energy savings and retrofitting and development of local energy production. For the customer, the main driver is the saving on the energy bill.

This ambitious energy retrofit project requires houses with high energy consumption. Many houses have already done some small work for energy saving. The first challenge is to find a house with high energy consumption and adapted for hybrid panels (without shadow or large roof window).

The second barrier is the consent of the owner for the whole project. Indeed, the retrofitting work to achieve very significant energy savings is expensive and the return on investment is very long. Owners retain solutions with less important work, faster return on investment, and low energy savings. Only households with significant financial support could have a short or medium return on investment and give their consent. Getting financial help takes a long time, more than one year sometimes.

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4.2.5 Takeaways

Technical solutions are ready to be deployed and replicated. However, the market is not ready yet. The return time for the client is too long. Funding is essential to deploy the solution. Nevertheless, the business on “medium” retrofitting combined with renewable production could be deployed.

4.3 Digital Boilers (Action 7)

4.3.1 Action description

In France, a company, Stimergy, has developed a few years ago a digital boiler that preheats water with the heat waste of computer servers. The innovation named TEBIOS® can be installed in different kinds of buildings (residential buildings, universities, swimming pools or public baths). Nantes Métropole Habitat, a social landlord, has chosen to implement this technology in one of its residential buildings named “L’Oiseau des Iles”, located on the Island of Nantes. The latter was built in 2014 by the architect Antonini – Darmon; it gathers 26 apartments and 4 small houses on 2,800 m² and there is a 548-squared meter area on the first floor available for shops or tertiary activities.

In the first place, both heating and Domestic Hot Water (DHW) were provided by the district heating network, which is working thanks to a biomass and wood boiler and with gas as a second heating system.

Nantes Métropole Habitat had already installed a first digital boiler in another building in the North of Nantes. As the results were good and the technology was innovative, they decided to repeat the experience. “L’Oiseau des Iles” building presented two important requirements for the installation of a digital boiler: enough space in a second boiler room and the proper number of dwellings (a minimum number of dwellings is necessary regarding the minimum power of the digital boiler). Thus, an 8 kW-digital boiler has been installed in 2018 in this residential building, and it will provide around 50% of the DHW needs. All procedures with the electricity grid operator for the digital boiler connection ended at the very beginning of 2019 and it has been operating since January 2019.

For the installation of the digital boiler and the heat supply, Nantes Métropole Habitat signed a 15-year contract with Stimergy. The latter is the company that produced the digital boiler but also the one that provided the data to the servers installed in it.

Nantes Métropole Habitat spent EUR 30,000 (excluding taxes) on this 15-year contract: EUR 14,900 for the digital boiler itself and the rest for the heat supply and installation.

Value proposition

The concept of a digital boiler allows integrating renewables in a building in a different way. Moreover, it is energy efficient in two ways:

- It lowers the DHW needs by preheating the water.

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- The cooling need of the computer servers used in the digital boiler is covered and it is no longer necessary to use air-conditioned rooms to store them.

As the investment cost of the project was entirely covered by the innovation budget of Nantes Métropole Habitat, it allows the social landlord to manage the expenses of the tenants and even to reduce them.

As for the calculation and data storage side, it allows it to be more environmental friendly, as the energy needed for cooling the computer servers is no more necessary.

Customers/beneficiaries segment

Digital boilers can be installed in every type of buildings that needs DHW regularly, as the computer servers might run all year round.

There are some requirements regarding the need of the building: the power needed to heat the water should be in a specific range and the building must be fitted with a boiler room that is big enough to receive the boiler(s). Thus, the following groups of people / organisation are the main targets of such a product:

- Condominiums or residential building belonging to social landlords,
- Hospital,
- Swimming pool or other sports facilities (private owners or public buildings),
- Military or firefighter buildings,
- Boarding schools,
- Retirement homes.

For all these kinds of buildings, the need for water is quite steady, which is required for the digital boiler.

Partners involved

The elements needed so that this digital boiler may be operating are the following:

- A building with regular DHW needs,
- A company to produce the digital boiler,
- A company/engineering consultancy that sizes the digital boiler(s) to be installed,
- A company to install it and all the other components needed (pumps, hot water network, electrical connections…),
- A connection to the fiber is also required so that an internet service provider is also part of this network,
- A company to provide the computer servers as well as the data/calculation to run the servers.

4.3.2 Business model innovation

The idea of the digital boiler gathers two distinct services. On the one hand, there is the heat supply for domestic hot water and, on the other hand, the data storage/computer calculation spaces supply. Although these two elements seem to have nothing in common, Stimergy has managed to bring them together around the same offer. Indeed, the

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company offers the two services one at a time, with a contract for the sale of energy on one hand and on the other hand, a contract for the supply of storage and calculation spaces. However, they also provide an offer in which the client has access to data storage and computer calculation spaces on computer servers, and the heat emitted by these computer servers during their operation is recovered for the production of hot water for the same client. Regarding the type of innovation, this is a configuration innovation project, more precisely, a product system innovation.

The digital boiler fulfils the same function as a hot-water tank: providing a building with Domestic Hot Water. The service is not new and does not involve a direct change in the user's experience. However, in the process, the heat generator is not anymore a gas boiler or a heating element, but operating computer servers.

The technology of the equipment itself is quite new. At a time where data centres are becoming more and more numerous, just like their cooling needs, and fossil fuel savings are a current matter, the digital boiler with this new heat source constitutes a technology change coming from another current market: the data centres.

It opens up a new market to IT hosting services, which is the production of digital boiler associated with the heat supply contracts. Thus, it gives access to a new kind of green energy for the production of DHW and it avoids the energy consumption for the cooling needs of the computer servers.

All these arguments indicate that in terms of degree, this intervention is the result of an incremental innovation.

4.3.3 Financing instruments

The digital boiler of the building "L'Oiseau des Iles" was funded by the innovation department of Nantes Métropole Habitat, so that this investment does not affect the tenants of the building. Nantes Métropole Habitat and Stimergy have signed a 15-year contract that includes all the different tasks related to the digital boiler. Thus, this contract includes the cost of the digital boiler itself (EUR 14,900 excluding taxes), as well as the installation cost (EUR 15,000 excluding taxes). The energy price and the maintenance cost are included in the installation cost. Stimergy covers the connection to the fiber and all the surveillance equipment for the data protection.

Stimergy committed to providing a specific quantity of energy: 19 MWh per year, or 285 MWh over 15 years. It means that the price of energy is here considered as constant over 15 years, in contrast with the usual energy contract. If the energy indeed supplied is below this value, the company must pay a compensation to the social housing landlord. The latter is calculated as follows:

$$Compensation = P_{u2} \times (E_m - E_{ca})$$

With P_{u2}: The price of the MWh compensated

E_m: The energy actually supplied

E_{ca}: The target value of supplied energy (19 MWh)

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If $E_m < E_{ca}$, there is an insufficient supply of heat. The compensation is then calculated as explained above and the company has to pay it to Nantes Métropole Habitat.

If $E_m > E_{ca}$, there is an excess supply of heat. In this case, Nantes Métropole Habitat benefits free of charge from this excess.

In this contract, the price of the energy produced is considered constant. Today 1 kWh produced with the digital boiler is a bit more expensive than 1 kWh of gas, but the trend is that the price of gas will increase. Moreover, the digital boiler provides renewable energy.

4.3.4 Innovation drivers, main barriers and weaknesses

Data flows increase each year, and data centers are developed all over the world to store our data and realize digital calculations. These data centers have to be cooled all the time to operate properly. When the cooling systems are in progress, they extract the calories inside the data center to release them in the outside air, so that all those calories are wasted. On the other side, the energy transition issue has become more and more important over the years.

The person that first created the company Stimergy, had the idea to link the two subjects by using the heat generated by a data centre for common use that can be found everywhere: the need of heat for DHW. To do so, the person imagined a boiler in which the heat of computer servers is transmitted to DHW through different heat exchangers. Then, the company was operating in two completely different markets: the data management and storage with the data centres and the energy production market. As a result, the company offered three types of contracts: the energy supply, the data centre, or both at once.

This model of selling energy is quite new and the company has two things to deal with: supplying the right amount of energy and the data/calculation management. The latter are two distinct markets, however, they are directly linked through Stimergy. The more data is stored and calculations are carried out, the more heat is supplied. Moreover, the markets are not operated in the same way. Thus, the company encountered difficulties regarding the data management market. Indeed, their business model being more focused on the heat production and supply, it had difficulties to be sufficiently attractive on the data centre side.

Moreover, some new shareholders have joined the company, so that the latter could grow; these new shareholders had quite high expectations regarding the ROI, which is not entirely compatible with an energy activity.

Signing a contract for both data centre and heat supply with the same client would be easier to deal with for the company. However, the company had difficulties to get this type of contract.

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4.4 Lighting optimization: gradation, rem management (action 18)

4.4.1 Action description

A remote management of lighting points combined with a presence sensor was installed in Nantes: the InteliLight streetlight control system was installed on a small area in the city centre: 79 lighting points were equipped with device controllers, with three different types of devices (table 3).

In June 2018, each device controller type was tested to identify wiring and commissioning procedure. Failures were generated to test fault detection on the supervision platform. Some parameter values were tested and the supervision platform started being handled. Next July, each of them was configured individually on the supervision platform to set GPS location, controller type and other data, so that the controller could be easily and quickly installed. Finally, from mid-July until the end of August, the controllers were installed in existing luminaires and in new ones. A visual check on wiring and lights turning on could make sure the controller was working. Now running in operating phase, the user can manage the street lighting by:

- Remotely switching or dimming lights,
- Programming schedule,
- Being notified of failures,
- Accessing history of functioning for each device (electrical consumption, failure, parameters, etc.).

Table 3: Types of devices

Controller type	Integration mode	Device
FRE-220-NEMA	Placed on the light top using NEMA connection	
FRE-220-M	Embedded in the light structure	
FRE-220-P	Installed into the lighting pole	

Value proposition

The global area (figure 11) is facing different constraints: as it is located on the “Ile de Nantes” in the middle of the river “La Loire”, it is directly bordering the river and the western tip is a high night-time activity place with pedestrian

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traffic almost all year round. The area changes: new residential buildings were built. Therefore, different challenges appear concerning street lighting to answer the Nantes citizens and inhabitants needs.

The zone equipped is divided in several areas with different needs of lighting and challenges:

- Echelles: Rescue ladders are installed along the dock and are enlightened by floodlights. The supervision is installed to detect failure.
- Esplanade des Riveurs: The need is to remotely switch on and off lighting for occasional events and detect failure.
- Mail des Chantiers: This path is used by walkers to reach the dock because it is very illuminated but buildings were recently built and inhabitants must not be annoyed by light and noise. The supervision enables to schedule and dim the lighting in order to make people use the other path called “Zone des Chantiers”. Presence detection functionalities are being tested with motion sensors installed on the path.
- Quai des Antilles: This is a high pedestrian traffic area during evenings, the lights must be powerful and well-functioning. The supervision is used for failure detection and remote management.
- Zone des Chantiers: Walkers should use this path rather than the “Mail des Chantiers”. The lighting must be powerful and well-functioning, the supervision is used for failure detection.

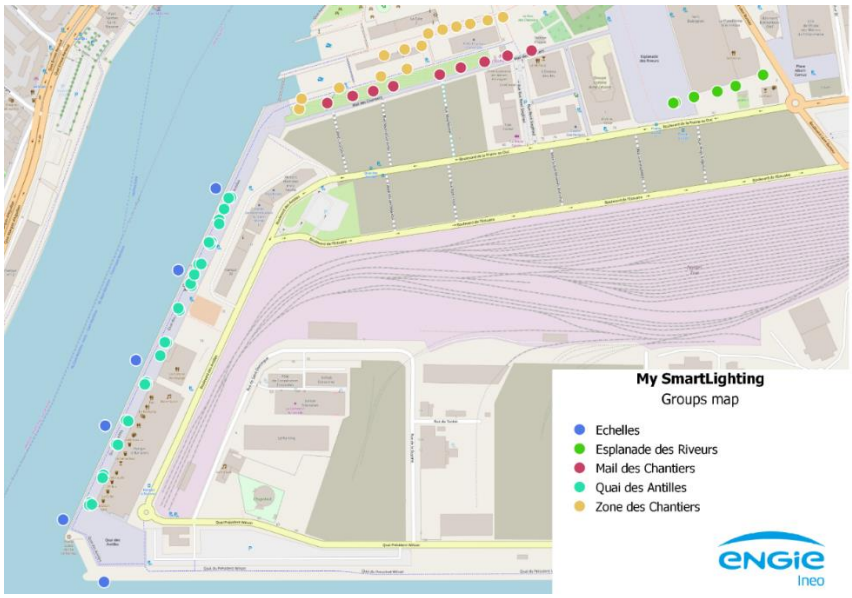

Figure 11: Intervention area

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Customers/beneficiaries segment

The city of Nantes acts as customer. Nantes operates lighting points in this area. Thanks to the supervision system, dimming schedules are programmed to reduce the light during a few hours in the night. It lowers energy consumption from street lighting and so reduces the city's electricity bill. The city is also the main user of the platform which enables to manage the street lighting by creating lighting groups or areas, programming dimming schedule, instantly switch on and off the lights, etc. The control system gives information as default or failure report. This data make maintenance easier to plan and realise. Indeed, the maintenance department does not have to ride around the area at night to find turned off luminaires anymore. It can plan and organise maintenance thanks to information provided by the system such as the number of failures, type, date, and localisation.

The main beneficiaries are Nantes inhabitants. Presence detection avoids inconvenience from outdoor lighting and adapt lighting power to usage needs. Thus, it decreases the light nuisance. As explained previously, time between default and repair is shorter. Then, the failure time is reduced, thus citizens and city users have a better quality of lighting.

Partners involved

The main supplier is FLASHNET who provides the entire system from electronic devices to the streetlight control software.

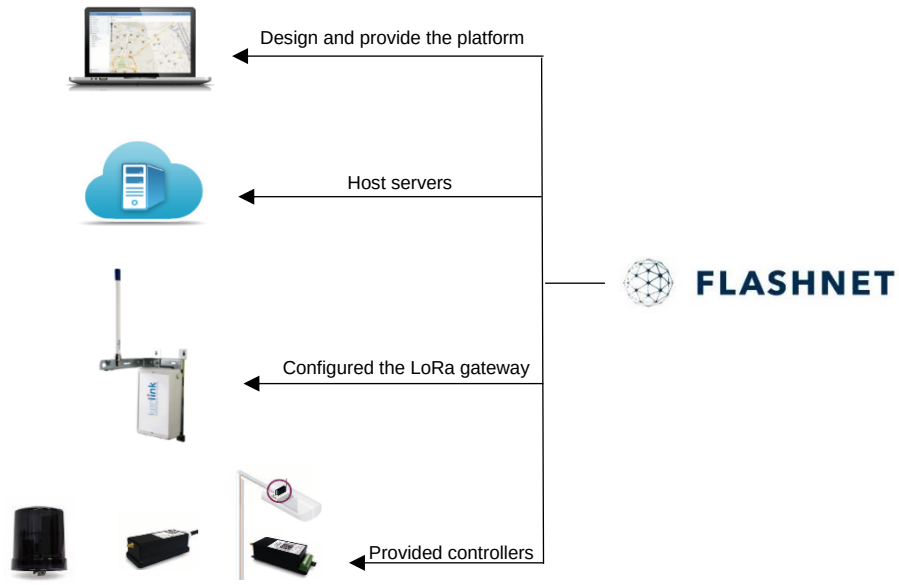

Figure 12: Services offered by Flashnet

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4.4.2 Business innovation

The intervention is based on the installation and use of a new product that adds the telecommunication and electronic technology to the existing street lighting system creating new functions such as remote management, real time monitoring, failure instant detection, etc., making the exploitation and maintenance easier by providing different ways of working. Therefore, it should be considered a product services innovation, which is one of the subtypes of the offering innovations. Regarding the degree of this innovation, it is clear that the product is the result of a sequential evolution, which means that we are in front of an incremental innovation.

4.4.3 Financing instruments

The solution can be financed by the reduction and saving of the energy bill and maintenance. As it has been already stated, supervision system also enables to do dimming on defined hours during the night and reduce energy consumption. Moreover, the maintenance is faster and can be planned easily. Thus it is another benefit. Additionally, savings on electrical consumption can be increased by installing LED technology.

4.4.4 Innovation drivers, main barriers and weaknesses

The main solution advantages are street lighting remote management for users, time saving, and efficiency increasing for the maintenance, expansion capacity to sensors and actuators for other domains.

On the other side, it is important to consider that installing a new technology requires a learning and experimentation time before being familiar with it. However, the hardest point was to make the client use new tools and work differently than he used to.

4.4.5 Takeaways

In order to install the right equipment in the good place and by integrating existing equipment constraints, the first step for deploying a remote system is the design of the solution with the operator team. The next important step is to train teams and support them in the use of these new digital tools. For the team, it is a new way of work and it could take time.

A part from that, as previously mentioned, the telecommunication network installed can be expended to other domains. Many more sensor types can be added, such as sensors for water, temperature, electrical contact, car traffic, etc. All data can be integrated to one supervision platform to centralise the management. The remote system could be connected to a hypervisor and the lighting system could be managed for new services and with others urban fields. For example, the lighting could be increased when the traffic is high.

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

4.5 Citizen solar projects – Support to citizen project of renewables (action 38)

4.5.1 Action description

The MIN, the wholesale market of Nantes Métropole, had to be transferred from the Island of Nantes to Rezé, a city in the South of Nantes Métropole, since a new hospital was about to be built on its initial location. New buildings with a huge roof surface were constructed.

Since the Métropole has set a list of energy targets to be reached by 2030 or 2050, such as 50% of local renewable energy by 2050 on Nantes Métropole territory, the implementation of solar power plants constitutes one of the main axes to be developed in the next years. Thus, a project of a solar power plant on the roof buildings of the MIN was launched. The project was split into two parts: a solar plant (5 MWp) that injects the energy produced into the grid and a second one (500 kWp) that is used in self-consumption for part of the cooling needs of the site. The latter is the one studied here; this 500 kWp-solar plant was funded and is now managed by citizens.

A first mobilization campaign took place at the beginning of 2018 to gather the citizens who will invest as shareholders and who will manage the project. Eleven citizens choose to join the project team. A fundraising was then set up to reach the required citizen investment, and the total citizen funds amount to EUR 140.000. The solar plant was installed during the year 2018, and it has been operating since the 2nd quarter of 2019.

Value proposition

This project has the benefit of addressing two issues: the development of renewable energy on Nantes Métropole territory as well as involving citizens in the energy transition, at a local scale. Thus, it is part of the answer to two commitments of Nantes Métropole's roadmap for energy transition.

The MIN buildings have a huge energy consumption, in particular for the cooling needs that are quite constant over the months. Thus, the new solar power plant will provide around 10% of the buildings cooling needs.

In the development of this project, a new company was created and supported by Nantes Métropole: Cowatt. Its goal is to help the development of citizen renewable projects and the MIN solar plant allows it to get good visibility and to develop itself. In this way, new renewable projects may be developed and managed by citizens in the area.

Customers/beneficiaries segment

This project also demonstrates how roofs, and especially big ones, can be used towards energy transition. This may also give the will to owners of huge buildings such as shopping centres or manufacturers to make their roof available for the installation of a solar power plant. This is also a way to promote a self-consumption project which is a subject that could interest various stakeholders involved in energy management: social housing landlord, other public institutions, developers, etc. Beyond that, it gives a shining example of what a citizen renewable project can be: it can give the will to other citizens to get involved in similar projects, and thus facilitate energy transition on the area.

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

Partners involved

The project was first impulsed by the building management department and energy department of Nantes Métropole. They launched the call for tenders in which the companies had to answer by including citizen funding for part of the project. The company selected was Armorgreen, which is specialised in renewable energy projects. The instructor service of the urban planning department of the City approved the project. Cowatt was the company that helped to found the group of eleven citizens that manages the solar power plant. Other citizens took part in the project as they participated in the funding of the plant.

Moreover, the project requested the involvement of three other organizations: SEMMIN, which is running the operation of buildings; the Energy Department of Nantes Métropole, which worked together with the Legal Department and the Public Procurement Department to write the different contracts, and Systovi, which is a local company that produced the solar panels.

4.5.2 Business innovation

Solar power plants on rooftops have already been implemented in many cities of France. Citizen solar projects have also already been implemented even if it stays a relatively new concept. In fact, the solar panels provider and the technological principle stay the same. Self-consumption projects are quite new even though they are becoming more numerous. However, linking these three elements into one and only one project is quite new.

For Nantes Métropole, this project is also new in the way that it is the first time that Nantes Métropole becomes a shareholder in an energy production project and that Nantes Métropole includes citizen investment in its project.

Thus, regarding the type of innovation, it seems that this is process innovation, which is classified among the configuration type. In terms of the degree, this project is the result of an incremental innovation.

4.5.3 Financing instruments

A simplified joint-stock company was created to manage the solar power plant, it is named MINàWatt. The shareholders of the company are the following (figure 9a):

- 65%: Cowatt: it gathers the eleven citizens of the project team as well as all the citizens that invested during the fundraising.
- 30%: Energie Partagée Investissement (a company limited by shares that allow citizens to invest in renewable projects; it is owned 90% by citizens and 10% by a fund for the development of citizen projects).
- 5%: Nantes Métropole; it is worth noting that it is the first participation of Nantes Métropole as a shareholder in an energy production project and the first integration of a citizen funding for Nantes Métropole.

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

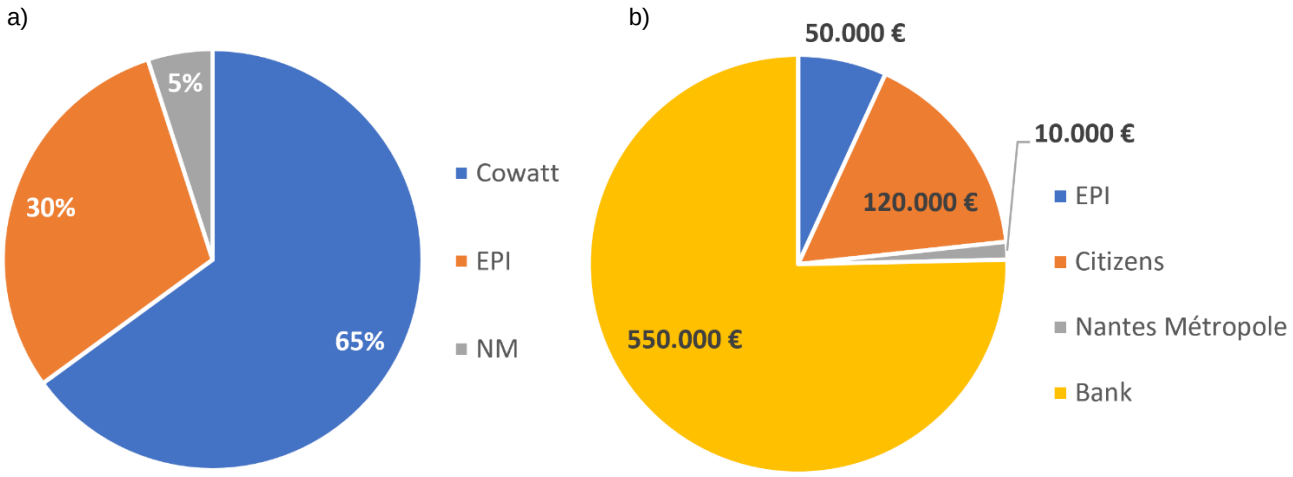

Figure 13: a) MINàWatt shareholders; b) Investors and invested amounts

The investment cost amounts to EUR 730.000, including studies, worksite management, supply and installation of all the equipment. The amounts are shared out as follows (figure 9b):

- Nantes Métropole: EUR 10,000
- EPI: EUR 50,000
- Cowatt: EUR 120,000
- Bank loan: EUR 550,000

A share MINàWatt represents EUR 100 and the citizens could choose the number of shares they wanted to buy. Investing in MINàWatt even with a single share provides access to its governance. Originally, the fundraising campaign was planned to start at the beginning of September and to end in early November, but the enthusiasm for the project was such that in 6 weeks the amount set for citizen financing had already been reached. EUR 120,000 were required to launch the project but a large number of financial contributions from citizens has made it possible to go beyond this amount. The choice was made to stop the fundraising campaign.

One of the shareholders of MinàWatt, Energie Partagée Investissement, also allows citizens to invest in the project. The latter is a company limited by shares that allows citizens to invest in renewable projects; it is owned by 90% by citizens and 10% by a fund for the development of citizen projects. Citizens choose to invest their savings in this kind of project through Energie Partagée Investissement, which then reinvests these funds in renewable projects (figure 10). These projects are chosen regarding their technical and economic relevance and their compliance with EPI charter.

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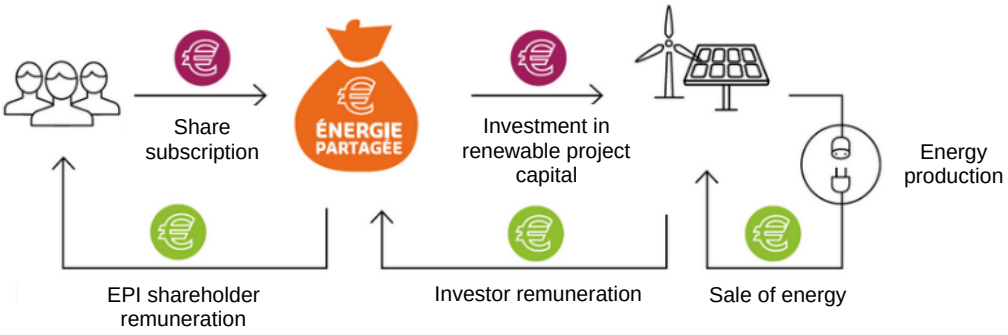

Figure 14: Energie Partagéne Investissement operational scheme

The citizens who invested in the project take part in the decision and management process: the governance is citizen-based. Thus, citizen engagement is not only financial but also shows a willingness to work, by devoting one's time, for the energy transition.

4.5.4 Innovation drivers, main barriers and weaknesses

Nantes Métropole is very involved in the energy transition, as its roadmap for energy transition shows it. In the latter, Nantes Métropole has taken 33 commitments related to energy transition; two of them are directly linked to renewable energies and the use of the rooftops in the Métropole. Moreover, for a public institution, the involvement of citizens is very important. Finally, it also answers to the increasing will of the citizens to get involved into the energy transition in meaningful projects and to choose and know where their money goes.

Regarding the technical aspect and the implementation, the installation involved additional expenses for the structure of the solar panels, which made the economic model less viable. The choice for the type of contract to be written was also an issue in the project. The legal frame in France made it more difficult to deal with and the interpretation of regulatory texts may be different according to who is reading it. Thus, the Legal and Public Order departments worked together with the Energy department of Nantes Métropole to find the most suitable way to proceed. The connection procedure was also the subject of delays since we were waiting for the local electricity distributor to approve it.

4.5.5 Takeaways

For this project, the citizen funding's were not an issue at all: the fundraising went well and was faster than expected. However, this should not be taken for granted. Indeed, this was one of the first citizens' projects on Nantes Métropole territory. Thus, the citizens that were already convinced by renewables and that wanted to involve themselves in energy transition responded easily and quickly. However, these people will not be able to rally around all the new citizen renewable projects that could emerge. Thus, the communication and mobilization plan around the future citizen's renewable projects should not be taken slightly.

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5. Hamburg's best practices

5.1 Introduction

The Free and Hanseatic City of Hamburg is one of the 16 states of the federal Republic of Germany. The city of Hamburg has a total population 1.787.408 inhabitants (2,6% of total population in Germany); thus is the 2th largest city in Germany by its population.

The population growth of Hamburg has been above the national average. The growth is due to a great extent to its dynamic economy and to the variety of available career opportunities, as well as the wide offer on education, leisure and culture, that attracts a big proportion of people from outside the city. In Germany, Hamburg is one of the federal states with the most energetic economic performance. Traditionally, Hamburg is Germany's largest trading centre. Accordingly, the logistics industry and companies involved in foreign, wholesale and retail trade, together with banks and insurance firms, are among the city's major employers. The media and creative industry is also an important source of employment. Furthermore, there are jobs in industry too, such as shipbuilding and repair and aircraft construction as well as in the chemical industry. The main sources of employment in Hamburg are financial and business services, followed by trade and transportation, hotel and restaurant business, information and communication. Hamburg's economy is still dominated by companies with names known around the world, such as Airbus, Beiersdorf, Hapag Lloyd, Helm, Olympus, Otto Versand or Tchibo. However, these big names should not vague the fact that the growing numbers of small and medium-sized enterprises are also attractive employers (Freie und Hansestadt Hamburg, 2017).

5.2 Smart Home Assistant (action 3)

5.2.1 Action description

A smart home solution will be installed in up to 100 flats operated by Bergedorf Bille, which is a local housing cooperative, in the Borough of Bergedorf. This solution integrates services for elderly people and services to control their energy consumption. It has been chosen the smart home system solution of the company "casenio" (figure 15), which is a very flexible "plug-in" system with a central data platform, optimized for the use of elderly people and offers different types of services such as:

- Smart living: intelligent light control, heating control, window control, functions for energy measurement, special functions when the person leaves the apartment.
- Security functions: protection against burglary, detection of water damages, fire detection, warning if the stove has been forgotten to turn out.
- Communication: pictures from relatives and friends direct on the central display and as separate project booking of assistance in every day live (via call back function).

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Figure 15: Smart home set from “casenio”

In this intervention is the last point the most innovative, because it connects a social component to the technical solution. Via the tablet, the tenants can order every day services like a help for shopping tours, a helping hand in the household or help by bureaucratic procedures with the municipality. These household helpers are trained and employed by “Sprungbrett Hamburg”, as a part of its activation activities for long time unemployment people. The aim is to keep the elderly people longer in their old apartments and their well-known area.

Value proposition

The advantages for the tenants (elderly people) are a gain of security in their homes from sensor as the stove control, window controls, help button etc. Further, they can get a better overview about the main energy consummators in their apartment and use services offered by the house hold helpers. The main goal is to keep the elderly people in their old apartments and familiar environment as long as possible, which is also a help for the relatives of the seniors.

Customers/beneficiaries segment

The customers are either the elderly people or their relatives installing the smart home assistant in their homes.

On the beneficiaries’ side, the first actor that takes advantage of this solution is the housing cooperative, which has a surplus of security for their apartments (building stock). Moreover, it can offer a new service for their members (marketing and social benefits) and, because of the reduction of movements, a decrease of relocation costs. The company “Sprungbrett Hamburg” is also a clear beneficiary because the household helpers are a new employment possibility for people outside of the regular labour market as part of their activation activities. The installed tablet offers a communication possibility to the elderly people. Finally, for the city of Hamburg, the advantage is the gain of social connections and it is a new approach to deal with some problems of the demographic chance in Germany towards an older society.

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Partners involved

The involved partners are the Borough of Bergedorf as the initiator. The housing cooperation “Bergedorf Bille” a local housing cooperative, with a huge housing stock in the Borough of Bergedorf, which offers the contact to the tenants (their members). The company “Sprungbrett Hamburg”, which will do the implementation of the system in the apartments and offer the households services as part of its work the field of activation and integration of unemployed citizens in the labour market. And the company “Casenio” for the technical support and deployment of the data and communication platform.

5.2.2 Business innovation

The company “Sprungbrett Hamburg” is establishing a new employment model and network of customers for their household helpers which will be self-sustaining in the long run, so it is a profit model innovation, inside the configuration type: The housing cooperation is the innovation to upgrade exiting (quite old) apartments with smart homes and an optimized use of energy in these apartments. Beyond that, the regular offer of social activities for the members of the housing cooperation will be extended with the household helpers. The quality of the care services of “Sprungbrett Hamburg” extended, so it is also an experience innovation, classified as service innovation. The Smart Home Assistant is a clear example of an innovation that combines more than one type of improvement.

Finally, it would be possible to add that the City of Hamburg, being involved in this project, introduces a structure innovation integrating people to the labour market reducing the unemployment rate.

All mentioned innovations are incremental. It is a combination of small innovations, regarding the communication between elderly people and helpers (basically phone calls) and the efficiency of apartments (they could be longer used, energy efficiency, security). The basic ideas and components are already existing, but the combination of the smart homes with a social part is innovative.

5.2.3 Financing instruments

The purchase of the first systems will be paid with funding of the mySMARTLife project (about EUR 1.500 per apartment). Only the installation of the stove control from an electrician is paid by the housing cooperative.

The training of the household helpers are paid with national labour market funding.

The hours of services for the elderly people could be paid by their insurance if they have care level 1[4]. Otherwise, they have pay for the services on hourly basis.

5.2.4 Innovation drivers, main barriers and weaknesses

The main driver of the innovation for the social pillar is the demographic development in Germany, which requests new approaches to optimize services for elderly people. For the technical pillar is the possibility to visualise energy

[4] https://www.alzheimer-europe.org/Policy-in-Practice2/Country-comparisons/2007-Social-support-systems/Germay

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consumption, automation of apartment infrastructure and the request for new digital communication methods (e.g. via smart phones apps) from the citizens a driver for the information.

For the housing cooperation is the main driver the offer of new services for their members and the reduction of movement costs.

The main barriers are the high starting costs for the purchase of the technical solution (covered by mySMARTLife) and possible fears to use the smart homes, because of a leak of technical experience with computers or smart phones by the elderly. The social services need a user density of about 50-60 apartments in a small area, to be financially self-sufficient.

5.2.5 Takeaways

Since the action has just started with the first information events (figure 16) and also the roll out of the systems, there is no experience with the technical solution until this point. However, it has shown, that the network between the different stakeholders and the integration of the social component, has been a very important point to start with this action in such a short time. A further mayor advantage is that the housing cooperation could offer the contact to their elderly members (more than 400 tenants had been requested in one month) via their established communication network. No “blind” advertising or acquisition had to be done and fears and barriers to get in contact with the project was needed.

Figure 16: Information event at a local community centre of the housing cooperation

A possible future evolution could be an extension of the area, where these services are offered. It is also possible, to integrate more sensors or functions to the smart home system. Furthermore, it is possible to offer more services (such as real nursing care services) via the integrated tablet. With the growth of the user community and with a

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planned acceptance study in mySMARTLife the system will be continuously improved. With new generations of old people the request for such smart home solutions will steadily rise and will be demanded as a standard service.

5.3 PV on roof and home battery storage (actions 5 and 7)

5.3.1 Action description

In mySMARTLife, Energienetz Hamburg (ENH) aims in action 5 (PVs on roofs) in conjunction with action 7 (home-batteries for self-consumption) to install photovoltaic systems on suitable roofs. These interventions promote the energy transition as well as climate and environmental protection through regional power generation with solar energy on existing buildings (without additional landscape consumption). The residents or (in trade) the users of the building can get a direct power delivery of the green electricity from their own roof at a low price. The electricity not directly consumed in the buildings is fed into the grid. As a smart solution to increase efficiency through a higher self-consumption rate and to relieve the public power grid, a battery for temporary storage will be integrated into the system.

ENH is a small company and so its activities are limited at the metropole region of Hamburg. In order to advance the Hamburg energy transition and to support the search for suitable roofs, ENH has initiated and co-founded an alliance called “Solaroffensive Hamburg”. The core of this initiative is an internet platform that enables Hamburg citizens to register their interest in a rooftop PV-plant. ENH contacts them and checks the suitability and conditions of the proposed roofs.

The budget for each installation depends on the size of the facilities (table 1). Most of the PV are in a range between 25 and 99 kWp. If it makes sense in terms of consumption and it is practical (space, connection options), an additional battery storage will be installed to increase the self-consumption rate in the building. The storage-capacity is based on the consumption profile and is between 5 and 20 kWh.

Table 4: Cost estimation

Component	Price per unit	Cost per component
PV-Plant	1,000 EUR/kWp	EUR 25,000 to 99,000
Battery storage incl. steering	900 EUR/kWh	EUR 4,500 to 18,000
Connection terminal box and metering concept		EUR 3,000
Other work e.g. cable trench		EUR 4,000
Overall		**EUR 32,500 to 120,000**

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The time for the implementation of a system varies considerably. The preparations, contract negotiations, and legal requirements take over most of this. The construction itself will be completed in two to three weeks. After that, there is still a waiting time for acceptance by the network operator and the connection. All in all, the projects need several months to be implemented.

Value proposition

The tenants or, in commercial buildings, the users can get real green electricity from their roofs at a good price. Moreover, they can participate on the energy change.

Customers segment

There are different types of customers. However, all of them related to building facilities:

- Tenants of residential buildings,
- Flat owners,
- Business organisations and other organisations,
- Social organisation like kindergartens, hospitals and other living and care facilities,
- Network operators by relieving the power grids.

Partners involved

The fundamental actor if the intervention is the cooperative and, especially, its members. They support the energy change and finance most of the facilities. However, it is possible to identify other actors that could play interesting roles in the process:

- Stromnetz Hamburg, which is responsible for the electricity connection and the questions about feeding into the public electricity grid.
- Architects and structural engineers to clarify structural requirements.
- The solar construction companies, which are in charge of buying the materials and implementing the panels on the roofs.

5.3.2 Business innovation

First of all, ENH proposes a configuration network innovation. ENH, as a cooperative, is standing on the shoulders of nearly 300 members that support the activities and finance of the organisation. ENH is also innovating in terms of offering, as it promotes a product system innovation, consisting of consulting, design, supply of electricity, and other complementary activities. Finally, in terms of experience innovations, ENH is also introducing a service innovation, which give tenants a way to well-priced green power and the customer engagement to become a member of the cooperative to participate on democratic organisation structure and energy change. This solution is a real example

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that it is possible to propose a holistic innovation, including in just one services the three main types of innovation: configuration, offering and experience, achieving excellent results.

Regarding the innovation degree, the ENH business is a lateral innovation. It does not look at citizens' energy supply from the usual big perspectives of the international market leaders, for whom only big projects are interesting. It starts from the small-consumer side and solves the energy supply with small local projects.

5.3.3 Financing instruments

The financing consists of the equity of the cooperative, consisting of the contributions of the members. Another pillar are subordinated long-term loans by members, supplemented by a share of secured by bank loans.

5.3.4 Innovation drivers, main barriers and weaknesses

The biggest motivator for innovation is the responsibility and the will to change energy as an important contribution to climate protection.

The acceptance of tenant power supply or direct power delivery is high by the tenants and commercial users of the buildings. Unfortunately, this does not apply to house owners, although many of them are convinced that it is necessary to protect the climate. Nevertheless, most are unwilling to commit themselves to a 20-year contract, thereby limiting themselves in possible future decisions (such as rebuilding). The financial benefit of the roof lease is too low. The low contribution margin for the operator of the PV system, however, does not allow a higher rewarding roof lease.

Unfortunately, this also partly applies to urban buildings. For these, the policy could impose a short-term policy checking the PV-suitability of all buildings to be used by citizens' initiatives or public agencies for PV-plants or solar heat. This would not only promote renewable energy without the investment of taxpayers' money but would also make the citizens more accountable.

A large part of the roofs is too old and must first be restored. As described in the case of retrofitting, it is difficult to motivate house owners to energetic renovations. Here, a nationwide combination of promoting roof renovation and making a contribution to the energy transition through photovoltaics would be a necessary support to accelerate the expansion of roof systems.

Unfortunately, the legal framework in Germany complicates the use of the abovementioned potential considerably. The bureaucratic hurdles and the regulatory jungle complicate and delay the implementation of projects. In addition, self-consumed electricity from own roofs for private small consumers is burdened with the EEG reallocation charge in Germany, while industrial bulk consumers (the large-scale polluters) are exempt from it. For economic reasons, this burden prevents the payment of a roof lease to the house owners and decreases the profitability down to inefficiency of a plant because the potential electricity rate is limited. This situation requires urgent legislative reforms that promote a fast and socially compatible energy transition.

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5.3.5 Takeaways

Although the importance of climate protection is slowly becoming clear to people, the willingness to accept possible restrictions (in this case for refurbishment, etc.) through long-term contracting is often low without rewarding financial compensation. Due to the legal and regulatory framework, the current profitability of PV plants is too low to pay for a significant roof lease. Many tenants of apartments and commercial real estate have great interest in green electricity from the "own" roof, but little influence.

In order to implement the use of solar energy in a broad front on all suitable roofs, clear requirements and obligations are required for the house owner, possibly supplemented by financial incentives. Politicians must show their will to act and set public institutions by example.

In the current situation, ENH can only advise house owners with a high level of environmental awareness and declare them the opportunity for PV systems without own investment in order to implement a solar concept on their building together with them.

5.4 Community car sharing (action 23)

5.4.1 Action description

The aim of the action is opening a Cambio Community Car Sharing Station on the premises of a local housing company, the Gemeinnützige Baugenossenschaft Bergedorf-Bille eG, in October 2019. This company is committed to install an electrically powered vehicle at this station in spring 2020 and documenting the development of corresponding KPIs. The station will be located on the tenant parking lot of the residential complex of the non-profit building cooperative Bergedorf-Bille eG at Binnenfeldredder/ corner Habermannstraße in 21029 Hamburg-Bergedorf with 2-3 parking spaces, and its cost is estimated around EUR 114,800 (table 5).

Table 5: Cost estimation/budget

Component	Cost (EUR)	Equivalent to EUR grant money
Direct personnel costs	EUR 52,800	EUR 36,960 (70%)
Other goods and services	EUR 38,500	EUR 26,950 (70%)
Indirect costs	EUR 23,500	EUR 16,450 (70%)
Overall	**EUR 114,800**	**EUR 80,360 (70%)**

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The kick-off event took place on the 26th of October 2019 and the delivery of the first vehicle was also in October 2019, which is a combustion engine. According to the experience and information from Cambio, the hurdle for the registration of a potential customer and the use of Car Sharing is lower and thus the success for a Car Sharing is greater, if in the first step vehicles with conventional drive type are available. Delivery of the second vehicle, which will be an e-vehicle (i.e. Renault Zoe), is expected in March/April 2020, partly because the delivery of the e-vehicle requires a certain lead time.

Bergedorf-Bille makes the parking areas available and has a charging socket with two connections installed, which will run via a separate electricity meter in the adjacent apartment building. Cambio delivers the vehicles to the station and the KPIs for the provision of the data on the Urban Data Platform to the project management mSL.

VHH plans and organizes the marketing activities together with Cambio. In the Info-Shop at the bus platform of the Bergedorf railway station it will be possible to register for Car Sharing on paper and to prove your identity with a valid driver's license. In addition, further possibilities will be sought in the immediate vicinity of the station. In addition, the vehicles are to be maintained and partly also maintained by Hamburger Verkehrsverbund (VHH). A corresponding agreement will be made between Cambio and VHH.

Value proposition

In the short term, through the cooperation of public transport and station-based Car Sharing, it will be offer to the inhabitants of the facility at the Binnenfeldredder/ Ecke Habermannstaße and its surroundings a solution to the problem of everyday life without their own car. In the medium and long term, the inhabitants of the plant and the surrounding area should be convinced step by step to abolish their private vehicle by means of a very good public transport connection and the station-based Car Sharing, thus making a significant contribution to the protection of the environment.

Customers segment

The main target is the residents of the Bergedorf-Bille. The area is served by 5 different bus lines, which are excellent public transport connections. The Bergedorf train station is about 20 minutes away on foot. This proximity to the centre and the lack of parking spaces for private cars favour the combination of public transport and station-based car sharing for the last mile. Moreover, it could be also possible to engage other residents of Lohbrügge within walking distance of the Cambio station.

The second target group is composed of public transport users. The combination of public transport and station-based car sharing finally offers a comprehensive mobility solution: for larger errands, furniture purchases or a weekend on the Baltic Sea. There is no need to keep a private car, if they can rent a Cambio vehicles.

Beyond that, there are other possible target groups, among which are those people who do not want to buy e-mobility but want to rent it, those who want to live more sustainably, or those who may want to abolish their private cars.

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Partners involved

This intervention involves 4 main partners: Baugenossenschaft Bergedorf-Bille, Cambio, the public transport companies Hamburg-Holstein and VHH.

- The Baugenossenschaft Bergedorf-Bille supplies both the parking spaces for the vehicles and the charging infrastructure for the e-mobile(s).
- Cambio supplies the vehicles and the registration facilities and is involved in marketing actions.
- The public transport companies Hamburg-Holstein, in conjunction with Cambio, is responsible for marketing, which will go beyond the monitoring phase to ensure successful operation of the car sharing station.
- VHH will clean and maintain the vehicles at regular intervals and carry out minimal maintenance.

5.4.2 Business innovation

Action 23 is another example that it is possible to merge different types of innovation in order to create a window opportunity on the smart cities market. In that sense, the VHH business model lies in a process innovation, which is classified among the configuration innovations, i.e. in the symbiosis of public transport and car sharing, to convince the residents in the vicinity of the car sharing station that life can be lived without a private car. Car sharing is therefore seen as a supplement to public transport. Through the combination of public transport and car sharing, two services are linked which can be of central importance for the development of new/revision of existing neighbourhoods or residential areas and their design, generation a product system innovation, which is one of the offering innovation types. In this way, roads and parking spaces can be planned much more economically in accordance with an environmentally friendly public transport offer in combination with car sharing and, for example, green areas or development areas can be planned more generously.

Furthermore, the Cambio's station-based car sharing system improves the residents' connection with public transport without having to maintain a private car, which represent a customer engagement innovation, inside the experience innovations, especially for those that want to become more eco-friendly and for those that cannot afford a private car.

Sharing economy is a term refers new approach for distributing goods or services among people, who do not need to buy assets to use them, they just must rent them when they have the need. Car sharing is part of this new economic current, and is just an evolution of it, so it could be said that in terms of innovation degree, the station-based car sharing is an incremental innovation.

5.4.3 Innovation drivers, main barriers and weaknesses

This intervention present three main driver. People are changing their habitats regarding mobility and it opens a window opportunity to deploy new proposals like car sharing. Doing it, as it is planned in mySMARTLife, VHH integrates car sharing in public transport providing a holistic public mobility for different needs. Finally, thanks to this intervention could be possible to reduce parking spaces in the streets, giving public space back to the public.

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

On the other hand, there are important barriers to tackle. Bureaucracy is one of the main barriers to overcome. In that sense, it is necessary to prepare a trade and craft insurance policy specifically for the transport of the car sharing vehicles from the car sharing provider (Cambio) by VHH workshop employees. It is also necessary to made an agreement with the car sharing vehicles operator (Cambio) and VHH regarding the cooperation. Moreover, as a public company, VHH is bound by tendering guidelines and has to tender the marketing campaign. This could lead to a delay of the marketing of the car sharing, because tender documents must be prepared, deadlines set and observed and bidders evaluated, before a contract can be awarded. Furthermore, the tendering of marketing services is difficult, since among other things creative work and ideas (intellectual property) are tendered here, which are not describable beforehand and for which an evaluation on the basis of facts and figures is hardly possible.

Finally, the consortium is also facing local obstacles. Regarding the physical location of the car sharing point are some restrictive for potential users at the moment. A large construction site is directly close to the site (construction of a roundabout) related to several traffic restrictions. This could lead to a mental barrier for possible first users of the car sharing.

5.4.4 Takeaways

The findings from combinations of local public transport with other mobility providers, here station-based car sharing, are intended to be incorporated into concepts that deal with the development and construction of new neighbourhoods and residential areas and the associated traffic equipment and connections in the traffic area of the VHH and beyond. VHH not only wants to make a contribution to urban development and in particular to climate protection with public transport, but also with tried and tested supplementary services that have been found to be useful in terms of the general welfare.

To achieve the main objective of this type of actions, it is important to consider the following ideas:

- The start of car sharing should not take place during a major construction site that causes emotional anger among passers-by and thus clouds the view for great solutions.
- The start of car sharing should not happen in winter, better in spring, when the weather motivates outdoor activities and travel.
- It is advisable not only to hope for tenants as users of car sharing, but also to convince local companies - experience has shown that private individuals rent vehicles (according to Cambio) in off-peak times and on weekends; if costs of car sharing can also be covered by companies that are active outside off-peak times (Mon to Fri 8-16 o'clock) and then use car sharing, the service life of the local car sharing offer will be extended or the offer can be extended.
- There are at the moment no guidelines for car sharing parking spaces within the urban land-use planning of residential areas. The housing companies have to develop it from scratch and have to be convinced to implement a community car sharing for their tenants. It should be a regular part of the mobility concepts of new town quarters and during the refurbishment of existing town quarters.

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6. Helsinki's best practices

6.1 Introduction

Helsinki is the capital of Finland and by far the biggest city in the country. The city has a total population of 628,208 inhabitants (11.5% of total population in Finland).

The Helsinki region produces almost one-third of Finland's gross national product. In late 2015, investments started to increase in the private sector, and 2016 saw a new upswing through construction and production investments. Yet, neither trade nor manufacturing have recovered to the same extent as, for example, construction and business services. Economic development is divided. Exports have lagged, and growth has been based on domestic demand only. Sales have declined somewhat in daily consumer goods trade, but for the rest, private consumption has started growing. The consumption of durable goods, in particular, has grown strongly. At the same time, the indebtedness of households has increased. (Teknologian tutkimuskeskus VTT Oy, 2017).

6.2 Viikki Environment House: Field-testing of a new Human Thermal Model (HTM) control concept (part of action 3)

6.2.1 Action description

A new thermal comfort control algorithm, HTM control concept developed earlier at VTT Technical Research Centre of Finland, has been field-tested at Viikki Environment House (figure 17). Aim of this field-testing action was to find out if such novel thermal control concept could improve thermal satisfaction of occupants.

Figure 17: Viikki Environment House (photo: mySMARTLife project)

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

The field-testing of HTM was conducted at Viikki Environment House between November 2017 and November 2018. During the reference period (November 2017-October 2018), temperature control was based on the original building automation system with manual adjustment of indoor temperature set-point temperature values, and during a HTM test period (November 2018), the existing control methodology was replaced by HTM control concept. This new thermal control methodology is based on the following parameters:

- Definition of individual body composition of test persons,
- On-line monitoring of thermal conditions in test rooms,
- Thermal sensation feedback given by test persons, and
- Autonomous adjustment of set-point temperature values of the test rooms.

Value proposition

The HTM control concept enables the room temperature to be automatically changed to a more comfortable level for those spending time in the room based on how they sense the temperature, fulfilling, occupants' individual thermal expectations. Consequently, better thermal satisfaction will evidently improve occupants' well-being, health and productivity, and demand-based thermal control of indoor temperature levels will improve energy efficiency of buildings by avoiding unnecessary heating and cooling.

Customers/beneficiaries segment

HTM control concept's end-users are occupants in different building types (offices, hotels, hospitals, schools, etc.), but building owners are actual decision makers for such services. Building owners can also benefit not only by better customer satisfaction, but also by better energy efficiency of buildings with HTM control concept.

Partners involved

Necessary partners for utilization of HTM control concept are building automation and control system (BACS) providers. HTM can be an additional feature of advanced BACSs, and it could be delivered to any building with a modern control system.

6.2.2 Business innovation

HTM control concept is an experience service innovation, and this innovation is developed to improve both thermal satisfaction of occupants and energy efficiency of buildings. This control system is a lateral innovation because it brings completely new features to thermal control of buildings. This is done by solving problems with individual thermal expectations of occupants implementing unconventional calculation methods in solutions of existing BACSs.

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

6.2.3 Financing instruments

HTM control concept (HTM Solutions) is accepted to VTT LaunchPad incubation program[5], and parallel commercialisation options are to be studied in 2020.

6.2.4 Innovation drivers, main barriers and weaknesses

According to Maslow's hierarchy, thermal satisfaction is one of humans' basic needs having evident impact on our health, well-being, safety, and productivity. Another fact is that there are significant differences between individuals in terms of thermal satisfaction, and VTT have developed science-based methodology to define optimal set-point temperature levels for individuals.

Along global climate change, energy efficiency of built environment needs to be improved. HTM control concept enables reducing emissions to environment by avoiding unnecessary heating and cooling of buildings and offering new tools for Demand Side Management (DSM) of community level energy systems.

According to the first field-testing results from Viikki Environment House, HTM control concept seems to be a promising new service solution to be commercialised. However, more field testing in different buildings types, under different climatic conditions, and with different occupant groups needs to be conducted before extensive utilisation of this new service solution.

6.2.5 Takeaways

Close collaboration between different actors (building owner, facility management, occupants, other service providers, and research organisation) is crucial for successful field-testing. Additionally, due to the testing results, HTM control concept can be implemented to business-to-business partners' existing BACS enabling fast market entry.

6.3 Demand management (EV charging points, Solar plant and storage) (action 27)

6.3.1 Action description

This section centers on Battery Energy Storage System (BESS), tested in Suvilahti (Helsinki). The studies performed in Suvilahti (Helsinki) have been focused in the different operations of the battery to gain more knowledge about the opportunities of the system. Thanks to that, Helen is capable to offer the battery as a service.

Suvilahti Battery Energy Storage System (BESS), which size is 1.2 MW and 600 kWh and has an installation cost of around EUR 1.400.000, has provided a research platform for Helen for three years since August 2016. The purpose of purchasing the battery was to demonstrate the multi-functionality of the battery and its technical capability to provide services for several stakeholders. The starting point was that the BESS (shown in figure 18) was first of its

[5] Source: https://vttlaunchpad.fi/

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kind. Even though the topic has already been much discussed in scientific articles, the applicability to different services was not yet proven in real terms. The local DSO Helen Electricity Network and Finnish TSO Fingrid participated in the “Suvilahti BESS research project” to learn the best practices from the operating environment, its limitations and how to make changes to the regulation.

Figure 18: Battery Energy Storage System (photo: Helen Ltd.)

In 2016 the installation of the battery energy storage system (BESS, 1.2 MW and 600 kWh) was complemented together with the implementation other technologies in the medium voltage network connection: a vehicle to grid (V2G) charger (10 kW, installed in 2017), a fast EV charger (50 kW, installed in 2018) and a PV power plant (340 kWp, installed in the rooftop in 2014, extended to the wall in 2018).

The main research questions were: how to provide ancillary services to transmission system operators (TSO), such as reserve power in frequency containment reserve for normal operation (FCR-N) market, how to implement peak power shaving and energy time shifting for the distribution systems operators’ (DSO) needs such as smoothing out PV production, shaving dynamic office electricity consumption loads and shaving the metro acceleration and braking peak power of the adjacent substation. The BESS also provided voltage control and reactive power compensation services to the local DSO during the research phase.

All of the studied cases have helped in defining the suitable business cases to Helen’s customers. Different customer segments have different needs, but it is typical that the battery is not fully utilized by the customer. Part of the time, the battery capacity could be used as reserve asset to provide services i.e. to TSO or maybe someday also to the DSO. The research has given insight into business models as how Helen offers the solution to its customers. Thanks to that, the Suvilahti BESS will start business operation in the TSO ancillary markets in 2020 (FCR-N, frequency containment reserve for normal operation).

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Value proposition

During the research phase, Helen has tested different operations of the Suvilahti battery. Business wise, operation in the TSO ancillary markets is the most feasible solution for the battery after the research phase has ended. The battery will support the operation of TSO via the ancillary market participation and provide frequency control services according to the market rules set by the TSO. The TSO ancillary markets operation is the best for Suvilahti battery. Suvilahti battery is a gird-scale battery and in the location, there is no need to store solar energy production, since the production of the PV power plant is fed directly to the gird. The electricity consumption in the gird connection point of battery + PV production + EV charging is negligible (only EV charging is consuming). Therefore, the customers of the services of Suvilahti battery are transmission and/or distribution system operators, since the battery can participate in the TSO ancillary markets and also provide e.g. reactive power compensation for the local DSO. Therefore, the Suvilahti BESS is different compared to batteries located in buildings, which main operations are to store solar energy production and/or optimize the electricity consumption of the building.

Currently, Helen offers services with three different business models of batteries for customers: customer-scale battery to a prosumer, virtual battery to a prosumer with PV, and a battery as a service. This section focuses on describing the third business model, battery as a service.

- Customer-scale battery to a prosumer: Helen offers a customer-scale battery (e.g. a 5 kWh Sonnen) to a prosumer (PV production at home). These customers want to maximize the use of own solar production and use the battery to store the PV production to use the energy in another time of the day. The battery answers the need to be able to utilize the own solar production and increase the utilization rate of the PV system to 90 %. With a virtual battery offered by Helen[6], the utilization rate of the PV can be increased to 100%.
- Virtual battery to a prosumer with PV production: For the customer's with PV production but no intention to invest in a battery, Helen offers virtual battery service. When the panels at customer's premises produce more energy than the consumption, the production will be saved to a virtual battery. In practice, Helen converts the surplus PV production to euros and gives these euros back to the customer. Without the virtual battery, the compensation of surplus energy fed to the grid is determined according to the spot price if the customer sells the surplus energy to the energy company. The spot price covers approximately one third of the purchase price of electricity. With the virtual battery, the customer can reach full utilization of the PV production economically.
- Battery as a service, personalized service according to the needs of the customer: In addition to the above-mentioned products, Helen offers service with a "battery as a service" - model to the customer. In this business model, Helen owns the battery and the customer has a ten-year contract and a fixed monthly payment. The technical solutions, e.g. size and model of the battery, are determined according to the specific needs of the customer. The customer can use the battery for example for the following operations:

[6] Source: https://www.helen.fi/aurinko/kodit/sahkovarasto-pientaloon/

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- Storing PV production if PV panels have been installed at the customer's premises,
- Peak power shaving (reducing the maximum power purchased from the grid in the building),
- Compensation of reactive power.

The contract of battery as a service also includes demand response operation. Helen can use the battery as a part of its virtual power plant and offer it to the TSO's ancillary markets to provide frequency regulation for the TSO. Helen can use the battery for this operation during the times that the customer does not utilize the battery for its own purposes. Typically, these times include:

- Bank holidays and weekends when the building does not have the normal operation (applies to i.e. office building),
- If the battery is used to store only PV production: the days during fall, winter and spring when the building consumes all of the produced solar energy.

As a case example, Helen has offered a battery as a service model to the customer, who has been interested to use the battery to optimize the operation of an office building. This customer has also multiple electric vehicle charging stations at the office, and therefore the battery will be used as a buffer to reduce the peak consumption. Battery plus EV charging stations bundle will reduce the power charge of electricity distribution tariff.

Customers/beneficiaries segment

The customers can purchase battery storage systems from Helen based on a 10-year contract with fixed monthly fee or with their own investment. This model includes a personalized service as it will be tailored according to the specific needs of the customer.

Helen's customers with a battery (own battery or battery as a service) can become a part of Helen's virtual power plant, which means that the storage solutions have built in capability to provide ancillary services to TSO reserve market with commonly agreed times. The possibility to participate in the TSO ancillary markets will give additional value to the customer, since the revenues received from the market operation will be shared between aggregator (Helen) and the customer so that the customer will receive higher share of the revenues. The revenue sharing between Helen and customer is decided case-by-case and it is dependent e.g. on the amount of available flexibility to be bid to the TSO ancillary markets.

Battery as a service model is targeted to a customer not willing to own the battery itself or to a customer, who is not allowed to own a battery due to regulation. In Directive 2019/944/EU article 36 states that a distribution system operator cannot own, develop, manage or operate energy storage facilities. The article 54 states that transmission system operators shall not own, develop, manage or operate energy storage facilities. However, the articles of EU directive 2019/94 also state that Member States of EU may allow distribution/transmission system operators to own, develop, manage or operate energy storage facilities in certain situations and if the energy storages are fully integrated network components. These certain situations include e.g. use of the battery for reliable and secure

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operation of the system. Therefore, TSOs and DSOs can use energy storages for the purposes of system operation. Therefore, the battery as a service has two main customer segments:

- Customers that are not willing to own a battery but to buy it as a service,
- Distribution and transmission system operators in Finland.

Partners involved

The partners involved are the energy company that is offering the service (Helen); customers willing to purchase the service; manufacturers of batteries; contractors (installation and maintenance); and the deliverer of the battery storage system.

6.3.2 Business innovation

The battery as a service model is an experience service innovation, since the innovation focuses on making the utilization of battery energy storage systems easier for the customers. The customer will pay a fixed monthly service fee and does not have to buy the device. The service will be personalized according to the specific needs of the customer.

The degree of the innovation can be seen as disruptive, since it represents a change in paradigm and breaks the pre-established model, where the customer had to buy a battery energy storage system. Therefore, it gives an alternative and new way for the customer to utilize the possibilities of energy storage systems.

6.3.3 Financing instruments

Helen is using its own financing to develop products and services in the batteries segment. If a customer chooses the battery as a service model, the customer pays a fixed monthly service payment to Helen for example for ten years.

6.3.4 Innovation drivers, main barriers and weaknesses

The battery as a service model suits the customer segment that is not willing to buy an own battery and prefers to buy it as a service. In the battery as a service model, Helen owns the battery and therefore is responsible of maintenance of the battery. Therefore, the model brings ease to the customer. The battery as a service model is targeted also to the DSOs and to the TSO in Finland that are willing to use a battery in certain location to support the operation of the distribution/transmission network.

The main barrier and weakness for batteries include:

- Battery technologies and recycling opportunities are still in development phase,
- High price,
- Legislations and possible slowness in decision making.

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6.3.5 Takeaways

During the research and piloting phase, the Suvilahti battery offered a research and development platform for Helen to test the operations of the battery in real environment. In addition, the possibility to actually present the Suvilahti "smart grid" area and tell about the results of the research phase has given added value to the conversations between Helen and customer segments. The Suvilahti battery and the results of the research project also give a concrete example about the expertise that the company has in the batteries segment.

In addition, during the research project in Suvilahti, the control and communication systems were tested and the battery was integrated to Helen's system. The limitations of the control signals of batteries were noticed. The pilot with Suvilahti battery gave knowledge on how to implement battery energy storage systems and how to integrate the batteries into Helen's existing systems while taking into account the possible future developments if the needs are changing. The research phase also offered knowledge of the capabilities of the batteries for the DSO and the TSO. For example, the TSO got knowledge about the capabilities and limitations of batteries compared to the rules of the TSO ancillary markets.

In the future, an overall service could be offered to the customers. This service could include e.g. EV charging stations + battery bundle or EV charging stations + battery + PV bundle. These service packages would be personalized according to the specific needs of the customer and would help the customer to optimize own consumption and production. However, the price of batteries should still decrease in order for the bundle of battery and EV charging points / PV production to become economically more attractive solution.

6.4 RES-AS-A-SERVICE Business Model development (action 33)

6.4.1 Action description

Helen's designated panels are an effortless way to become a solar energy producer: by renting a solar panel anyone can use renewable solar energy without own investment cost. The customers can rent a panel currently from three designated PV panels in Helsinki: Suvilahti, Kivikko and Messukeskus (figure 19).

Helen built the first solar power plant with the concept of designated solar panels in Suvilahti in 2014. The Suvilahti PV plant was the first solar power plant that offered designated solar panels in Finland. The business model was successful and there was demand to build second solar power plant with the same opportunity for customers to rent PV panels. In 2016, Helen installed the second designated PV power plant to the rooftop of Kivikko Arctic sports centre.

In 2018, Helen decided to invest in a third designated solar power plant after the success it had experienced with the first and the second solar power plants. The demand from customer's side has been high for a third designated solar power plant, since both existing designated panels, in Suvilahti and in Kivikko, were sold out in early spring 2019.

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Figure 19: PV panels at the rooftop of Messukeskus, in Pasila, Helsinki (photo: Helen Ltd.)

This section will describe the business model and implementation of a new designated solar power plant, Messukeskus, which main characteristics are summarized below:

- Location: Rooftop of Messukeskus, Helsinki Convention and Expo Centre in Pasila, Helsinki.
- Implementation of panels: Started in the end of May 2019 and done in two phases. The first phase was finished in the end of August 2019 with 1589 panels installed to the rooftop. The installation continued with the second phase and ca 300 panels are currently being installed in the rooftop of Messukeskus.
- Size of the PV plant after the installation of the first phase:
  - Number of panels: 1589 panels,
  - Power of solar panels: 500 kWp,
  - Estimation of annual production: 445 MWh.
- Other information: The installations have been done at the same time with the renovation of the roof of the building. Therefore, the timing to install solar panels was good.
- Budget: about EUR 400,000 and EUR 500,000 with the expansion.
- Business model: Designated solar panels

The designated panels are currently sold for a monthly charge of EUR 4.40. Helen will credit the electricity produced by the panel in accordance with the spot price. The production of the solar power plant varies with the seasons, but an average credit for a panel is about one euro per month, leaving approx. EUR 3.40/mth to pay on the panel (varies according to the production). The panel's production is deducted from customer's electricity bill[7]. Economic aspects

[7] Source: https://www.helen.fi/en/sun/homes/solar-power-plants/

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do not drive the purchase, since it does not give economic benefits. The driver is the easy access to take part in solar energy production and prevent climate change.

Customer can rent a PV through Helen's webpage[8] or through customer service. The customer can select the panel(s) from online reservation system. In addition, customer can view a figure illustrating the annual production of the PV plant as well as use live monitoring to see the power at the moment and produced energy during the day.

Value proposition

Helen's designated panels give an easy way to the customers to participate in solar energy production. Customers without possibility to invest in own solar power plant still have an opportunity to support solar energy production in Finland. From the aspect of the customer, designated solar panels are an easy way to support environmental friendliness and renewable energy production. Economic savings do not drive the purchase; the motivator is the climate awareness and an easy way to support renewable energy production.

Customers/beneficiaries segment

The designated panels are intended for customers who have an electricity contract with Helen Ltd. If an interested customer does not have an electricity contract with Helen, the contract is set up separately. The product is addressed to environmentally conscious persons, who are interested to participate in solar energy production and reduction of CO_2 emissions. In addition, companies have rent PV panels and therefore companies willing to support PV production are also a target group.

Partners involved

In order to be successful, the designated solar panels always need an investor and seller of the product (Helen), energy companion (owner of the property) and customers. All three are needed to implement the solar power plant and to produce local, renewable and emission free energy. The target group of designated solar panels are Helen's environmentally conscious customers.

In addition to the customers, investor and owner of the property, the following partners are needed:

- Manufacturers of the components of a solar power plant,
- Deliverer of the above mentioned components,
- Contractors (installation and maintenance of the PV plant),
- Permission from the City of Helsinki to build a PV plant in the location,
- Partners of technical planning of the PV plant (PVs, electrical engineering, structural engineering),

[8] Source: https://www.helen.fi/en/sun/homes/solar-power-plants/

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- Energy aid from Business Finland (20% from 1.5.2019[9]).

6.4.2 Business innovation

The designated panels represent an experience services innovation and experience customers' engagement innovation, since the innovation focuses on making the participation to solar energy production easier for the customers. The product offers an easy access to solar energy with a possibility to rent a PV panel. Therefore, the participation does not require investment cost from the customer's side.

The degree of the innovation can be seen as disruptive, since it represents a change in paradigm and breaks the pre-established model, where the customer had to buy PV panels to the own rooftop in order to participate in solar energy production. Therefore, it gives an alternative and new way for the customer to participate in solar energy production.

6.4.3 Financing instruments

The financing of the implementation costs of power plant comes from Helen Ltd. and a part of the investment cost is received from the energy aid of Business Finland. The energy aid of Business Finland for solar electricity projects in Finland was 25% until 30.4.2019 and 20 % from 1.5.2019.

After the implementation costs, Helen will receive revenues from selling the electricity produced by designated solar panels to the customers who have rented a panel.

6.4.4 Innovation drivers, main barriers and weaknesses

The driver of the innovation is the easy access to participate in solar energy production. The participation does not require investment cost, since the customers rent a panel from the PV plant. In Helsinki, the demand from our customer's side has been high for designated solar panels, since this was already a third solar power plant with the designated panels concept. During early spring 2019, both of the designated solar panels of Helen (Kivikko PV and Suvilahti PV) were sold out. Consequently, there was demand for a third PV plant offering the same possibility to rent PV panels. Therefore, the product has answered to the need of the target customer group. The drivers of the solution include also growing solar energy market and increased interest to participate in PV production.

The main motivations for Helen to implement three designated solar power plants in Helsinki have been to answer the needs of Helen's customers, to increase the share of solar energy production in Finland and to reduce the CO_2 emissions of electricity production.

From the perspective of the property owner, the main motivations for developing this new project have been responsibility, sustainability, reduction of CO_2 emissions and the possibility to participate in a solar energy project. In addition, the new solar power plant in the rooftop brings media interest to the property owner.

[9] Source: https://www.businessfinland.fi/en/for-finnish-customers/services/funding/energy-aid/

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In Helsinki, the business model of designated solar panels has been successful. However, the business model reaches the certain type of customers (environmentally conscious customers that are also willing to use some money to rent a PV panel and support solar energy production). The solution does not reach customers that are also willing to have the economic benefit and for whom the environmental friendliness alone is not a good enough reason to rent a PV panel.

The business model has been a success in Helsinki, but this does not guarantee that the same kind of success could be reached in other regions or in other countries. The success of the business model is a customer segment that is willing to rent a PV panel and participate in renewable energy production without economic incentive. Therefore, the successful implementation of the business model needs local knowledge on the customer segments and their needs.

6.4.5 Takeaways

With the experience of three designated solar panels in Helsinki, Helen has noticed great interest from the customers' side to rent PV panels. For the energy companion (who is offering the roof for installations) sustainability and responsibility are the main themes that are driving the cooperation and willingness to offer the rooftop for solar panels installations.

However, designated solar panels are targeted to a specific group of customers and it does not reach all customer segments. In that sense, the possible future evolution of the model could be to sell shares of the solar power plant to companies. This could be an alternative possibility for companies to participate in solar energy production if the company is not willing to invest in own solar power plant or in the case that it is not technically possible to install PV panels to the rooftop of the company's building. There is also an economical aspect in buying a share of a PV plant, since, on the contrary to renting a designated panel, it will pay back. In practice, this would mean crowdfunding of solar power plant (an energy company and other interested companies to invest in a share of the PV plant).

The evolution of the service also includes packing of different types of RES and energy efficiency services and solutions to answer the specific needs of the customer.

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7. Discussion about Business Models Innovation

Sections 4, 5 and 6 have described and analysed accurately the best practices in terms of business models innovation that mySMARTLife project is implementing in its lighthouse cities, Nantes, Hamburg and Helsinki, in order to explain what works and what does not work. The overview presented of the ten interventions, four in Nantes, three in Hamburg and three in Helsinki, provides an interesting contextual background for business models innovation in smart and sustainable cities, which will help other cities and enterprises when planning the deployment of city services.

In order to summarize the information already presented, table 6 and table 7 describe synthetically the most relevant concepts of each intervention. Table 6 shows the general features of the interventions, specifying the following: name of the intervention, acronym, city, leading company, type of company and field.

Table 6: General characteristics of interventions

Name of the intervention	Acronym	City	Leading company	Type of company	Field
Retrofitting in individual houses	RIH	Nantes	Engie	Private (multinational)	Energy efficiency
Digital Boilers	DB	Nantes	Nantes Metropole Habitat	Public (third party)	Energy efficiency
Lighting Optimization System	LOS	Nantes	Engie	Private (multinational)	Energy efficiency & ICT
Citizens Solar Project	CSP	Nantes	MINàWatt	People-public-private partnership	Energy efficiency
Smart Homes Assistant	SHS	Hamburg	Borough of Bergedorf	Public	Energy efficiency & social care
PV on Roof and Home Battery Storage	PVBS	Hamburg	Energienetz Hamburg	Private (cooperative)	Energy efficiency
Community Car Sharing	CCS	Hamburg	Hamburger Verkehrsverbund (VHH)	Public-private association	Public transport & EV
HTM control concept	HTM	Helsinki	VTT Technical Research Centre of Finland	Private (Ltd)	Energy efficiency
Demand management (EV charging points, solar plant and storage)	DMEVS	Helsinki	Helen	Public (third party)	Energy efficiency
RES as a service	RESasaS	Helsinki	Helen	Public (third party)	Energy efficiency

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Table 7 focuses on business model innovation giving details on the following aspects: acronym, value proposition, customers, type of innovation, degree of innovation, drivers, and barriers.

Table 7: Business model innovation features per intervention

Acronym	Value proposition	Customers	Innovation type	Innovation degree	Drivers	Barriers
RIH	Increase of comfort, decrease of energy consumption, and production of energy (thermal and electrical)	Occupants of houses	Offering – product system	Incremental	Climate change awareness, and energy transition going through energy savings	High cost - owners concerns, and low number of houses needing a holistic intervention
DB	Renewables integration and energy efficiency, reducing DHW needs and removing the air-conditioned of data centre rooms	Owners of buildings that needs DHW regularly	Offering – product system	Incremental	Climate change awareness and the increase of data centres	Supplying the right amount of energy and data/calculation management
LOS	Offer the right light in the right place at the right moment, graduating its intensity and reducing its consumption	Municipalities and big industries	Offering – product services	Incremental	Climate change awareness and remote management control, decreasing costs	Long learning and experimentation time
CSP	Renewable energy development through PV panels and involving citizens on it	Roofs owners	Configuration – process	Incremental	Nantes metropole commitment in energy transition	High economic expenses and complex legal framework
SHS	Increase elderly people's (tenants) security and better overview of energy consumption	Tenants of apartments and their relatives	Configuration – profit mode + Experience – service	Incremental	Optimization of services for elderly people and Climate change awareness	High starting cost and the need of having in small area 50-60 apartments for the social service
PVBS	Get real green electricity from their roofs	Private or public building owners	Configuration – network + Offering – product system + Experience – services	Lateral	Climate change awareness	Long-time contracts, low financial benefits of the roof lease, roof poor conditions and legal framework
CCS	Offer the possibility of moving without having an own car and promoting public transport	Residents of Bergedorf Bille	Configuration – process + Offering – product system + Experience – customer engagement	Incremental	Changes in the habits of people concerning mobility and integrating car sharing in public transport	Bureaucracy (agreements and tender) and local physical obstacles
HTM	Increase of comfort and indoor temperatures control, improving efficiency and avoiding unnecessary cooling and heating	Occupants and owners of different building types	Experience – service	Lateral	Climate change awareness and CO_2 emissions reduction	Few number of test with homogeneous type of occupants and climate conditions

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Acronym	Value proposition	Customers	Innovation type	Innovation degree	Drivers	Barriers
DMEVS	Battery as a service, where users can store PV production, peak power shaving and compensation of reactive power	People not willing to own a battery, and distribution and transmission system operators in Finland	Experience – service	Disruptive	Products as a service tendency and climate change awareness	Batteries are in developing phase, high prices and legal framework
RESasaS	People who cannot afford a power plan can participate and support solar energy production	Customers who have an electricity contract with Helen	Experience – service + Experience – customer engagement	Disruptive	Easy access to participate in solar energy production. It is not required an investment cost and climate change awareness	Replication strategies requirements need a deep knowledge of the local reality to understand customers desires

Business model innovation is to create or to redefine a business essence. It is about introducing new ideas and/or strategies in any of the elements defining a business model: the value proposition, the value chain, the resources used, the channel to deliver products or services, the costumers segment, the profit formulation, etc., with the aim of getting a good market share, taking advantage of an existing opportunity or creating new ones. As we have already seen, each company has a huge range of options when it wants to innovate its business model, and thus each organization decides how to approach it according to their feelings, studies, resources and possibilities.

Value proposition innovation focuses on developing a new way to meet the (new or old) needs of customers. Normally, those elements that are not valued by customers are declassified and those that they really value are enhanced. Comparing the different interventions presented in this deliverable, we can see that the innovations that mySMARTLife are implementing covers a vast spectrum. However, most of them are focused on improving the citizens' well-being, which is logical to some extent if we take into account that we are in a research project that is helping cities on their transit from traditional cities to smart and sustainable ones. In that respect, all value propositions showed a clear desire of creating a positive impact either on climate change mitigation or social welfare, or both things at the same time. Beyond these general and somewhat intangible values, the core value proposition of most of the cases is related to savings, and these savings can be economic, can be in terms of energy or in terms of time. It is also important to remark that, to some extent, in all the cases under analysis, energy has an important relevance, as much as the value propositions include energy savings, green energy production or emissions reduction. Climate change is one of the worst challenges that our society has to face, and organizations are pivoting their value propositions to tackle it. According to Ahvenniemi et al. (2017), cities should play a key role on protecting our environment, decreasing greenhouse gas emissions and improving energy efficiency. In that sense, buildings use 40% of all energy in developed countries (Gynther et al., 2015; and Liang et al., 2018), therefore, as International Energy Agency (2006) and Li and Colombier (2009), among others, state, several actions to reverse this situation should rely on improving the energy efficiency of buildings, as proposed in this project. Economic savings are usually

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linked to resource efficiency, which in the case of mySMARTLife project is basically again energy efficiency. It means that these innovations have to combine technological with business models improvements, which is not easy.

Another real challenge, in most cases, is the involvement of people, i.e. to integrate them in the definition of these new proposals. For doing that, one of the best tools is the co-creation programs. In that way, the Citizens Solar Project lead by MINàWatt is a fantastic business model innovation through a real people-public-private partnership. Nantes Métropole, with its commitment with the energy transition has played a crucial role on the development of this interesting scheme. Also, Energienetz Hamburg is presenting an excellent proposal involving roof owners on the production of renewable energy through PV panels.

Although, it refers just to one of the interventions, it is important to point out the community car sharing proposal, which will be sustained in the near future by electric vehicles. This value proposition is aligned with the European Commission strategy (European Commission, 2010a, b, c), which explicitly supports clean fuel transport. According to the International Energy Agency (2017), 90% of transport energy use depends on oil-derivative products. Therefore, any improvement, however small, deserves maximum support from the public administration.

Social value is just as important as economic value. Although we have stated that wellbeing improvement is present in almost all the interventions, it is particularly important for the case of Smart Home Assistant. This business model innovation, apart from increasing elderly people's security, connecting a social component to a technical solution, is employing long term unemployed people, who are being trained to accompany and help these elderly people.

Some of these value propositions are the result of close collaboration between companies or between companies and public authorities. Collaboration is a key success factor. Each organization contributes with its expertise, knowledge and resources, creating stronger services.

Concerning the customers' segment, most of the innovations target buildings' owners or tenants, who should afford important investments to finance the corresponding interventions. Although mySMARTLife project has reached its objective in terms of customers' engagement, this is one of the great challenges that organizations will face on the scale-up phase. High upfront costs (Ciulla et al., 2016; and Regnier et al., 2018) are a significant barrier that, combined with risk abrasion (International Energy Agency, 2017), makes the scalability complicate. In that sense, it is very interesting the RES as a service intervention proposed by Helen. This public company, aware of the fact that high costs are one of the main barriers for supporting these business models, targeting people who cannot afford a power plan but want to participate and support solar energy production. Renting panel to panel involves many Helsinki's residents in this project. This leads us to say a few words about the concept of "product as a service", which is a clear new business model. Through this idea, customers pay for the outcomes a product can provide them rather than the asset that produces it. This kind of ad hoc punctual "purchase" is done by a usage fee or through a leasing contract. The community car sharing is another clear example of this tendency. There is a clear consensus about the fact that past generations wanted to own, future ones just want to use, i.e. they just want to experience it.

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This statement about experience drives us directly to talk about the type and the degree of innovations. Table 8 presents an interesting picture of how each intervention combines these two concepts. It seems clear that companies have understood new tendencies regarding the desire of living and experiencing since more than half of the proposals (6 out of 10) focus their new business model on experience innovations. Inside this category, organizations have concentrated their efforts on the service subcategory, making their products easier to try, use and enjoy. Additionally, they also have paid attention to the customer engagement subcategory. Similarly, organizations have worked out on offering innovation. In this case, they have been centred on the product system subcategory, making their products/services more robust and interconnected. Enterprises have also worked on modifying the configuration of their products and services, but in this case, there is not a predominant subcategory.

Table 8: Structural categories of business model innovations per intervention

		INCREMENTAL	LATERAL	DISRUPTIVE
CONFIGURATION	**Profit model**	Smart Homes Assistant		
	Network		PV on Roof and Home Battery Storage	
	Structure			
	Process	Citizens Solar Project Community Car Sharing		
OFFERING	Product Performance			
	Product system	Retrofitting in individual houses Digital Boilers Lighting Optimization System Community Car Sharing	PV on Roof and Home Battery Storage	
EXPERIENCE	Service	Smart Homes Assistant	PV on Roof and Home Battery Storage HTM control concept	Demand management (EV charging points, Solar Plant and Storage) RES as a Service
	Chanel			
	Brand			
	Customer engagement	Community Car Sharing		RES as a Service

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Regarding the degree of the innovation, although Rohrbeck (2013) stated that the required business model innovations in sustainability need to be radical, table 8 shows that the majority of the new business models come from an incremental innovation process, which mean that they try to take advantage of previous products/services already in the market. This is because there has been a great social awareness regarding climate change in recent years, and many companies have been working since then on that. So, nowadays, we are getting the results from previous efforts. As a paradigmatic and excellent example of this value proposition incremental evolution is the Lighting optimization: gradation, rem management solution led by Engie. Beyond that, it is very remarkable that in public projects, which tends to be very conservative in terms of innovation, mySMARTLife presents two offerings developed through a lateral innovation and two others through disruptive innovation.

Generally, innovation, which is much linked to replication and scalability, business model included, relays on the resources and capabilities of the enterprises that want to develop them. Companies appreciate any help in this regard, especially small ones that do not usually have money to afford these processes. For this reason, it is essential that public administrations offer advantages, funds and grants to support these practices. At this point, we want to remark again − it has been stated several times in sections 4, 5, and 6 −, that the initial capital cost is one of the main barriers that these new approaches are facing, making their scalability and replication very difficult.

Finally, just to conclude this section, it is fair to remember that business model innovation can lead the creation of job opportunities, as we have seen in the case of the Smart Homes Assistant, but it is also true that other positions could decrease, as a consequence of the impact that these innovations will have on other sectors.

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8. Investment mechanisms for innovative business models

8.1 Introduction

As it has been remarked in previous section, one of the main barriers for business model innovation is the initial capital costs that companies have to face for implementing their solutions, particularly in initial phases. In order to provide some guidelines on this topic, this section presents different existing instruments form private sector and it also exposes the role public administration can play in this issue.

8.2 Private financing schemes

Innovative business models in the areas of energy, transport, and ICT for cities present a vast range of similarities with other business models, therefore it could be argued that raising funds for their financing is based on the same generic principles and models of investment financing as elsewhere in the economy. To do so, it is highly recommended to understand how private sector investment and financing decisions are taken. According to Nuñez et al. (2012), investments represent decisions to acquire assets, being real assets in the form of fixed and working capital or financial assets. The financing decision then concerns the question of how much capital the company needs to raise to fund the related operations, and what the funding mix should include. In that sense, firms can generate capital internally, through their own net operating cash flows, or externally through equity capital markets, bond markets or the banking system.

The financial system acts as a conduit through which the cash surplus of 'savers' is channelled to companies and government entities that need cash. The institutions and processes that facilitate the transfer of funds between the cash-deficit firms and the suppliers of capital constitute what is called the financial system (Hawawini and Viallet, 2007). The financial system operates through two alternative financing channels; these are known as direct and indirect financing.

Table 9: Contribution of partners

Direct financing	Contributions Indirect financing
Companies might opt for raising funds, obtaining them directly from savers by selling them securities[10] for cash.	Newly established firms and companies that are too small to issue a sufficient amount of securities to appeal to investors cannot directly access the financial market but through indirect or intermediated financing.

[10] A security is a certificate that specifies the conditions under which the firm has received the money.

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Indirect financing refers to alternative ways of raising funds. Examples of these could be found in commercial banks, insurance companies, pension funds, and/or venture capital funds. Depending on the size, profile, and potential to generate a return on investment companies strategy will differ. Delving into risk-sharing, companies seeking to leverage funding to carry on a need to be tailored to the interests of investors. Funding may also be gained from government budgets, investment agencies, but also from international institutions.

In the following subsections, we address the issue of financing innovative business models. We present the most relevant instruments: debt financing mechanisms, subordinated debt, and mezzanine financing, equity financing, social impact bond, green bonds, crowdfunding, leasing on innovation

8.2.1 Debt financing mechanisms

Debt financing refers to the acquisition of funds by borrowing: a lender provides capital to a borrower for a defined purpose over a fixed period. These can be loans or bonds, structured as recourse or limited recourse debt with full or limited guarantees. Loans can take several forms, but fundamentally, they are of two types:

1. Secured – the borrower pledges a specific asset as collateral, of which lender may take possession in the event of a default,
2. Unsecured – where there is no potential asset to take possession of in the event of a default; interest rates tend to be higher as a result.

Loans have three main elements: face (or nominal) value the amount of money owed by the borrower; interest rate (the cost of borrowing), which will be higher for riskier projects; and maturity (or tenor) meaning the term over which the loan is to be repaid.

Financing with recourse means that the company stands behind the project or venture and the related debt; the financiers can have a claim on the company's assets in the event of default. Financing with recourse is usually used by companies for core investment activities.8 However, they also frequently opt for the so-called limited or non-recourse financing depending on the characteristics of the investment (see project financing below). Debt instruments also include bonds, which are debt securities issued by companies or governments. They entitle the lender to recover the investment over a certain period (usually long term) with interest. Bonds provide the borrower with external funds to finance long-term investment. These are similar to loans but are simpler to trade. If bonds are issued by project companies to raise funding from the markets for a specific project on a non-recourse basis, they are often called 'project bonds'. EU Project Bonds are a financial instrument because they are enhanced by an EU/EIB-funded risk-sharing mechanism, to increase their credit rating. This reduces risks and the interest rate required by the investors to buy the bonds thus lowering the costs of capital for the promoters of the project. For investors, the strength of bonds is that these are classified as senior debt and are therefore the last financing source to cover the costs of any losses. This security is required, as bonds then have lower interest rates and long terms to maturity. A particularly interesting aspect of bonds is that they can be raised for a class of investment, a fund that is used to finance many projects, reducing the transaction costs of raising funds for single projects. Bonds are also easier to trade.

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Debt instruments may require some sort of a guarantee mechanism. In some cases, where risks are too high to attract private finance, guarantee programs/mechanisms (often publicly backed) could be provided for companies/projects to access debt financing. Guarantees can be applied in all phases of a project's development to improve both access and the terms of financial products that would be under-supplied if there were no guarantees (Rezessy and Bertoldi, 2010). There are some common guarantee structures available:

- Pari passu partial guarantees (e.g. the EIB and the Commission offer guarantees sharing the risks in parallel),
- Portfolio first loss and second loss guarantee (e.g. the European Commission takes the first loss up to a designated amount, followed by the EIB with a second loss if the amount is exceeded),
- Subordinated recovery guarantees (providing partial coverage of risk exposure against loans),
- Loss reserves acting like loss guarantees, and liquidity support schemes.

Guarantees have an important function to bridge the gap between the perceived risks and the actual risks, thus assisting beneficiaries in providing them access to finance, reducing their cost of capital, and expanding loan tenor9 and/or grace periods10 to match project cash flows (Rezessy and Bertoldi, 2010). In other words, they can overcome risk-related barriers in financing companies/projects.

8.2.2 Subordinated debt and mezzanine financing

Subordinated debt finance is capital that sits midway between senior debt (e.g. long-term secure bonds) and equity in the order of repayments i.e. level of seniority. Because it sits after the senior debt, it is considered riskier in terms of collateral rights and right to cash flow as senior debt holders have preferential rights to those. There are fewer sources of subordinated debt financing. It is usually obtained from insurance companies, subordinated debt funds, and finance companies, or it is raised with public offerings of high-yield bonds to institutional investors. Mezzanine debt financing has features of both debt and equity financing. It is considerably cheaper than equity (it does not involve forgoing control of the company) and also could help raise sufficient capital to meet the risk-return requirements of senior lenders. It is often considered a complementary or alternative solution to portfolio guarantees as it can reduce or substitute the amount of senior debt (Rezessy and Bertoldi, 2010), but it is less suitable for large projects with long terms to maturity.

8.2.3 Equity financing

Equity financing refers to the acquisition of funds by issuing shares of common or preferred stock in anticipation of income from individuals and capital gains as the value of stock raises. Equity is a residual claim or interest and the most junior class of investors in an asset after all liabilities are paid. Equity financing can come in the form of public listing or private equity (venture capital or growth capital).

There are different levels of seniority of equity and debt financing when it comes to the order of repayments. Depending on who is the lender and what are the agreements on the debt and equity, the finance for a company can

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be listed in the following order of repayment priority. The top form of financing needs to be reimbursed first and at the bottom, there is equity, which can only be paid once all other loans have been covered (if anything is left):

- Senior secured debt;
- Senior (unsecured) debt;
- Subordinated debt (mezzanine financing);
- Equity.

The financing architecture of a project, such as the share of equity financing and any risk-mitigating public support, needs to be measured according to the needs of potential investors. The risk-return trade-off has to be right. For each risk level, investors need a minimum return to participate, and the higher the risk, the higher the return needs to be. Either the risks are mitigated through financial instruments or the ratio of debt to equity has to be lower. Public equity with low interest can thus allow higher returns to be spread among private investors, improving their risk-return prospects.

8.2.4 Social Impact Bond

A Social Impact Bound (SIB) is a mechanism for the delivery of public services. It is a contract from the public sector to foster projects that generate verifiable social and/or environmental outcomes (Social Finance, 2018) regarding concrete target groups, areas and sectors. In general, a SIB frequently promotes projects to tackle social and environmental problems.

This contract is based on a public-private partnership that usually involve four types of stakeholders. The commissioners who are public bodies responsible for ensuring services. The services providers who delivered the services commissioned. The external investors who provide “upfront” capital for the realization of services in exchange for a commitment from commissioners to re-pay their initial investment plus a return if pre-defined outcomes are achieved. Specialist intermediaries who are often involved in developing the projects (Fraser et al., 2018). Under a typical model, the functioning implies that the governing authority contracts an intermediary to implement a social and/or environmental project in exchange for a promise of a payment contingent on the social outcomes delivered by the project. The intermediary will raise the capital for the project—hence use of the term bond—from commercial and/or philanthropic investors. It will then contract a service provider to deliver the project’s outcomes.

An example of a social bound are Green bonds. These can mobilize resources from domestic and international capital markets (investment) for climate change adaptation, renewables, and other environment-friendly projects. They are no different from conventional bonds, their only unique characteristic being the specification that the proceeds be invested in projects that generate environmental benefits. In its simplest form, a bond issuer will raise a fixed amount of capital, repaying the capital (principal) and accrued interest (coupon) over a set period of time. The issuer will need to generate sufficient cash flows to repay interest and capital (Galitopoulu and Noya 2016). To this regard, a SIB tends to be a risk investment. The reason is that the projects based on this term do not follow the

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financial logic of a bond (Fraser et al., 2018). The return is contingent on the outcomes. If the project fails to deliver, the governing authority does not pay and the investors will lose part or all of their capital. If the project is successful, the governing authority pays the intermediary and investors.

8.2.5 Green bonds

A green bond, also referred as climate bond, is a bond used for environmental projects. It is constructed quite similar to a conventional bond, but the purpose of financing and use of proceeds are different (Lindberg, 2018).

This financial instrument is rather new - first green bonds were from 2007/2008 -, which invests exclusively in green projects generating climate or other environmental benefits. It is a green instrument on the debt market to increase sustainable investing. A climate bond is designed as an intermediary between wholesale investors and desirable low-carbon investment projects such as clean transportation, energy efficiency, or sustainable waste management (Deutsche Bank 2018; Mathews and Kidney, 2012). Green bonds have to go through third-party verification providing the certainty that the raised funds are financing projects generating environmental benefits.

The needed requirements for recurring to green bonds are the following: (1) a regulated capital market to oversee the issuance of debt; (2) sufficient liquidity of the market; (3) financial strength and creditworthiness of the issuer; (4) consistent income has to be generated by the project and dividends distributed in the form of coupons at regular intervals.

In general, green bonds could be an attractive investment because they bring tax incentives such as tax exemption and tax credits. It is a monetary incentive to attract investment in these type of project, which tackle social and climate issues.

The market of bonds with a green label started with the European Investment Bank's "climate awareness bond" issued in 2007 (Ehlers and Packer, 2017). The market has grown rapidly but still very small compared with wider global bond market.

8.2.6 Crowdfunding

Crowdfunding is a new source of financing which have had a rapid expansion in recent years. One of the main reason regards to the fact that many new firms face difficulties in attracting external finance during their initial stage (Belleflamme et al. 2013). To tackle such problems, firms search for a different type of investor, a "crowd" investor rather than a specialized investor. So, at the end, the objective is to collect money for investment from a wide range on little investors and small amounts of investment tickets. Furthermore, it is a joint effort of citizens who raise funds to support initiatives promoted by other people or organizations, not just firms.

Four models of crowdfunding have emerged: (1) donations-based where the crowdfunder donates funds without expecting any return; (2) rewards-based, hence the crowdfunder transfers funds with the expectation of a reward, which may be in the form of a token gift or an early/exclusive release of a product or service offered by the startup

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company; (3) lending-based or Peer-to-Peer (P2P) in which the crowdfunder lends money to individuals or companies in return for interest; and (4) equity-based based on equity purchases in a company.

According to the Cambridge Centre for Alternative Finance (2017) resorting to crowdfunding is recommended in only four scenarios: (1) lack of legislation. In some instances, generic provisions that protect investors may apply; (2) intermediary/platform regulation–controls are established on some forms of crowdfunding—e.g. equity and lending—with registration and other governance and reporting requirements; (3) banking regulation–lending and equity platforms are considered banks, requiring a banking license for certain crowdfunding operations; and (4) Two-tiered regulation–crowdfunding platforms are monitored at the federal level along with state-level agencies.

Social networks as well as online communication are the channels throughout raising funds is conducted. Crowdfunding emerged from innovation in technologies that made it possible for businesses, NGOs and individuals to secure funding with no or limited intermediation.

8.2.7 Leasing on Innovation

The leasing practice is a rental contract that incorporates a purchase option in favour of the lessee to exercise at the end of the contract. During the contract, the lessee has the right to use the asset and pays a rental charge to the lessor who owns the asset (Blumberg and Marin, 2004).

Nowadays, leasing is becoming a great option among firms and clients as a new way to sale and buy. In fact, leasing has gain ground compared to traditional ways of buying such as cash or debt (Innovation Credit Union, 2018). The principle reason for this business practice focus on the shift of clients' values and behaviours from ownership towards usage or sharing (Asset Finance International, 2018).

From an innovation perspective, the key aspect is that business does not rely anymore in ownership rather in using the equipment. In this regard, the return of investment focus in the usage rather than ownership. This is a great opportunity for the leasing sector.

One of the main reason for these trends relies in the fact that as the speed of innovation increases, the useful lifespan of a company's technology and equipment decreases inversely (Coretech, 2016). To this end, paying only for the useful life of the equipment represents an advantageous from an efficiency and technological perspective. Moreover, from a financial perspective, leasing enables to maintain cash on reserve, pay nothing for upfront costs, and translate requirements to monthly of annual expense.

8.3 The role of public governments

Public procurement is a process by which public agencies buy jobs, goods and services from companies. Public procurement from OECD (2016) represented 12% of GDP and 29% of public spending.

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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 a higher quality, sustainability or innovation.
- Professionalizing public buyers as they often lack the required business skills, technical knowledge or procedural understanding.
- Increasing access to procurement market to small- and medium-size 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.

A key element that can be very useful is the public procurement of innovation (PPI), as it emphasizes the shared visions of the departments that are committed from the beginning of the project to work with the chopped agents. In this sense, public agents play a key role in accelerating the innovative ecosystem. In addition, public agents demonstrate today that we must give much more weight to initiatives with sustainability and innovation objectives through public procurement. In this sense, the public administration acts as an agent of change.

This financing instrument provides benefits and advantages for both actors involved in smart city environments. At the strategic level, it can help governments accelerate innovation in local, regional and national contexts, as well as improve productivity and inclusion. In addition, it helps with urban growth and the improvement of citizen welfare. On the other hand, it promotes the internal capacity of private suppliers and increases their export potential (European Commission, 2016).

In conclusion, public procurement is one of the most liquid financing practices and the PPI can be considered as an update of traditional public procurement processes as it focuses on an open and collaborative market. This is a good practice to plan and develop smart cities as it presents agile implementation models and creates important synergies and resources.

Beyond that, governments are able to design expenditure/investment programmes in order to respond to investment needs and respond to market barriers and market failure. This can take the form of traditional grant support schemes, technical assistance, soft loans and other forms of financial instruments (including debt and equity).

Grants are a traditional form of support, which do not normally require repayment. They are often used to support high upfront costs for some projects or basic research. Grants can increase the financial rate of return on investment and leverage additional resources through requirements on co-financing/matching funds.

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Soft loans is a newly instrument used by governmental institutions and agencies. Its main characteristic is flexibility. Based on extended payback periods, low or zero interest as well as short-term interest deferral periods, if necessary can also include a payback grace period. This allows companies to assume a higher risk of failure when presenting a disruptive business model.

Revolving funds are those loans offered to be repaid with revenue earnings. This same revenue earning can be reinvested in the same geographical area for new projects. Companies (and more concretely, SME) are recommended to make use of revolving funds when their liquidity is limited or scarce.

8.4 Other type of resources: Energy Performance Contracting (EPC)

The Energy Performance Contracting (EPC), through Energy Service Companies (ESCOs), is a form of 'creative financing' for capital improvement which allows funding energy upgrades from cost reductions. Under an EPC arrangement an external organization (ESCO) implements a project to deliver energy efficiency, or a renewable energy project, and uses the stream of income from the cost savings, or the renewable energy produced, to repay the costs of the project, including the costs of the investment. Essentially the ESCO will not receive its payment unless the project delivers energy savings as expected (E3P Team, 2017).

The approach is based on the transfer of technical risks from the client to the ESCO based on performance guarantees given by the ESCO. In EPC ESCO remuneration is based on demonstrated performance; a measure of performance is the level of energy savings or energy service. EPC is a means to deliver infrastructure improvements to facilities that lack energy engineering skills, manpower or management time, capital funding, understanding of risk, or technology information (E3P Team, 2017).

Within the framework of smart cities, one of the main problems of this instrument is the proportion of solid guarantees for banks. Banking institutions offer loans for initial investments of these projects in which savings are easier to forecast and quantify. On the contrary, projects in which it is more difficult to forecast, for example in the construction industry, are more difficult to quantify and it is difficult to obtain initial capital from banks. This is also more complicated for the smaller residential sector, with high transaction costs and lower liquidity. On the other hand, these companies have a very specialized knowledge of this type of projects and can play with a good portfolio of projects to distribute risks and establish cost recovery mechanisms. It must also be taken into account that ESCOs combine public financing instruments with private investments. This is important because these companies can obtain very favorable conditions and guarantees.

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9. Conclusions

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

- Business model innovation is a key aspect to impulse the transition from a traditional city to a smart one in order to promote a sustainable future in terms of environmental protection as well as social inclusion and financial viability. As depicted from the analysis, innovation goes far away from traditional conceptions focused on technologies, and it implies new ideas or strategies in any of the elements defining a business model. In this regard, we recommend looking at section 7, Table 6, 7 and 8 with grouped comparative information about interventions characteristics, business model innovation features and types and degrees of innovation.
- The value propositions of business models show a desire of creating a positive impact either on climate change mitigation and/or social welfare. These is a clear need for cities to become smart and sustainable in the fields of energy efficiency, mobility, and ICT. A common path in value propositions focuses in savings, which can be economic, energetic or temporary. Due to the nature of the project, energy has an important relevance in the formulation of value propositions and include energy savings, green energy production or emissions reduction.
- Besides the economic and environmental value mainly focused in savings and efficiency, it is important to point out that the value propositions clearly improve citizens' well-being. As an example, the Smart Home Assistant intervention in Hamburg is quite representative about this improvement and presents a high social value because increases elderly people's security and it employees long term unemployed people. In this regard, it is clear that benefits of the interventions are greater than the cost of producing them.
- The success of many interventions relies on how business models deal with challenges. In many of the energy efficiency interventions, challenges regard to customer engagement due to participation or investment. Regarding participation, we find a great business model innovation within the Citizens Solar Project lead by MINàWatt in Nantes Métropole. The project presents a real people-public-private partnership, which clearly helps governance, and it is based on a co-creation program, which involve citizens - customers - along the project. Also, the PVs on roofs lead by ENH presents an interesting proposal to involve roofs owners on the production of renewable energy through PV panels.
- Regarding investment, high upfront costs - especially in retrofitting projects - are significant barriers to develop and scale-up projects. In this sense, it is interesting the RES as a service intervention presented by HEN in Helsinki. This public company overpass the barrier on high costs by renting panels through an interesting idea based on the concept of "product as a service". This is a new business model where customers pay for the outcomes a product can provide them rather than the asset that produces. New values pay attention on use rather than in ownership.

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- The types of innovation from cities, organizations and companies mostly focus their new business models in experience and offering. Regarding experience, they concentrate their efforts on the service, making their products easier to try, use and enjoy, and customer engagement. On the other hand, regarding offering, they focus on the product system, making their products/services more robust and interconnected.
- The degree of the innovation of the new business models majority focuses in an incremental innovation process followed by lateral and disruptive as shown in Table 8. This means that innovation takes advantage of previous products and services already in the market. In this sense, innovation often comes from experience and relays on the resources and capabilities that organizations have to develop them. Many innovative elements are already present in business models, but as mentioned above, investment represent an important barrier to scale-up and replicate them.
- To sum up, the EU, national authorities and municipal governments have the responsibility to set up the conditions for business model innovation and help stakeholders to overcome the important barriers to implement, scale-up and replicate them. As depicted from the analysis, innovative elements in governability, customer engagement, collaboration or investment have a clear impact in the success of the intervention and contribute to achieve smart and sustainable goals. Nonetheless, it is essential that public organizations keep offering advantages, investment, soft credits, funds, grants, etc. to support innovation in business models, which promote a sustainable future in terms of environmental protection, social inclusion and, financial viability.

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