RENEWABLE INTEGRATION & SUSTAINABILITY IN ENERGY COMMUNITIES

D3.1 – BENCHMARKED BUSINESS CASE REPORT PHASE 1

Pilar Meneses (IKERLAN), Aitor Milo (IKERLAN)

Document Number	D3.1 phase 1
Document Title	Benchmarked business case report phase 1
Version	1.0
Status	Intermediate deliverable
Work Package	WP 3
Deliverable Type	Report
Contractual Date of Delivery	31.05.2020
Actual Date of Delivery	12.05.2020
Responsible Unit	IKERLAN
Contributors	Maria Luisa Lode (VUB), Pilar Meneses (IKERLAN), Aitor Milo (IKERLAN), Hans Bludszuweit (CIRCE), Giourka Paraskevi (DUTH), Maarja Meitern (BAX), Valentina Zea (BAX), Thierry Coosemans (VUB)
Keyword List	Business models, benchmarking, local energy communities
Dissemination level	PU

This project has received funding from the European Union's H2020 research and innovation programme under the grant agreement No **824342**. This document reflects only the author's view and the Commission is not responsible for any use that may be made of the information it contains.

RENAISSANCE Consortium

RENAISSANCE "Renewable Integration & Sustainability in Energy Communities" (Contract No. 824342) is a Collaborative project) within the H2020-LC-SC3-2018-2019-2020/H2020-LC-SC3-2018-ESSCC. The consortium members are:

1	VUB VRIJE UNIVERSITEIT BRUSSEL	VRIJE UNIVERSITEIT BRUSSEL (VUB) 1050 Brussels, Belgium	Contact: Thierry Coosemans thierry.coosemans@vub.be
2	AtoS	ATOS SPAIN SA (ATOS) 28037 MADRID | Spain	Contact: Javier Valiño javier.valino@atos.net
3	ikerlan	IKERLAN S COOP 20500 MONDRAGON | Spain	Contact: Aitor Milo Urkiola amilo@ikerlan.es
4	deepblue	DEEP BLUE Srl (DBL) 00193 ROME | Italy	Contact: Alessandra TEDESCHI Alessandra.tedeschi@dblue.it
5	ingeniería everis	EVERIS ENERGIA Y MEDIOAMBIENTE SL (EXE)	Contact: Miguel Fontela Miguel.Fontela.Martinez@everis.com
6	oca MANZANEDA ESTACIÓN DE MONTAÑA	ESTACION DE INVIERNO MANZANEDA SA 32780 A POBRA DE TRIVES | Spain	Contact: Gustavo Samartín direccion@manzaneda.com
7	circe RESEARCH CENTRE FOR ENERGY RESOURCES AND CONSUMPTION	FUNDACION CIRCE CENTRO DE INVESTIGACION DE RECURSOS Y CONSUMOS ENERGETICOS 50018 ZARAGOZA | Spain	Contact: Andreas Munoz renaissance@fcirce.es

Horizon 2020
European Union Funding
for Research & Innovation

8	DIMOKREITIO PANEPISTIMIO THRAKIS 69100 KOMOTINI | Greece	Contact: Pantelis Botsaris panmpots@pme.duth.gr
9	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS 57001 THERMI THESSALONIKI | Greece	Contact: Nikos Nikolopoulos n.nikolopoulos@certh.gr
10	BAX INNOVATION CONSULTING SL 08013 BARCELONA | Spain	Contact: Maarja Meitern m.meitern@baxcompany.com
11	SDM-PROJECTS 3090 OVERIJSE | Belgium	Contact: Ellen Vanderdood vanderdood@sdme.be
12	NARODOWA AGENCJA POSZANOWANIA ENERGII SA 00 002 WARSZAWA | Poland	Contact: Andrzej Wiszniewski awiszniewski@nape.pl
13	ABB OF ASEA BROWN BOVERI 1930 ZAVENTEM | Belgium	Contact: Luc Picard luc.picard@be.abb.com
14	SUNAMP LIMITED EH33 1RY MACMERRY | United Kingdom	Contact: Tianyue Li tianyue.li@sunamp.com
15	GEMEENTE EEMNES 3755 ZH EEMNES | Netherlands	Contact: Wilma de Boer w.deboer@Eemnes.nl

Horizon 2020
European Union Funding
for Research & Innovation

Document change record

Version	Date	Status	Author (Unit)	Description
0.1	24/07/2019	Draft	M.L. Lode (VUB)	Draft
0.2	28/08/2019	Draft	H. Bludszuweit (CIRCE)	Draft revision, General document formatting
0.3	18/12/2019	Draft	P. Meneses (IKERLAN)	Draft (BM classification and benchmarking)
0.4	27/01/2020	Draft	P. Meneses (IKERLAN)	2nd Draft (BM classification and benchmarking)
0.5	03/04/2020	Draft	P. Meneses/Aitor Milo (IKERLAN)	3rd Draft (Demo-sites BM description)
1.0	12/05/2020	Final version	P. Meneses/Aitor Milo (IKERLAN)	Reviewed version ready to submit

Horizon 2020
European Union Funding
for Research & Innovation

Executive summary

Energy regulation changes in Europe are contributing to the transition towards a more sustainable, democratic and end-user centred energy system. In this transformation the integration of RESs (Renewable Energy Sources) and DERs (Distributed Energy resources) will play a main role from the energy generation point of view. But this transition goes beyond the energy sources itself, a new paradigm of economic relations between energy systems actors is emerging where the communities and the development of new BMs (Business Models) will have an important role.

Energy communities will be the scenario to develop the bottom-up energy system transition where the members of the community will be able to manage the relationship between them and with other communities or transfer this role to a third party to operate on behalf of them. These relationships will be managed by new business models based with not only economic, efficiency and environmental criteria but also with social, solidarity and equality ones.

This deliverable provides a global perspective of the potential business models for the existing local energy system configurations through a comprehensive literature review, mapping and benchmarking.

The report aims to provide an overview of the innovation of sustainable business models on the overall ecosystem and examples of new business models. An identification process of business models, activities and actors in the local energy communities' framework is accomplished. A benchmarking of five (5) potential BMs for LEC implementation based on KPI defined in T2.3 is presented. In addition, in this document, a description of the BM and markets that potentially could be developed in each of the RENAISSANCE project demo-sites is provided.

Horizon 2020
European Union Funding
for Research & Innovation

The present document is the first version of the deliverable, providing the European perspective. A second version will be delivered M34 by VUB, including international perspective.

This document is divided in four main sections:

- **Chapter 2- Business Models**: In this chapter the BM general concept is described. The BM representation and the relationship among traditional BM's actors are presented.
- **Chapter 3 - Business model ecosystem**: In this chapter specific BMs at Local Energy Community level are described. Several BMs are presented from the configuration, technological, experience and financing perspective. Finally, different generic BMs canvas for LEC are presented.
- **Chapter 4 - Overview of the potential business model**: Considering the previous analysis developed in chapter 3 and the KPI criteria defined in D2.3 - KPI definition and Selection -, in this section, a benchmarking of five (5) potential BMs for LEC implementation point of view is described.
- **Chapter 5 - Overview of the demo-sites BM**: In this section a detailed identification and description of potential BMs for each RENAISSANCE demo site is presented. Actors identification, energy service operation description and related BM canvas for each service are provided.

The main outputs of this first version are the energy services and the BM related to these services for each RENAISSANCE demo site, chapter 5. These outputs will be the inputs for T3.2 where the definition, design, and development of the smart contracts to certificate the economic and energetic transactions of each identified BM will be carried out.

Horizon 2020
European Union Funding
for Research & Innovation

Table of Contents

1. Introduction 12
2. Business models 13
2.1 Business Model Canvas 14
2.2 Peculiarities of Sustainable Business Models 17
3. Business Ecosystem 18
3.1 Major Trends and Developments 19
3.2 Players, their Functions and New Actors 20
3.3 Business Models within the Energy Sector 24
3.4 Examples of New Business Models 27
4. Overview of the potential business models 31
4.1 Identification of Business Models 31
4.2 Benchmarking of the Business Models for LEC 34
4.2.1 Technical criteria 34
4.2.2 Environmental criteria 36
4.2.3 Social criteria 37
4.2.4 Economic criteria 39
4.3 Business Models of Renaissance project 40
4.4 LEC activities, actors and sub-Business Models 41
5. Overview of the demo-sites business models 52
5.1 Rural Ski Village Manzaneda (Spain) 52
5.1.1 Electricity services 53
5.1.2 Thermal services 68
5.1.3 Mobility services 71
5.2 Kimmeria Student Buildings, Xanthi (Greece) 73
5.2.1 Electricity services 74

Horizon 2020
European Union Funding
for Research & Innovation

5.2.2 Thermal services ... 82
5.2.3 Mobility services ... 84
5.3 Eemnes (The Netherlands) ... 84
5.3.1 Electricity services ... 85
5.3.2 Thermal services ... 91
5.3.3 Mobility services ... 91
5.4 Brussels Health Campus (Belgium) ... 92
5.4.1 Electricity services ... 93
References ... 99

Horizon 2020
European Union Funding
for Research & Innovation

List of figures

Figure 1 – Business Model Canvas by [vi]. 15
Figure 2 – Intra-actor relationships within the Ecosystem Pie Model [xiii]. 17
Figure 3 – BM Innovation Categories based on [xxiv]............................ 25
Figure 4 – Grid Manager BM.. 27
Figure 5 – Energy Service Contracting BM... 28
Figure 6 – Energy Performance Contracting....................................... 28
Figure 7 – BM of an energy cooperative [xxiv]. 29
Figure 8 – Virtual Utility BM. 30
Figure 9 – Platform Model.. 30
Figure 10 – Methodology used for BM identification in LEC. 31
Figure 11 – Categorisation of the global business models of LEC........... 32
Figure 12 – Degree of performance of the indicators for each BM. 34
Figure 13 – Allocation of each demo-site to a global BM. 41
Figure 14 – Prosumer canvas BM. 43
Figure 15 – Local generation canvas BM.. 44
Figure 16 – Grid operator canvas BM.. 45
Figure 17 – Retailer canvas BM. 46
Figure 18 – Aggregator canvas BM.. 46
Figure 19 – Local storage canvas BM.. 47
Figure 20 – Market operator canvas BM... 48
Figure 21 – Platform provider canvas BM... 50
Figure 22 – App provider canvas BM. 50
Figure 23 – Smart meter provider canvas BM...................................... 51
Figure 24 – Energy service scenarios representation in Manzaneda. 59
Figure 25 – P2P energy service actors. 61
Figure 26 – Energy storage capacity actors. 63
Figure 27 – Power load side management energy service actors. 64

Horizon 2020
European Union Funding
for Research & Innovation

Figure 28 – Power management exchange scenario actors. 66
Figure 29 – Flexibility services to external DNO scenario actors. 67
Figure 30 – Energy service scenarios representation in DUTH. 79
Figure 31 – Energy service scenarios representation in Eemnes. 90
Figure 32 – Energy service scenarios representation in UZB-VUB. 98

List of Tables

Table 1 – List of Acronyms... 11
Table 2 – Nine Building Blocks [vi] with example [12]. 15
Table 3 – Power Market Players... 21
Table 4 – Examples of new Actors. 23
Table 5 – Broad BM-Categories by [xxxviii]. 25
Table 6 – Classification of Energy Services [xl]. 26
Table 7 – Benchmarking of business models using technical criteria....... 35
Table 8 – Benchmarking of business models using environmental criteria. 36
Table 9 – Benchmarking of business models using social criteria. 38
Table 10 – Benchmarking of business models using economic criteria. .. 40
Table 11 – Classification of the actors involved in LEC per activity. 42
Table 12 – Current electricity services BM in Manzaneda demo-site. 53
Table 13 – Future electricity services BM in Manzaneda demo-site. 56
Table 14 – Current thermal services BM in Manzaneda demo-site. 68
Table 15 – Future thermal services BM in Manzaneda demo-site. 69
Table 16 – Current electromobility services BM in Manzaneda demo-site. 71
Table 17 – Future electromobility services BM in Manzaneda demo-site. 72
Table 18 – Current electricity services BM in DUTH demo-site. 74
Table 19 – Future electricity services BM in DUTH demo-site. 76

Horizon 2020
European Union Funding
for Research & Innovation

Table 20 – Current thermal services BM in DUTH demo-site. 82
Table 21 – Future thermal services BM in DUTH demo-site. 83
Table 22 – Current electricity services BM in Eemnes demo-site. 85
Table 23 – Future electricity services BM in Eemnes demo-site. 88
Table 24 – Current electromobility services BM in Eemnes demo-site. 91
Table 25 – Current electricity services BM in UZB-VUB demo-site. 94
Table 26 – Future services BM and stakeholders in UZB-VUB demo-site. 97

ACRONYM	
BM	Business Model
EPM	Ecosystem Pie Model
EU	European Union
ESCOs	Energy Service Company
KPIs	Key Performance Indicators
RES	Renewable Energy Source
LEC	Local Energy Community
EV	Electric Vehicle
LCOE	Levelized cost of energy
ROI	Return on Investment
PPA	Purchase Price Agreement
PV	Photovoltaic
IT	Information Technology
DNO	Distribution Network Operator
P2P	Peer-to-Peer
FECS	Full Equivalent CycleS
DSO	Distribution System Operator
PCC	Point of Common Coupling
ESS	Energy Storage System
LEC SP	Local Energy Community Service Provider

Table 1 – List of Acronyms.

Horizon 2020
European Union Funding
for Research & Innovation

1. Introduction

The current energy market regime is contested by various global trends that impact the entire energy supply chain. In the realm of climate change, a reduction of fossil fuel resources and CO2 (carbon dioxide) emissions became global policy targets. The increase of global electricity demand and the necessity of increased energy efficiency to meet the demand and policy targets are triggering the energy market regime that dominated for the past 40 years. Till 2030 the current business models of power supply utilities are expected to completely change or significantly alter [[i]]. Diversification of energy resources, the rise of the shares of renewable energy resources and the increasing importance of local governance of global policy developments lead to the emergence of new players in the energy market accompanied by new Business Model (BM) developments around the world [[ii]].

End-users and consumers of energy are evolving to central actors in the energy transition. This energy transition is currently characterized by developments from global to local, from central to distributed and smart, from large fossil fuel or nuclear assets to decarbonized small generators and from a one-way to a two-way distribution. Therefore, the transition is not only expanding over the technical sphere, but also has crucial implications for the social, institutional and economic spheres [[iii]]. Energy communities are emerging around the world and are embodying the mentioned transition [[iv]].

Horizon 2020
European Union Funding
for Research & Innovation

2. Business models

The investigation of business models became increasingly important since the year 1990 when the way of doing business of firms changed fundamentally with the start of e-commerce [v]. Several definitions and understandings of business models exist whereas most of the definitions include the organizational pillars: product, customer interface, infrastructure management and financial aspects [vi]. In [vii], a selective overview of business model definitions over time and author is provided. Business models serve as a tool to assess the architecture and strategy of how an organization creates value, delivers this value through its network channels and how profit is generated. This framework of business models aims to communicate the *value proposition* of a product or service an organization is providing, it identifies the *market segment*, i.e. the customers that will be attracted by the specific value, it assesses the *value chain* and *value network*, i.e. how the value is created within the organization, which resources and assets are required for that and is locating the organization within the network of suppliers, customers complimentary and competitors, it estimates the *revenue structure* and *profit potential* and therewith, displays the *competitive strategy* or innovative potential of the organization [viii]. Business models have been used to foster innovation and to make the business more resilient to influences on the macro-level and from outside the organization's area of influence. Furthermore, business models serve as boundary objects and as frameworks for discussion [ix].

In short, at the core of the business model theory lies on the question of how value is created, delivered and captured by an organization [x].

Horizon 2020
European Union Funding
for Research & Innovation

Business models are inherently complex because they are influenced by many different factors and business elements might reinforce or weaken each other [xi]. It is therefore beneficial to develop and display business models in a simplified way to facilitate the comparison of different business logics and architectures. Therefore, the business model canvas by [x] is introduced in the following section.

2.1 Business Model Canvas

The most applied and recognized business model canvas was developed by Alexander Osterwalder [x] and it is used to describe, analyse and design business models. In Table 2 the key building blocks are described.

Different key building blocks will lead to different BM configurations. In the BM canvas, it can also be displayed how the key building blocks are grouped and connected (see Figure 1). Grouped elements form a "perspective": Key partners, activities and resources represent the perspective "activity", the value proposition represents the product or service offered, customer relationships, segments and channels represent the customer perspective, and the cost and revenue model displays the financial perspective [xii].

Key Building Block	Description	Example
Partners	Partnerships for activities outside the organization are established	Consultancy firms, innovation partners, research partners
Activities	Key activities are essential for the entire workflow of the organization and value capture, delivery	Software manufacture, software sales to partners, implementation, service and new product development
Resources	Key resources that are needed for the other key building blocks	Innovation know-how, sales competence, ICT (Information

Horizon 2020
European Union Funding
for Research & Innovation

		Communications Technology)
Propositions	The value proposition aims to fulfil customer wants and needs or to solve a customer's problem	ICT enabled enterprise interoperability
Customer Relationships	Key customer relationships are connecting the organization with their customer segments	Global-business-to-business customized
Channels	Key channels describe the ways how the organization is connecting their value proposition with their customer segments e.g. through communication, distribution and sales channels	Partner network
Customer Segments	The customer segments the organization is serving and targeting at	Partners, software distributors
Cost Structure	All key building blocks connected will display the cost structure of the business model	Software development, sales and marketing, customer support
Revenue Streams	Revenue streams are shown in value propositions that are successfully designed, offered and supplied to the customers.	Software sales, implementation, customer support services and training

Table 2 – Nine Building Blocks [vi] with example [12].

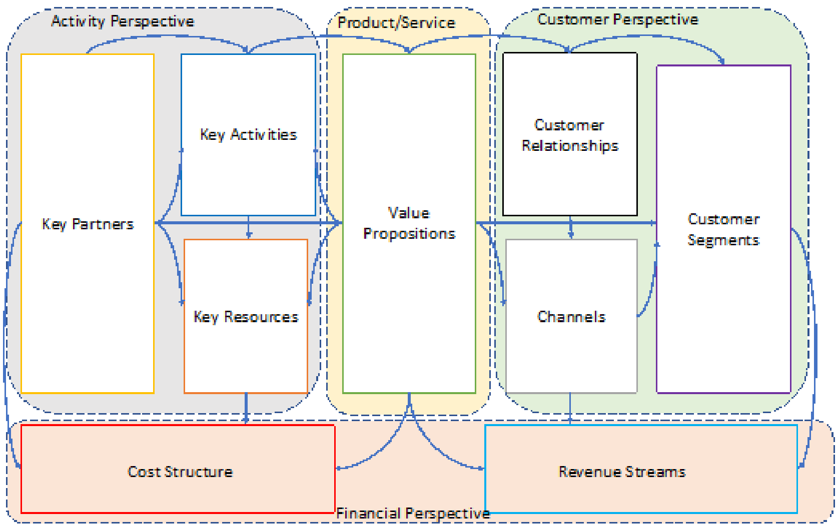

Figure 1 – Business Model Canvas by [vi].

Horizon 2020
European Union Funding
for Research & Innovation

Key partners perform key activities and provide key resources that enable the value proposition. Key activities are reliant on the key resources. The central aspect of the BM is the value proposition which is generating the revenue and cost model and is supported by the customer perspective. Customer relations are established through the distribution channels and are targeting at the customer segments. The financial perspective is composed of the cost and revenue structures of the BM whereas the customer and product perspective are mainly contributing to the revenue model and the activity and product perspective to the cost structures.

The BM canvas is used in this work for further investigation of BMs within the current, but also within the developing energy market. BMs in the energy market can be clustered taking different points of analysis: By analysing changing key building blocks, e.g., key customers, key resources, the value proposition, or by analysing where the BMs apply within the supply chain of energy. It must be kept in mind that BMs change for each participant in the energy market and are not a rigid constellation but rather one element in a bigger ecosystem.

The recently developed "Ecosystem Pie Model" (EPM) by [[xiii]] addresses this short coming by adding actors, dependencies and risk to the analysis of value creation and capture (Figure 2). Reflecting on the overall ecosystem value proposition, it becomes clear that actors depend on each other to create and capture specific values that contribute to the systems' value proposition. Furthermore, the EPM also shows that low willingness of actors to contribute to the ecosystem value proposition, e.g. based on low dependence on actors, fungibility of resources or activities, or inability of actors to create the needed value poses a risk on the overall value creation and capture. It also acknowledges that actors are able to take over important responsibilities or tasks from other actors – if the risks are low, resources available and the dependencies limited.

Horizon 2020
European Union Funding
for Research & Innovation

The EPM offers an extended and more holistic analysis of BM and their integration within an ecosystem and the introduced BMs could be analysed using the EPM.

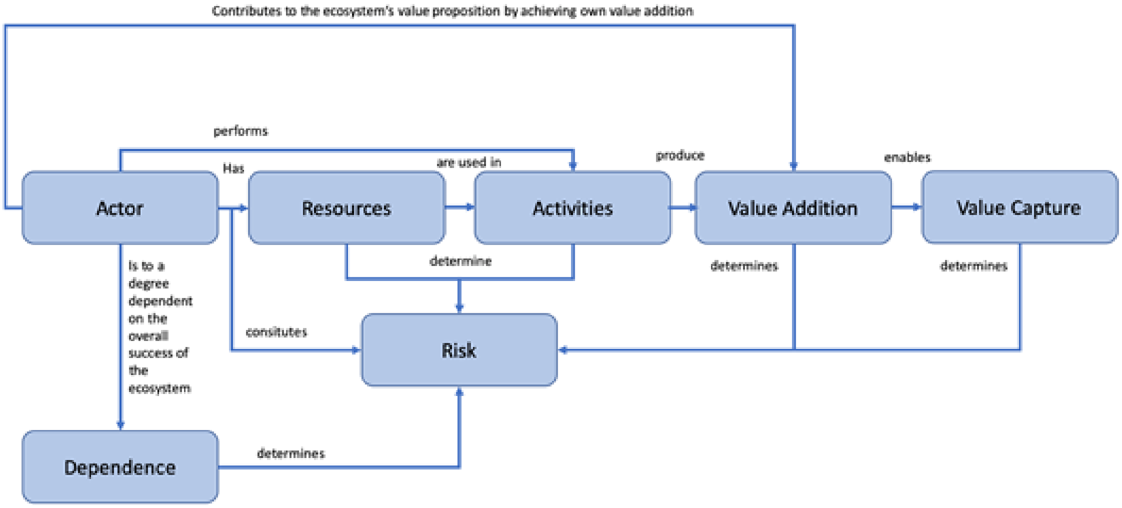

Figure 2 – Intra-actor relationships within the Ecosystem Pie Model [xiii].

In the next section, sustainable business models are shortly addressed as they indicate in what direction future BM will develop.

2.2 Peculiarities of Sustainable Business Models

A holistic view on the overall ecosystem is becoming increasingly important, especially because the value propositions becoming more complex and sustainability oriented [xiv]. The innovation of BMs and new value propositions are not only aiming at economic profitability but are extended with social and environmental goals [xv]. That is why BM innovation is now often connected with sustainable innovation and a social value creation [xvi]. [xvii] have clustered sustainable BM into four categories:

Horizon 2020
European Union Funding
for Research & Innovation

1. Circular BMs (BMs that aim to reduce the environmental impact of the resource loop).
2. Social enterprises (BMs that aim to increase social value).
3. Bottom of the pyramid solutions (BMs that aim to provide value to low income customers)
4. Product service systems (BMs that combine both products and services, e.g. a functionality or result, as a value proposition).

They further summarized major sustainable BM strategies based on which BM can be clustered as well: Maximize material and energy efficiency, closing the resource loop, substitution with renewable and natural processes, deliver functionality rather than ownership, adopt a stewardship, e.g. for the environment, encourage less consumption, aiming for an inclusive societal and environmental value creation and the development of solutions that are scalable [[xviii]].

The shift from a sole economic profit orientation to sustainable BM is recognizable within the energy value chain. BM innovations within the energy market can largely be associated with at least one of the mentioned sustainable business strategies. This will be further evaluated on in chapter 4.

3. Business Ecosystem

BMs and businesses are embedded in a “business ecosystem” which describes the overall business environment [[xix]]. [[xx]] includes all actors within the industry, e.g. customers, producers, competitors, in the business ecosystem which is continuously changing and organizing itself. Features of the business ecosystem include fragmentation and interconnectedness and competition as well as cooperation among the businesses within the overall system [[xxi]]. BMs are more likely to succeed in a healthy business

Horizon 2020
European Union Funding
for Research & Innovation

ecosystem that is characterized by robustness, adaptiveness and openness for new players and businesses [xxii].

The business ecosystem itself is integrated into a system that is constituted by social, economic, environmental and institutional factors which can serve as an explanation why specific BMs do or do not foster in certain business ecosystems. E.g., country specific legislation can restrict the ownership and connectedness to the national energy grid, a natural or desired monopoly on energy supply can limit business opportunities, the civil society has an anti-nuclear sentiment, or the national government is in favour of a green energy transition. Generally spoken, to shift a dominant business ecosystem to a new one requires either continuous changes of the dominant regime, great disruptive power of a niche BM or a major trigger [xxiii]. Currently, transformations within the energy business ecosystem are recognized and widely discussed and therefore, this report only shortly addresses these macro-trends in section 3.1.
But within the existing literature, an empirical quantitative analysis of the developments of BMs caused by these macro-trends is lacking.

3.1 Major Trends and Developments

Local Energy Communities (LECs) are embedded in a complex ecosystem influenced by trends on the micro- and macro level. On the macro level, climate change has led to global institutional efforts to reduce CO2 emissions, to phase out fossil fuel resources focusing on energy intensive sectors like buildings, transport, power generation and industry. Institutions like the European Union recognized the importance of the energy transition and has published the new Clean Energy Directive and the Renewable Energy Directive to make the citizens become the centre of this transition and to make the energy system more efficient [xxiv, xxv]. As a result, renewable energy resources increase in the energy mix and the generation of energy

Horizon 2020
European Union Funding
for Research & Innovation

becomes more distributed and smarter. With an expected urbanization rate of 75% in 2050, solutions to combat climate change have the highest impact implemented in an urban environment [xxvi]. European citizens are now participating and contributing to the energy transition as prosumers, but the need of a stable and resilient grid and local energy system is growing simultaneously [xxvii]. The digital and technology revolution made it possible to monitor the demand side of electricity and is opening new opportunities for balancing demand and supply via e.g. electric vehicles [xxviii]. Organizations are increasingly pressured to make their BMs more sustainable and more customer centred, a servitization of energy is recognizable as a long-term trend for utilities [xxix, xxx, xxxi, xxxii].

3.2 Players, their Functions and New Actors

Within the energy market, there are different market players involved fulfilling different functions to make the energy system work. In the following the key players and their (traditionally) corresponding functions are displayed (Table 3). Afterwards, a summary on new evolving actors is given (Table 4).

Player	Function	Examples Belgium
Producer	Generates electricity	Engie, Electrabel, Luminus
Consumer	Consumes electricity	Residential, commercial households, industry
Transmission System Operator (TSO)	Transmission of electricity on the high voltage grid, the TSO is responsible to balance demand and supply	ELIA
Distribution System Operator (DSO)	Distribution of energy on the low voltage grid	Eandis

Horizon 2020
European Union Funding
for Research & Innovation

Energy Supplier/ Retailer	Supply of energy to households and small companies, final step of the energy supply to the end-consumer	Eneco, E.ON, Lampiris
Balancing Responsible Party (BRP)	Balances electricity extraction/injection at the point of access	Often supplier or large consumer groups themselves
Regulator	Guarding the level-playing field of the free market - TSO (Transmission System operator)/DSO are often operating as natural monopolies	In Belgium among others: Commission for the regulation of electricity, gas (federal)

Table 3 - Power Market Players.

Because of the transition and changes within the power market, new actors and entities are evolving. This is also supported by EU (European Union) legislation and its recent Renewable Energy Directive and directive for electricity aiming at a liberalized European energy market [xxxiii, xxxiv]. These directives also strengthened the stand of energy communities and prosumers which are, among others, new players in the power market. It can also be seen that new actors are reaching beyond boundaries of their traditional field of expertise: The differentiation between industry sectors, e.g. building sector and energy sector, are becoming more blurry as energy production increases in built-environment and private properties and demand-response management takes place on the respective locality [xxxv]. Third-party investors like banks - although here not displayed as a direct player - will become increasingly important and influential for the energy transition [xxxvi] and directly affect ownership models and therefore, BMs too [xxxvii]. This is important because new BMs can connect financing methods with BMs that address other areas in the supply chain. The players that are

Horizon 2020
European Union Funding
for Research & Innovation

emerging currently offer a broad range of energy services which are new value proposition in the BMs, but do not necessarily take over the responsibilities of traditional players. Some examples of new players/actors are given in Table 4. This list cannot be complete, as new actors are emerging continuously.

New Player	Function	Examples
Prosumer	Consumes and produces electricity. They 'self-consume' some of the electricity they produce and sell the excess to the grid.	Household with PV installation
Power Exchange	Fulfil an anonymous and transparent energy trading for demand and supply bids	EPEX Spot Belgium
Independent Operators	Fulfil the tasks of the DSO/TSO individually	VuB Zellik
Energy Cooperatives	Legal Entity that supports RE projects and provides several energy services to its members	Energia, Spain; Eemnes Energie
ESCOs- Energy Service Companies	Offers a broad range of energy services like retrofitting, energy saving projects, risk management	Exeleria, VITAL Energi, UK
Renewable Batteries and Energy Storage providers / operators	Offer storage solutions and maintenance services	Vivint Solar, USA
Smart Meters providers / operators	The providers offer smart meter installation and maintenance The operators offer services for metering, display and management of energy	The distribution Co ESMIG

Horizon 2020
European Union Funding
for Research & Innovation

	consumption and production at consumer premises	
Electric vehicles providers / operators	The providers (manufactures) sell electric vehicles The operators offer electric vehicle installation and maintenance	Keolis
EV charging providers / operators	EV charging providers offer charging infrastructure and the operator manages the charging stations	EVgo, USA
Aggregators / Virtual power plants (VPP)	Manage a large number of small clients (prosumers, generators, storage providers, EV chargers, etc.) in order to provide advantages in wholesale market operations (e.g. offer flexibility services)	Lichtblick, Germany KIWI Power, UK Urbenber, Spain
ICT developers	Provide tools to automatically manage the certification of the transactions in the energy services and BMs providing private Blockchain platforms, tools to manage digital coins, apps or web applications to participate or monitoring in the markets.	PYLON, Power Ledger, SunContract, Bittwatt, Electron, Lo3 Energy, Blue note, Lition…
New digital added services providers	Provide information around the prediction of electricity demand or generation of an individual prosumer/consumer, groups of prosumers/consumers or the global community	Independent developers, entrepreneurs

Table 4 – Examples of new Actors.

Horizon 2020
European Union Funding
for Research & Innovation

Consumption and generation service, in which this agent provides information around the prediction of electricity demand or generation of an individual prosumer/consumer, groups of prosumers/consumers or the global community.

A diversification and liberalization of the energy market can be observed. Therefore, the transition not only poses threats to participants of the business-as-usual but also offers opportunities to expand existing services and products offered by the monopoly holders.

This diversification can also be seen in the number of new BMs which will be elaborated on in the next chapter.

3.3 Business Models within the Energy Sector

New BMs are evolving, and they are characterized by changing key building elements, such as the energy services that are provided, the actors (or legal entity they represent) involved and most prominently the value proposition offered. Also, BM innovations occur along with the whole value and supply chain of energy by introducing new technologies, ways to supply, generate and store energy, new methods to conduct trading, distribute and sale energy and to manage the consumption.

Because numerous of new BM exist, it simplifies the analysis by clustering them. A macro-overview was given by [[xxxviii]], they distinguished three major types of BM for the energy transition (Table 5).

More in detail and according to the introduced sustainable business innovation strategies mentioned in chapter 2, new BMs were clustered into four categories by [xxiv]. The category “configuration” refers to all innovations that address the internal functioning of the business, e.g. the profit model, vertical value chain integration, partnerships; the category “technological” refers to innovations that are arising from new technologies addressing optimization, circularity, substitution with renewables; the category “experience” refers to customer-related innovations including

Horizon 2020
European Union Funding
for Research & Innovation

product-service-functionality, customer engagement, channels, product system (bundling of various services) and the last category "financing". In Figure 3 clustered new BMs are summarized that are relevant for local energy communities.

BM category	Types
Customer Owned Product – centred BMs	For Demand Side Management Renewable Energy Technologies
Third-Party Service centred BMs	Renewable Energy Technologies For Demand Response For Energy Efficiency
Energy Community BMs	Many types

Table 5 – Broad BM-Categories by [xxxviii].

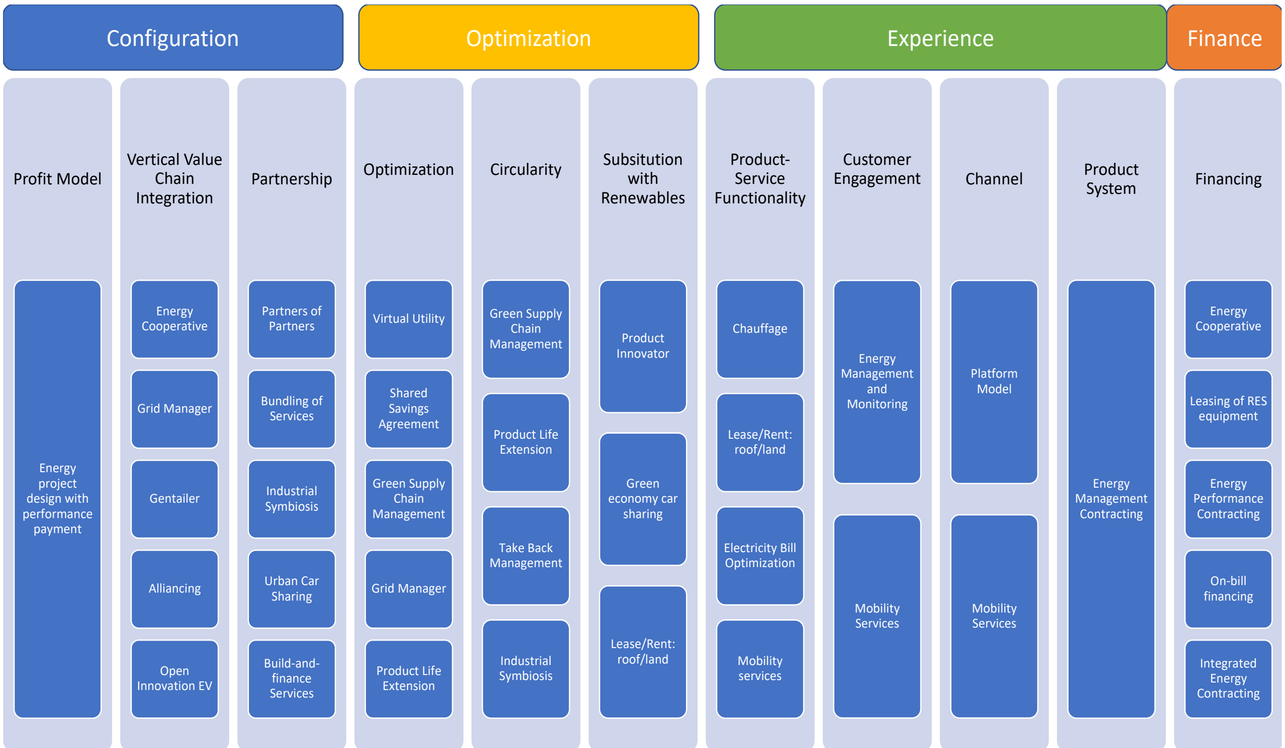

Figure 3 – BM Innovation Categories based on [xxiv].

It can be seen that new BMs include a broad range of services and that the utility BMs are transforming into service BMs. This servitization of business is characterized by expansion of the business portfolio: Not only products (e.g. energy) are provided but also services that cover information (data

Horizon 2020
European Union Funding
for Research & Innovation

gathering), service (transmission), support (training), products for services (e.g. smart meters, applications), self-service (demand management) and knowledge [xxxix]. The design, engineering, construction, on-site execution, operation, maintenance, energy performance management, financial risk reduction and retrofitting are other examples for new services that are provided [xxxv, xl]. In Table 6 a broad classification of services is shown.

Innovation in the value proposition is therefore often created by adding services to the business portfolio. The following examples of BMs will provide an understanding of how BMs can differ in their key elements.

Supply Chain Segment	Service Offering	Activities
Supply	▸ Energy Supply Contracting ▸ Renewable Energy Generation ▸ Virtual Power Plant and Direct Marketing	Planning, installation, management, financing, generation, sales, pooling of energy, optimization,
Distribution	▸ Grid Services	Engineering and optimization services, micro grid commercialization
Consumption	▸ Performance Contracting ▸ Demand Response Measures ▸ Energy Efficiency ▸ Energy Management ▸ Energy Procurement ▸ Smart Home Solutions ▸ E-Mobility Solutions	Investment, risk management, energy efficiency measures, consulting, installation, training, controlling, trading, private and public charging provisions

Table 6 – Classification of Energy Services [xl].

Horizon 2020
European Union Funding
for Research & Innovation

3.4 Examples of New Business Models

In Figure 4, the BM of a Grid Manager is displayed. In Figure 5 and Figure 6 two similar BMs are displayed: The energy service contracting BM and the energy performance contracting BM. The energy service contracting BM focuses on the fulfilment of certain tailored service provisions to customers. These services have a range from installing, over maintaining the installation to manage the energy efficiency of the customer. Revenue is created through these services. In comparison to that, the performance contracting BM is an innovative financing model too and is usually conducted by energy service companies. Here, revenue is not created directly through the services offered but through the energy savings that were agreed upon with the customer. This form of BM is accompanied by risks for the implementing organization because revenues will only be generated if energy savings will be achieved [xli].

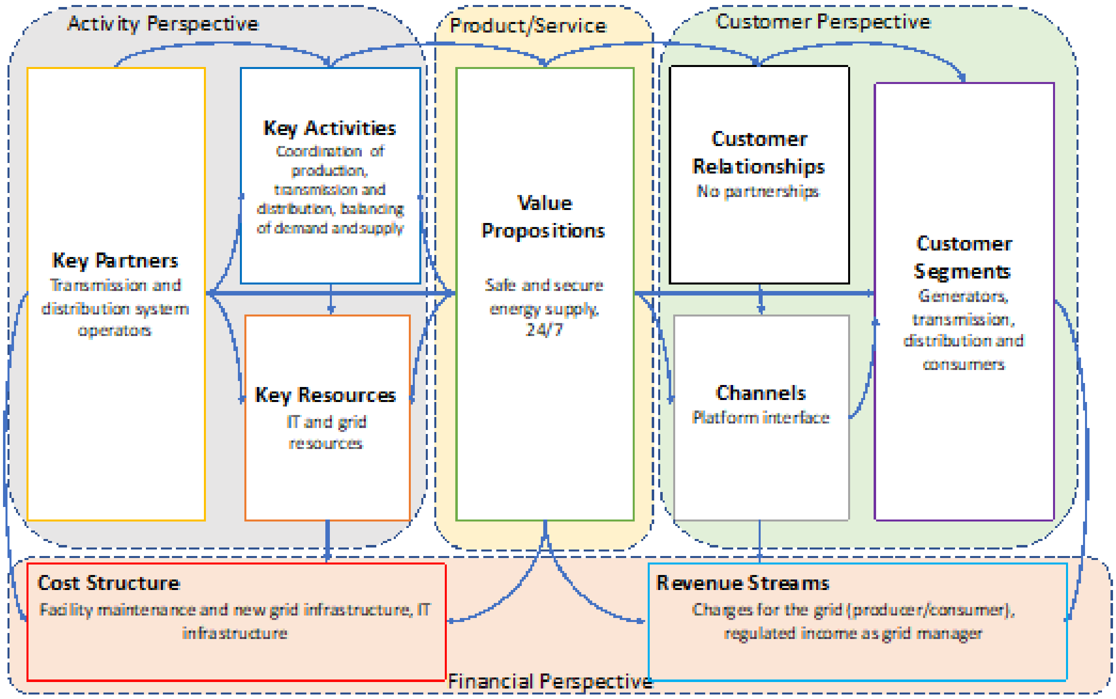

Figure 4 – Grid Manager BM.

Horizon 2020
European Union Funding
for Research & Innovation

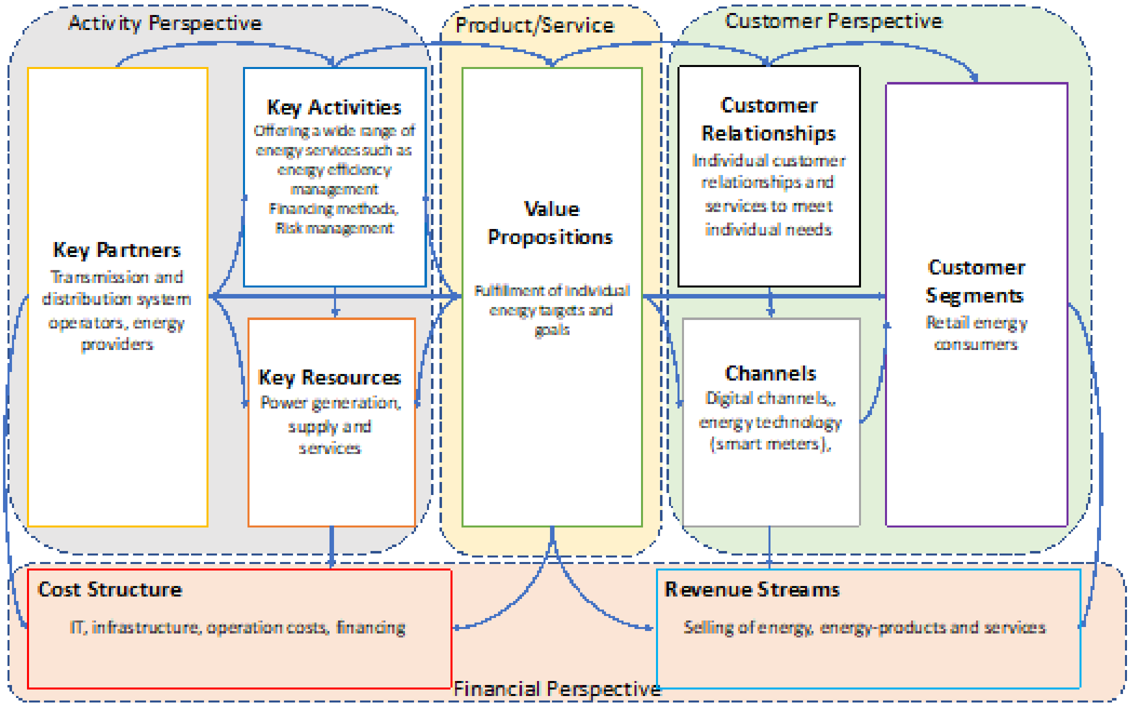

Figure 5 – Energy Service Contracting BM.

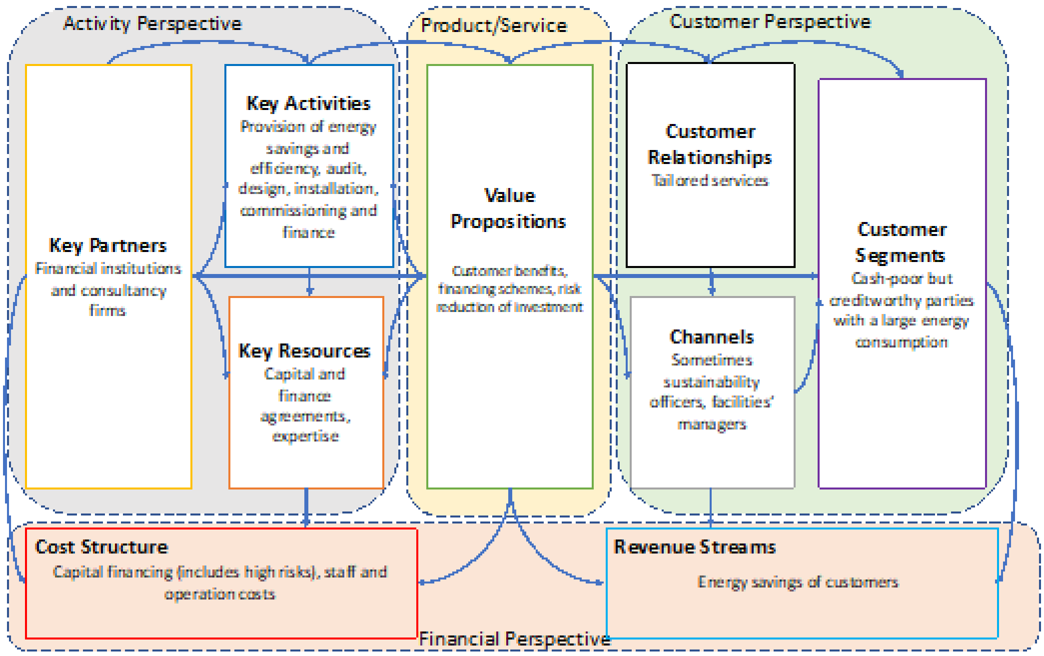

Figure 6 – Energy Performance Contracting.

There are different forms for performance contracts, but shared-savings and guaranteed-savings contracts dominate the current market [xlii, xliii, xliv].

Horizon 2020
European Union Funding
for Research & Innovation

For the shared-savings contract, ESCOs (Energy Service Company) sign a contract with clients about designing, financing and implementing a project and the ESCOs are required to prove that they are achieving the set of energy savings during the project period. There is a very low risk for clients as the ESCO only receives a payment when the energy savings goals are implemented [xlv].

For the guaranteed-savings model, the ESCO guarantees savings but must not finance the installation. The energy savings cover the amount of debt service payments [xlvi].

The chaffee or chauffage contracting model is the most extreme form of energy management contracting: ESCOs are responsible for the entire energy system and burden the energy costs [xlvii].

In these BMs the energy services are combined with smart financing solutions and a low risk for clients. In China and France these models can be found being implemented on a larger scale.

A display of a possible BM of an energy cooperative, is given in Figure 7. Examples of possible BMs for a virtual power plant (or virtual utility) and an energy platform are shown in Figure 8 and Figure 9, respectively.

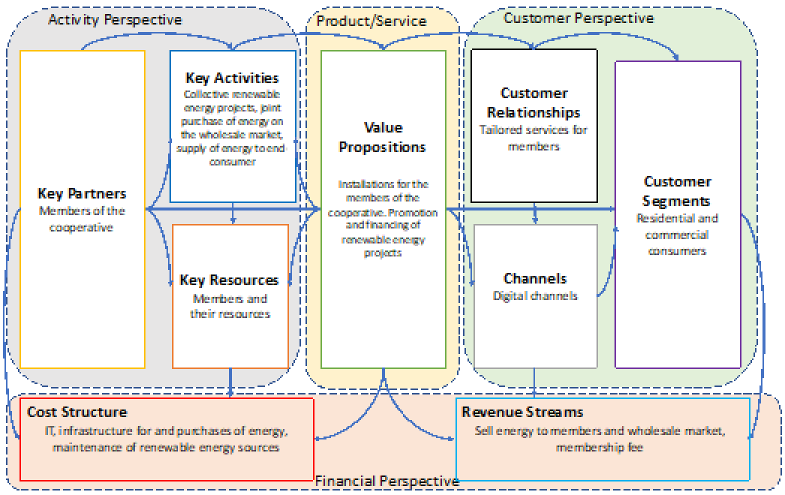

Figure 7 – BM of an energy cooperative [xxiv].

Horizon 2020
European Union Funding
for Research & Innovation

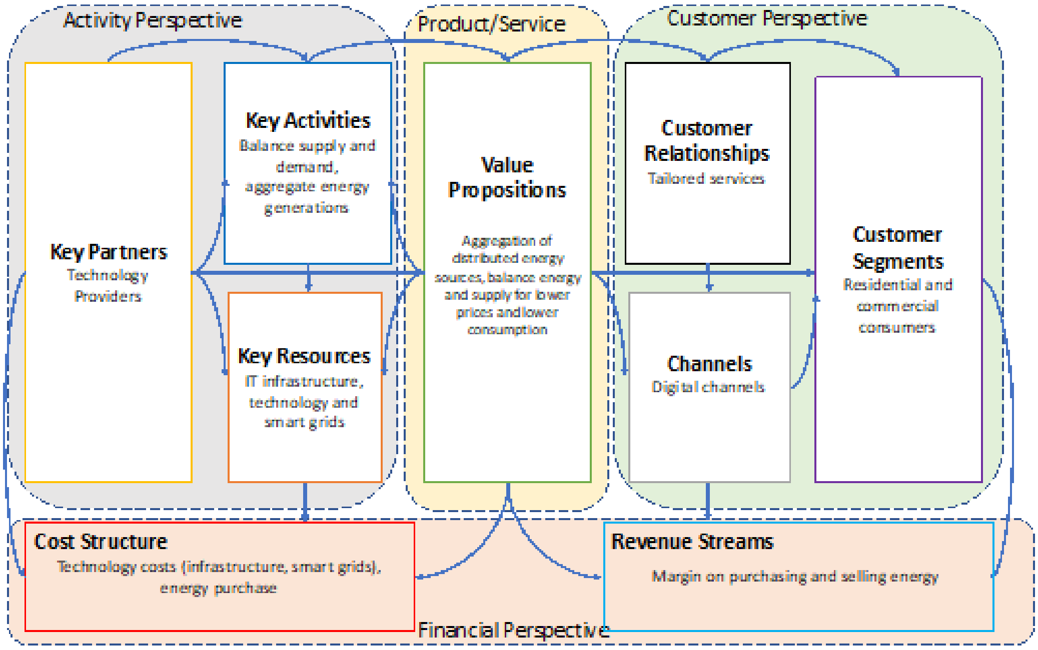

Figure 8 – Virtual Utility BM.

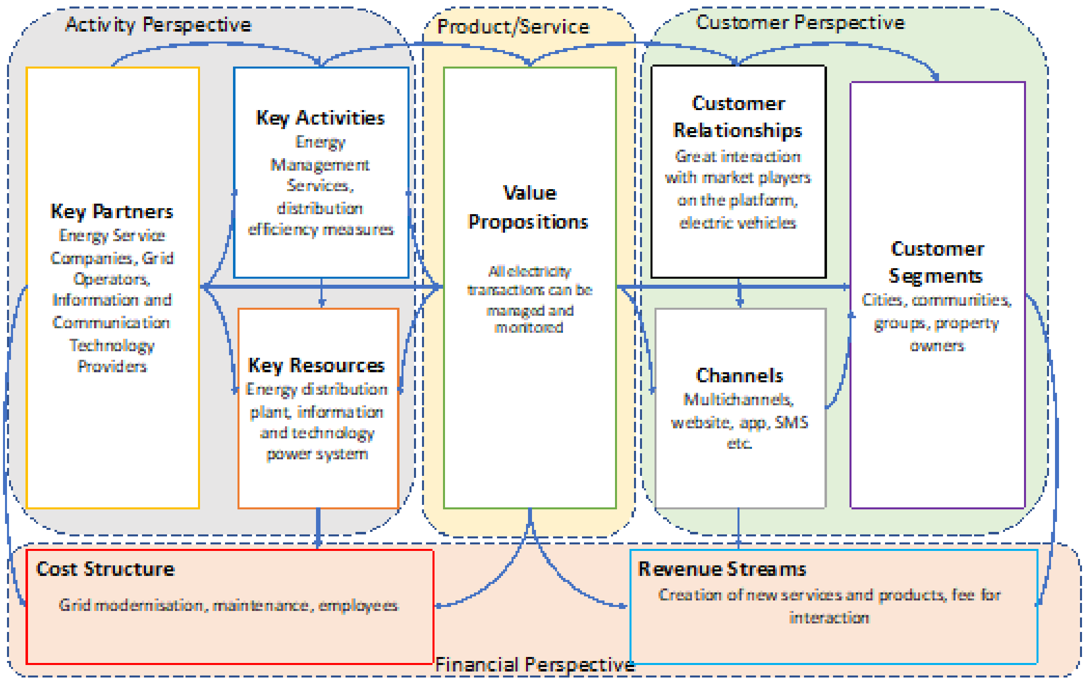

Figure 9 – Platform Model.

Horizon 2020
European Union Funding
for Research & Innovation

4. Overview of the potential business models

The main objective of this section is to identify the existing local energy system BM configuration. Based on a comprehensive literature review a benchmarking has been done. In order to do this, the methodology applied has the following steps described in Figure 10:

1.- Selection of Global Business Models (BM) for LEC.

2.- Benchmarking of the Global BM for LEC.

3.- Allocate each demo-site to a Global BM.

4.- Identification of the LEC activities, actors, and its associated sub-BM.

5.- Analysis of each sub-BM with canvas.

Figure 10 – Methodology used for BM identification in LEC.

4.1 Identification of Business Models

This section presents a mapping of the potential BM to be implemented in in the LEC.

More and more customers consider having their own on-site decentralized power production as an addition or as an alternative to grid supply. New BMs and new ownership structures are required to enable cost-efficient operation of the decentralized energy systems. A choice of a BM is relevant in order to face financial risks, fit the regulatory framework, suit the market environment most efficiently and economically.

Horizon 2020
European Union Funding
for Research & Innovation

Taking as reference the study presented by Vanadzina [xlviii], the potential business models for implementation in LEC can be classified in these major categories (see Figure 11):

1. Energy service company BM
2. Customer-owned BM
3. Energy cooperative BM
4. Third-party ownership BM
5. Utility BM

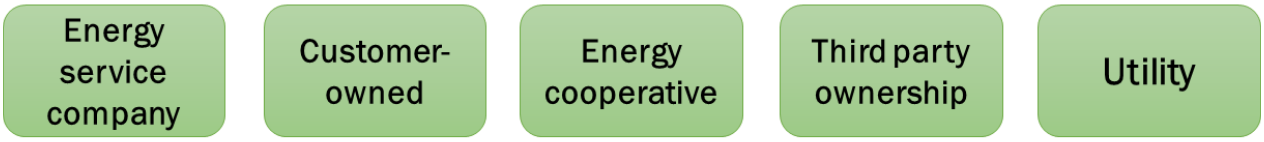

Figure 11 – Categorisation of the global business models of LEC.

The first category considered is the **ESCO**. This BM is based on energy savings, meaning that customer pays for the amount of energy saved, while the company invests in energy efficiency or other technological solutions to deliver energy savings. Savings agreement is signed often over a set period and can be calculated based on units of energy saved or percentage of the customer's utility bill. Thus, the main objective is the design and implementation of energy savings projects, that is, prioritize the improvement in efficiency and the reduction in operation and maintenance expenses.

The **customer-owned** BM is that the customer finances and owns the RES and batteries (if there are); however, the planning, construction and operation can be outsourced. This model is widely used by Universities, institutions, industrial consumers and businesses where large initial investment costs can be overcome. The major target of this BM is to prioritize the reduction of costs in the energy bill.

Horizon 2020
European Union Funding
for Research & Innovation

The **energy cooperative** BM promotes that the resources are shared between the community members and the reduction in costs can be relevant, especially with shared ownership between community members. In the same way as the customer-owned BM the planning, construction and operation can be outsourced. The essential objective is to reduce the dependence of external generation promoting the local development and empowering the community while also reducing costs.

Another BM is the **third party ownership**, in which a company owns and operates the renewable or thermal energy power plant, for example, solar panels installed on the rooftops of consumers, while the customers pay a monthly fee for the power they consume according to their Power Purchase Agreement (PPA). This model can be beneficial for consumers because they do not have to pay upfront costs, or concern about operating microgrid or carry any risk, as they are protected by guarantee agreements for the period of exploitation. So, in this way, the third part promotes the development of a new BM obtaining sustainable benefits without low risk.

Finally, the **utility** business model is based on the idea that energy utility can shift their traditional BM to a new one that invests in microgrids that hold up LEC obtaining better reliability and quality of supply to their customers. For instance, building a microgrid can be cheaper than installing a parallel high voltage distribution line to ensure the required reliability level. Basically, the principal goal is to improve the profitability of developing new infrastructure through new implementations that advance to the energy transition. In this way, the utility maintains the sustainability of their business.

Horizon 2020
European Union Funding
for Research & Innovation

4.2 Benchmarking of the Business Models for LEC

Once the potential business models of the LEC have been identified, a performance of each global BM can be benchmarked quantifying the promotion and encouragement in specific key objectives. These objectives are linked to technical, environmental, economic and social criteria, in which each one has different indicators aligned with the KPIs (Key Performance Indicator) defined in Deliverable 2.3 that express as precisely as possible to what extent the BM promotes each indicator. So, the benchmarking is done as follows based on some indicators classified in the four criteria aforementioned which distinguish between low, medium and high performance (Figure 12):

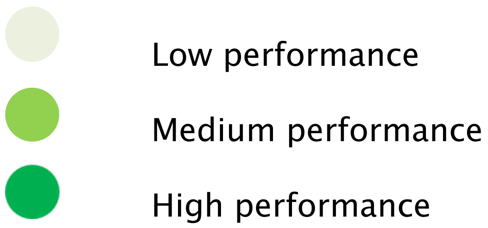

Figure 12 – Degree of performance of the indicators for each BM.

4.2.1 Technical criteria

The technical indicators used to benchmark each global BM are the following ones:

- **Energy savings**: this is based on the emphasis each global business model promotes the reduction of energy consumption.
- **Share of RES (Renewable Energy Source)**: considers the fact that the business model promotes the share of RES.
- **Degree of self-consumption**: this indicator evaluates the degree that a business model encourages the increase in the ratio of locally produced energy from RES and the energy consumption over a period.
- **Peak load reduction:** defines the degree of peak demand reduction of each business model.

Horizon 2020
European Union Funding
for Research & Innovation

Technical	Energy savings	Share of RES	Degree of self-consumption	Peak load reduction
ESCO	● (dark green)	● (dark green)	● (dark green)	● (dark green)
Customer-owned	● (pale)	● (dark green)	● (dark green)	● (dark green)
Energy cooperative	● (pale)	● (dark green)	● (dark green)	● (light green)
Third-Party	● (pale)	● (dark green)	● (light green)	● (light green)
Utility	● (pale)	● (dark green)	● (light green)	● (light green)

Table 7 - Benchmarking of business models using technical criteria.

As mentioned before, the ESCO is specialized in delivering energy savings due to the improvement in energy efficiency technological solutions, as installing more efficient systems and equipment and developing a broad set of strategies. Moreover, the ESCO can also invest in renewable energy greatly encouraging the entry of RES in the LEC and the degree of self-consumption. The current ESCO are assessing how to enhance its existing BM including the peak load reduction in its energy service offerings.

The customer-owned BM do not take care of energy savings as the main target is to invest in renewables increasing the penetration of RES in the LEC and the self-consumption. Additionally, the customer-owned BM has a great interest in reducing its peak load in order to adapt its demand to the instant generation.

In the case of the energy cooperative, the main target is to greatly encourage the use of renewables in the community so the customers can consume the energy locally. The renewable sources can be shared between the community members; thus, they can self-consume the local generation. In the same way as the customer-owned, the energy cooperative foments the decrease in the peak load in order to adapt it to the local resources.

Horizon 2020
European Union Funding
for Research & Innovation

The third-party ownership main interest is to invest in RES, to operate it and sell renewable energy to the consumers. Secondarily, it can also promote the degree of self-consumption and the peak load reduction in their agreements with its customers. However, the third-party BM does not concern in energy savings and efficiency solutions. Finally, in terms of technical criteria, the utility performance is similar to what it is explained for the third-party ownership. This benchmarking is represented in Table 7.

4.2.2 Environmental criteria

In terms of environmental criteria, the indicators used to benchmark each global business models are the following ones:

- **CO_2 reduction**: this indicator accounts for the intensity that a business model reduces the major share of Greenhouse Gas Emissions. The main sources for CO2 emissions are combustion processes related to energy generation and transport. CO2 emissions can consequently be considered a valuable indicator to assess the contribution of urban development on climate change.
- **Reduced Fossil Fuel Consumption**: considers the degree of reduction in the fossil fuels consumption for heating, transportation and power generation of each business model.

Environmental	CO_2 reduction	Reduced Fossil Fuel Consumption
ESCO	●	●
Customer-owned	●	●
Energy cooperative	●	●
Third-Party	●	●
Utility	●	●

Table 8 - Benchmarking of business models using environmental criteria.

Horizon 2020
European Union Funding
for Research & Innovation

Regarding the environmental indicators (Table 8), all the BM reduce the CO_2 emissions as they invest in RES and renewable energy is directly consumed by the customers. However, the reduction of CO2 emissions and fossil fuel consumption is not the main objective of the ESCO, the third party and the utility BMs. They simply invest in renewables, thermal equipment, batteries and EV due to the opportunity that these technologies offer in their profit scheme under this new energy framework. That is, they indirectly reduce greenhouse emissions and consumption from fuel generation. In the customer-owned business model, the main target is to avoid the conventional generation with local owned energy promoting the reduction from traditional fossil fuel generation. Furthermore, in the case of the energy cooperative, the idea is to form a society with people who want to consume electricity from renewable generation to reduce the global pollution and the dependence from an external generation which is principally composed of fossil fuel generators.

4.2.3 Social criteria

The social criteria consider the community change and involvement as customer acceptance and awareness creation. The specific criteria used to benchmark each business model is as follows:

- **LEC participation**: measures how each business model encourages consumers to get involved in the LEC.
- **Increased sustainability education**: this index shows to what extent citizens are actively engaging within the LEC.
- **Demand response sensibility**: this indicator shows how each business model promotes the demand response in the LEC.
- **EV (Electric Vehicle) sensibility**: this indicator shows how each business model encourages consumers to use EV.
- **Scalability**: represents the capability of each business model to meet increasing demand while being able to be duplicated at another location or time.

Horizon 2020
European Union Funding
for Research & Innovation

Social	Participation	Sustainability education	Demand response	EV	Scalability
ESCO	○	○	◐	○	●
Customer-owned	●	●	●	●	●
Energy cooperative	●	●	●	●	●
Third-Party	○	○	○	○	●
Utility	○	○	◐	●	●

Table 9 - Benchmarking of business models using social criteria.

Related to the indicator of the LEC participation, on one hand, the customer-owned and the energy cooperative encourages greatly the customers to engage in the community. On the other hand, the ESCO, the third party and the utility do not have any purpose related to the participation of the customers and the do not promote the sustainability education inside the community as it does not give any beneficial result. The same situation is considered in the third party as they do not have any intention in promoting any educational scheme as its motivation is only to sell energy to the customers. However, the customer-owned and the energy cooperative are aware of climate change and they want to increase the education about sustainability and the environment. Regarding the demand response scheme sensibility, the customer-owned and energy cooperative are aware that this mechanism promotes that the generation adapts to the demand. The ESCO and the utility can also provide demand response mechanisms to its clients. Nevertheless, the third party is not interested in offering demand response schemes sensibility. Are consumers going to be using EVs within the next years? The customer-owned, the energy cooperative and the utility are promoting the use of the EV while the other BM do not care about it.

Horizon 2020
European Union Funding
for Research & Innovation

Finally, all the global business models found in LEC can be scalable. The benchmarking is represented in Table 9.

4.2.4 Economic criteria

The purpose of these criteria is the contribution to the economic growth of each business model. The specific indicators definitions and assessment of each business model are described below.

- **Levelized cost of energy (LCOE)**: this indicator measures the value of the total costs of energy generation and distribution divided by energy production for each business model in the LEC.
- **Total investments**: this represents the total assets that are purchased or implemented with the aim to generate payments or savings over time. This indicator measures the quantity of each business model investment in assets for the LEC.
- **Payback**: indicates the time needed to cover investment costs in the LEC.
- **Return on investment (ROI)**: this indicator measures the rentability of each business model in the LEC framework.

Regarding the economic indicators (Table 10) the achievement of a low LCOE is the main purpose of the energy cooperative and customer-owned and they look for an energy invoice reduction. The other BMs in some way want to have a low LCOE, nevertheless it is not their main idea.

Specifically, in the case of the third party and the utility, their principal goal is to increase the total investments in order to obtain a higher benefit at the end of the project. The ESCO also quite invests with the purpose to increase the energy savings and efficiency over time. Regarding the payback indicator, mainly the customer-owned wants to recover the investment as soon as possible. Similarly, in less grade the ESCO and third party try to have a medium ROI contrary as the energy cooperative and the utility that does not care when the investment is recovered as it is not their main preference. Finally, the ROI is a key indicator for the ESCO, third party and

Horizon 2020
European Union Funding
for Research & Innovation

the utility as they want to maximize the rentability of their business. In the situation of the customer-owned and energy cooperative do not want to have a high rentability as the idea of contributing to the LEC is conceptually more environmental and social.

Economic	LCOE	Total investments	Payback	ROI
ESCO	[light green]	[dark green]	[light green]	[dark green]
Customer-owned	[dark green]	[light green]	[dark green]	[light green]
Energy cooperative	[dark green]	[light green]	[pale grey]	[light green]
Third-Party	[light green]	[dark green]	[light green]	[dark green]
Utility	[light green]	[dark green]	[pale grey]	[dark green]

Table 10 – Benchmarking of business models using economic criteria.

4.3 Business Models of Renaissance project

Each of the RENAISSANCE demo site project is related to one of these global BMs mentioned above as illustrated in Figure 13.

- In Electromanzaneda pilot site, a **third-party** company will provide the energy generated at a PPA fix price.
- In Eemnes, an **energy cooperative**, that is a mixed-ownership approach, is responsible of the management of the LEC.
- In Xanthi, the University of DUTH is the owner of the renewable energy assets, the buildings and facilities, so it can be categorized as a **customer-owner** owned LEC centred.
- In Brussels Health Campus and the University (VUB) demo site is also the owner of the renewable energy assets, so it can be categorized as a **customer-owner** owned LEC centred.

Horizon 2020
European Union Funding
for Research & Innovation

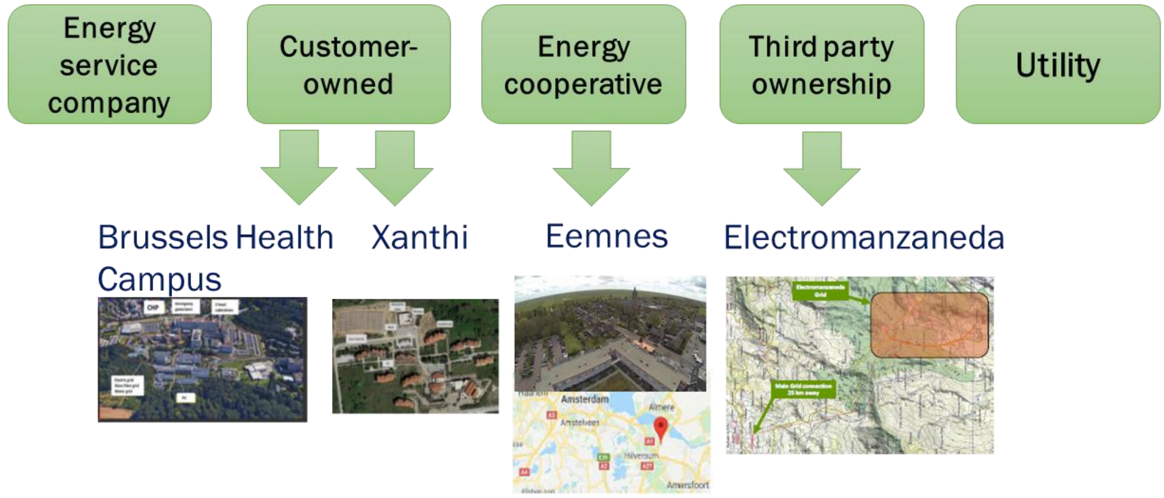

Figure 13 – Allocation of each demo-site to a global BM.

4.4 LEC activities, actors and sub-Business Models

The LEC are integrated local energy systems which have associated different activities as generation, distribution, retailing, consumption, aggregation, storage, grid operating, energy exchange and provision. The LEC are formed by different actors in which each agent has its corresponding business sub-model.

In Table 11, the different activities of the overall local energy systems with its associated actors are defined.

Horizon 2020
European Union Funding
for Research & Innovation

Activities	Actors
Generation	Prosumer, Local generator
Distribution	Grid operator
Retailer	Retailer
Consumption	Consumer
Aggregation	Aggregator
Storage	Local storage
Energy exchanges	Market operator
Provision	Platform provider, app provider, smart meter provider, charging infrastructure provider, energy services provider

Table 11 – Classification of the actors involved in LEC per activity.

The different BM canvas are displayed for the actors defined above, except for the consumer as it has not any associated BM.

Firstly, in Figure 14, the canvas BM for the prosumer is represented. The prosumer value proposition is the encouragement to promote the local renewable energy and the efficient consumption of the energy. In this way, the prosumer contributes to fight against the climate change, improves the social cohesion of the energy community and empowers with renewable energy sources the end-users with the provision of its energy excess at lowest possible cost. The prosumer is motivated to adopt and appreciate the benefits of new technology and claims for a consistent service without any surprises on the bills. The prosumer needs to invest at least in PV (Photovoltaic) panels and maybe in batteries, which will be recovered through the reduction of the electricity bills due to the sale of the energy excesses.

Horizon 2020
European Union Funding
for Research & Innovation

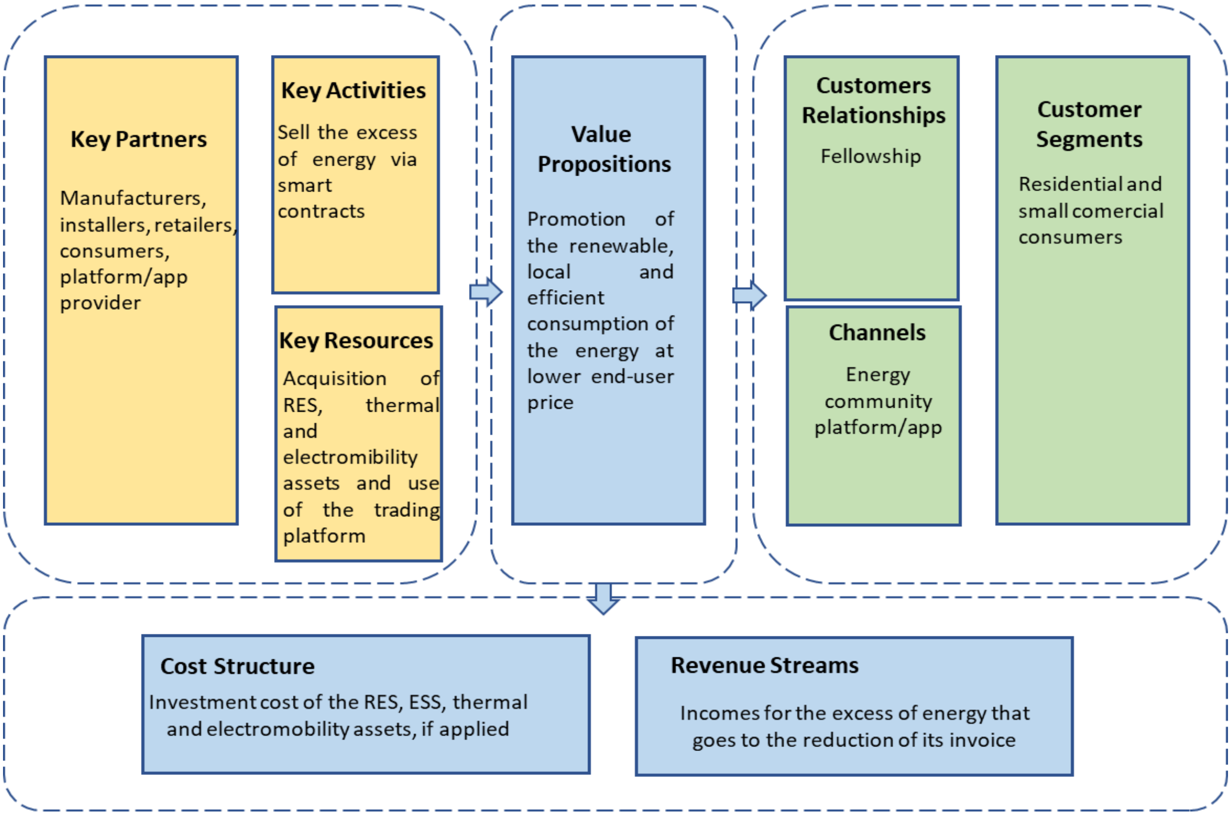

Figure 14 – Prosumer canvas BM.

Secondly, the local generator objective is to provide with renewable energy to the local community members at a lower price than the retailers one. This is a great opportunity to empower the end-users with local green generation in contrast to the traditional generators. The revenues come from the sale of the energy generated that can be through a contract defined as PPA or savings or smart contracts, etc. The costs come from the deployment of the local power plant, the operation and maintenance and the staff. The canvas BM is shown in Figure 15.

Horizon 2020
European Union Funding
for Research & Innovation

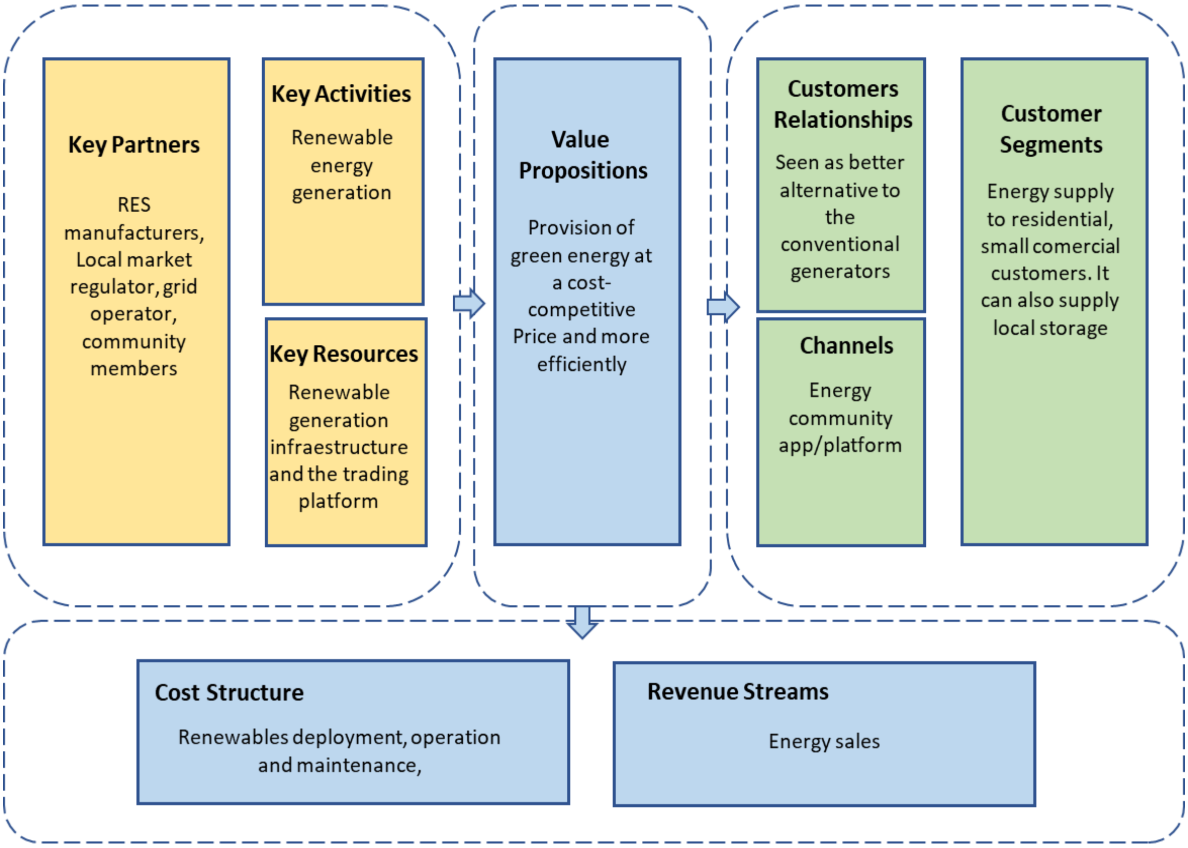

Figure 15 – Local generation canvas BM.

The grid operator (see the BM canvas in Figure 16) is in charge of guaranteeing the security and the uninterruptible electric supply to the customers. For that, the grid operator has to invest in new grid infrastructure, grid maintenance and IT infrastructure to control the technical limits of the electric network. An intelligent grid operator could include initiatives as real time monitoring, active switching, operational control, curtailment of renewable sources, etc. The revenues come from the regulated income as a grid manager that mainly comes from the charges that paid the consumers in their bills in order to be connected to the grid.

Horizon 2020
European Union Funding
for Research & Innovation

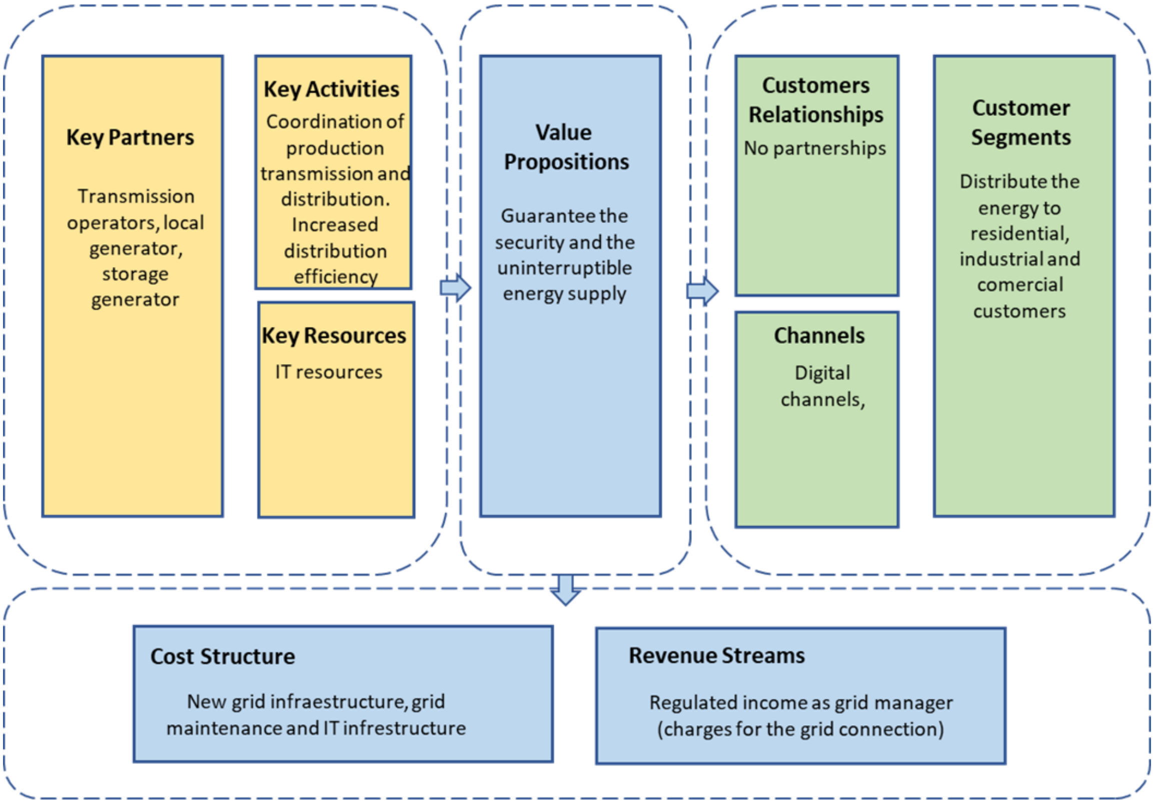

Figure 16 – Grid operator canvas BM.

In Figure 17, the BM of the retailer is represented. The main goal is to provide energy to the end-users and balance the energy. In Renaissance project, within the LEC context and the smart contract implementation, it is also very important that the retailers have the information regarding the smart contracts and the power exchange transactions, and, like now, receive the measurements of the consumers from the distributor in order to do the settlement correctly. Therefore, seeking to be distinct from other retailers, they offer lower prices than their competitors, commercialise only energy that is guaranteed to be 100% renewable, and aim at a closer relationship with the customer, for better consumer engagement. Their costs are basically the purchase of energy in the wholesale market and, within the Renaissance context also the LEC market, and the IT infrastructure. The revenues come from the invoice the customers pay and the energy balance of the consumers.

Horizon 2020
European Union Funding
for Research & Innovation

In Figure 18, the aggregator canvas BM is displayed. Aggregation entails grouping the energy consumption or generation of several prosumers.

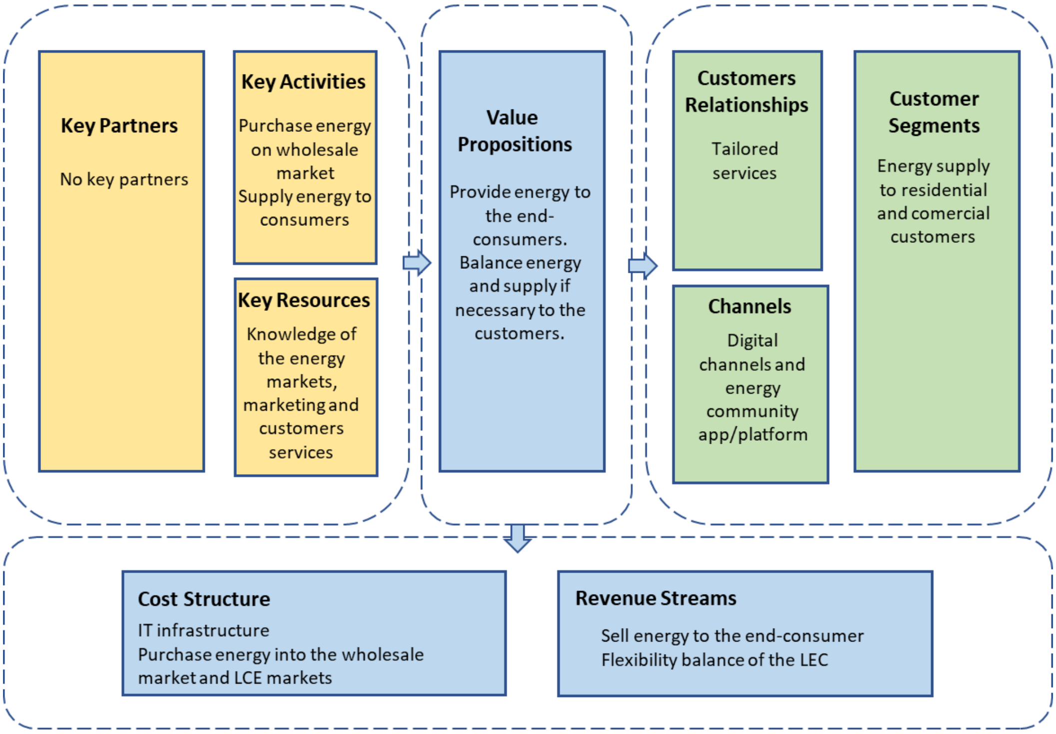

Figure 17 – Retailer canvas BM.

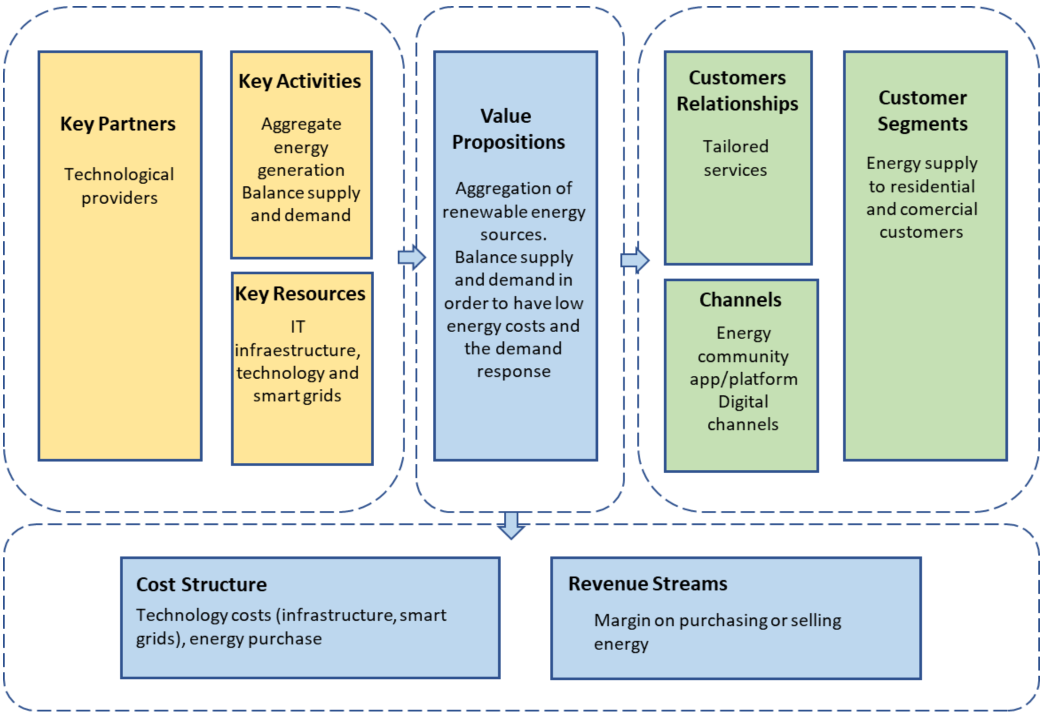

Figure 18 – Aggregator canvas BM.

Horizon 2020
European Union Funding
for Research & Innovation

In terms of energy demand, an aggregator can set up an agreement with several consumers, based on which he can temporarily reduce their electricity consumption when there is a high demand for electricity. An aggregator could also be operating the reverse action and could increase the consumption of an electricity consumer when electricity prices are favourable. In LEC, aggregation can be carried out by new entrants such as independent aggregators which can also operate as a virtual power plant on behalf of a group of consumers engaging in self-generation by selling their excess electricity. Their incomes are based on a margin on purchasing or selling energy and the costs are the purchase of energy and the new smart grids technology required.

The local storage provides flexibility to the energy community as it supplies with renewable energy that has been stored in order to supply it at other times at a lower price than the tariff. The costs are the storage deployment, operation and maintenance, staff and energy purchases while the revenues are the sale of the energy stored. The canvas BM of the local storage is illustrated in Figure 19.

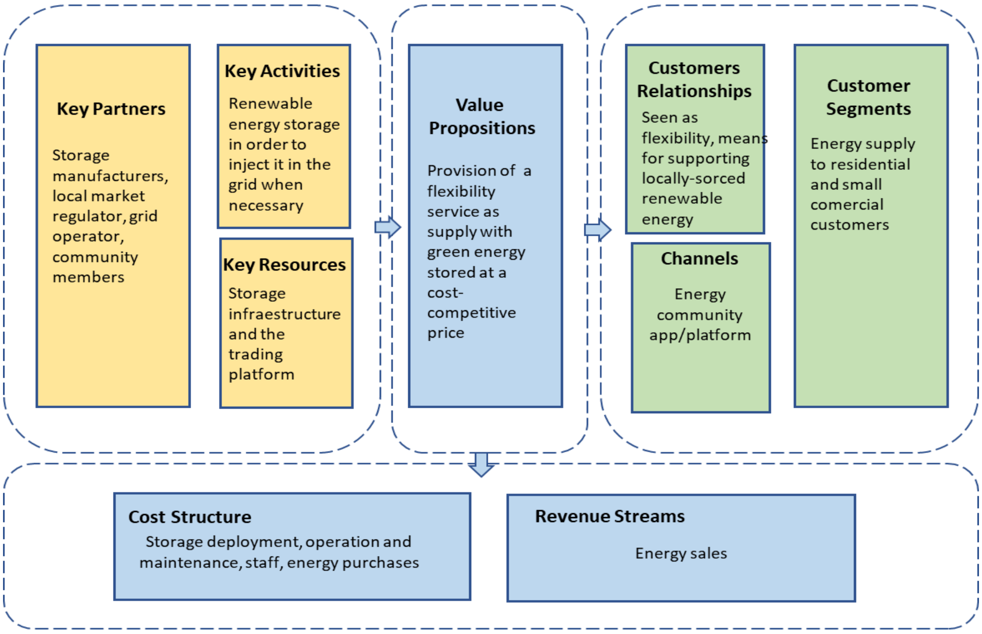

Figure 19 – Local storage canvas BM.

Horizon 2020
European Union Funding
for Research & Innovation

Within the LEC context, a local energy market could be implemented. The overall goal of the local energy market is to provide electricity efficiently while meeting the demands of the consumers. In order to face with the integration of new sources of generation, technology, infrastructure and end-user consumer-oriented market a local energy market should be created. For that, the LEC market operator is an agent linked to the organization and performance of the local energy market. As responsible for the system management, it assumes the management of the bids of the system through the smart contracts. The development and operation of the computer systems necessary for the proper functioning of the market also correspond the LEC market operator (Figure 20). So, the costs are the acquisition of the platform and the definition of the smart contracts, and the incomes could be a fee for every transaction every user does for launching or matching the smart contract.

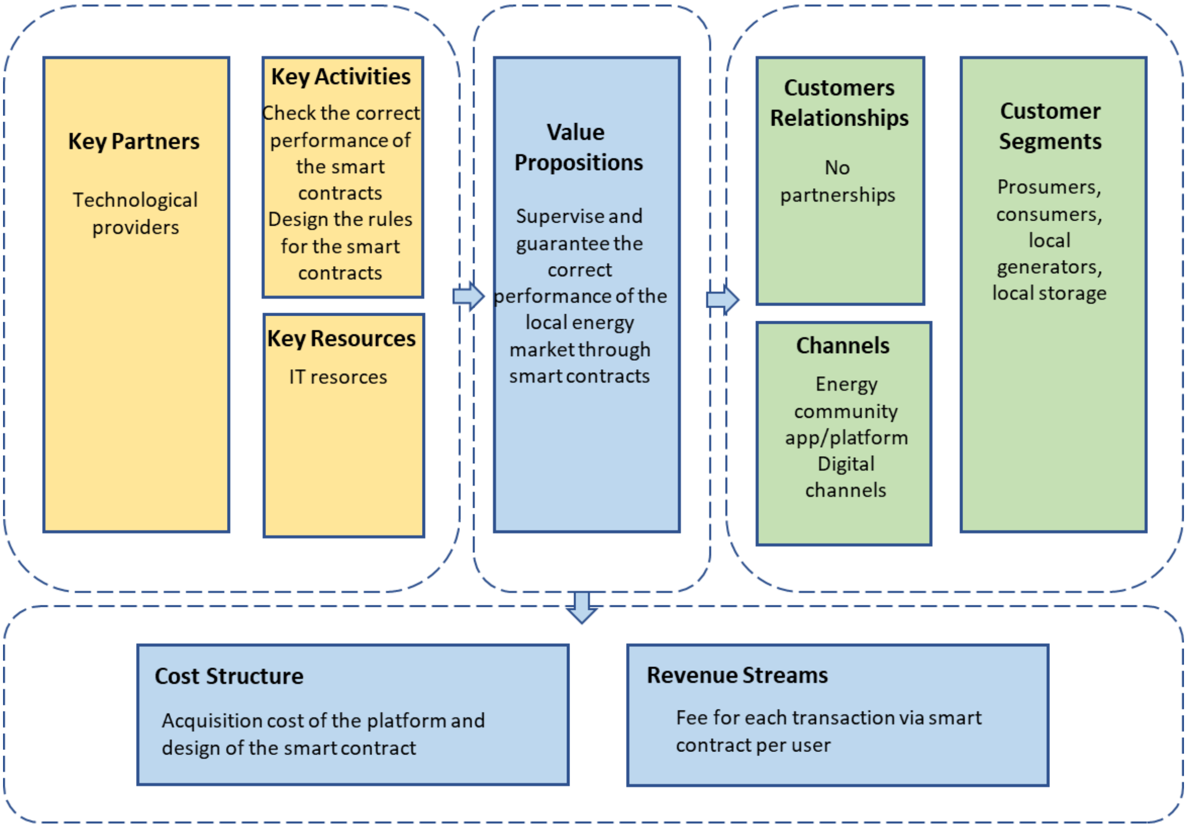

Figure 20 – Market operator canvas BM.

Horizon 2020
European Union Funding
for Research & Innovation

The platform provider business model creates value by facilitating exchanges between two or more actors, usually consumers and producers. In addition, it facilitates exchanges by reducing transaction costs and enabling externalised innovation. Their main aim is to be a leader in customer product design, creating products using modern technology, which not only satisfy customers' needs but are also energy efficient. In this way, all energy transactions can be managed by the LEC market operator, monitored and the information can be saved in a database. The platform allows the interaction between market players as consumers, prosumers, local generator, local storage, aggregator or retailer and they can access via website or app. The revenues streams come from the sale and maintenance of the platform and the costs are the platform development, running costs and maintenance as displayed in Figure 21.

Quite similar to the platform provider business model is the app provider business model as represented in Figure 22 in which the main value is the quick and comfortable way to perform the transaction that allows the energy exchange between the energy community members, i.e. using in the mobile. The revenues and costs are the same as the platform provider but in terms of App instead of the platform.

Horizon 2020
European Union Funding
for Research & Innovation

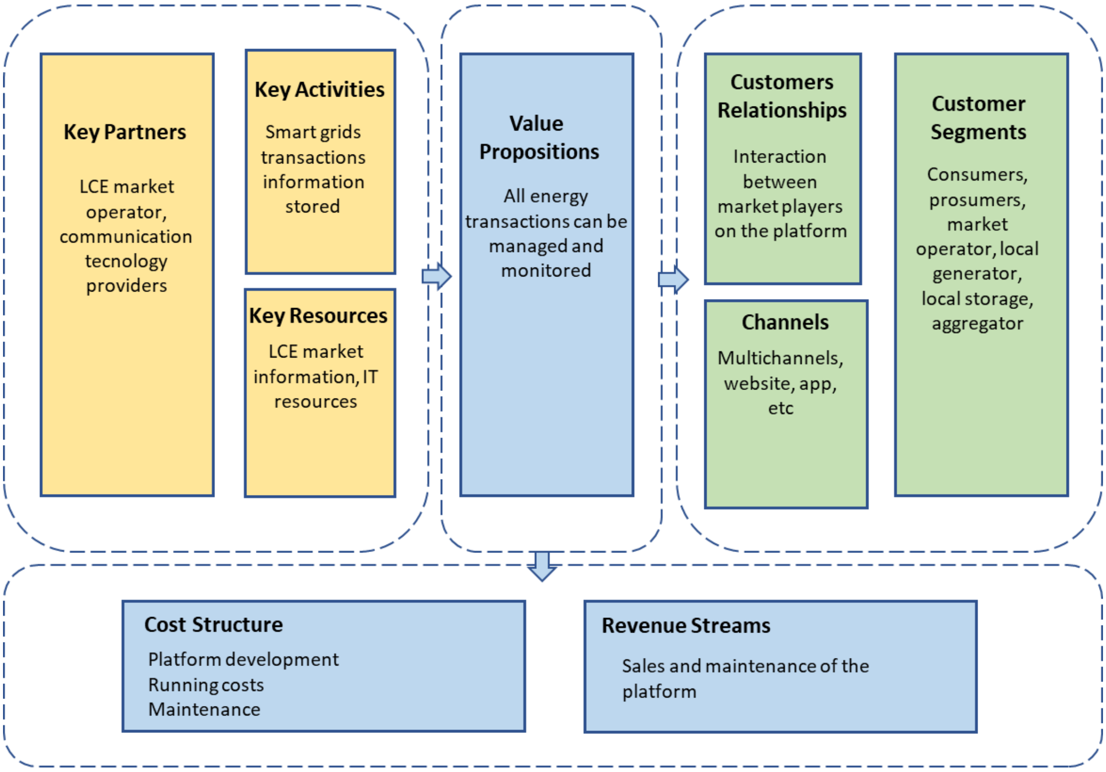

Figure 21 – Platform provider canvas BM.

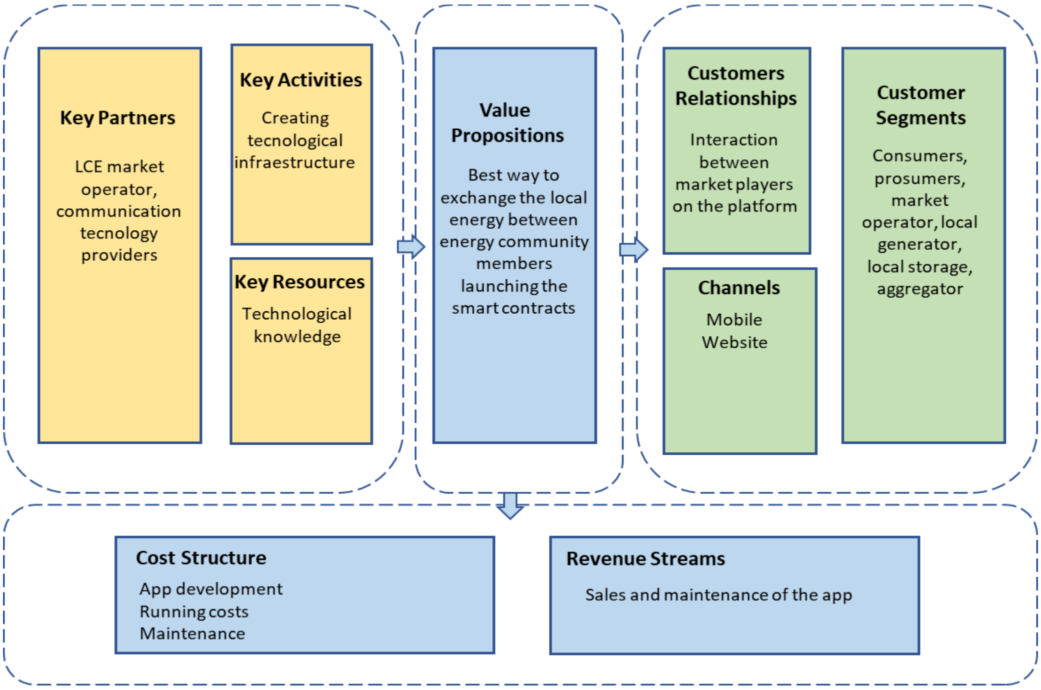

Figure 22 – App provider canvas BM.

Horizon 2020
European Union Funding
for Research & Innovation

Finally, Figure 23 illustrates the smart meter provider canvas BM in which the smart meter service provider supports energy suppliers in the rollout and operation of intelligent measuring systems. Compared to the conventional meter, the advantage of the technology is that customers can access information in greater detail about energy consumption via the meter's display. For instance, energy providers can optimize their internal processes in order to support automatic billing based on actual consumptions. Its function is to measure energy consumption and optimise meter data management processes. The smart meter enables energy savings and integration of renewable energy resources. If the energy community decide and act, the smart meter can become a sustainable, circular product that can help to build an integral and sustainable solution for the end consumer. The smart meter provider costs are the manufacture and IT (Information Technology) infrastructure costs while the incomes come from the usage-dependent charges. In a similar manner, other providers mentioned as the charging infrastructure and energy service provider will have a similar BM.

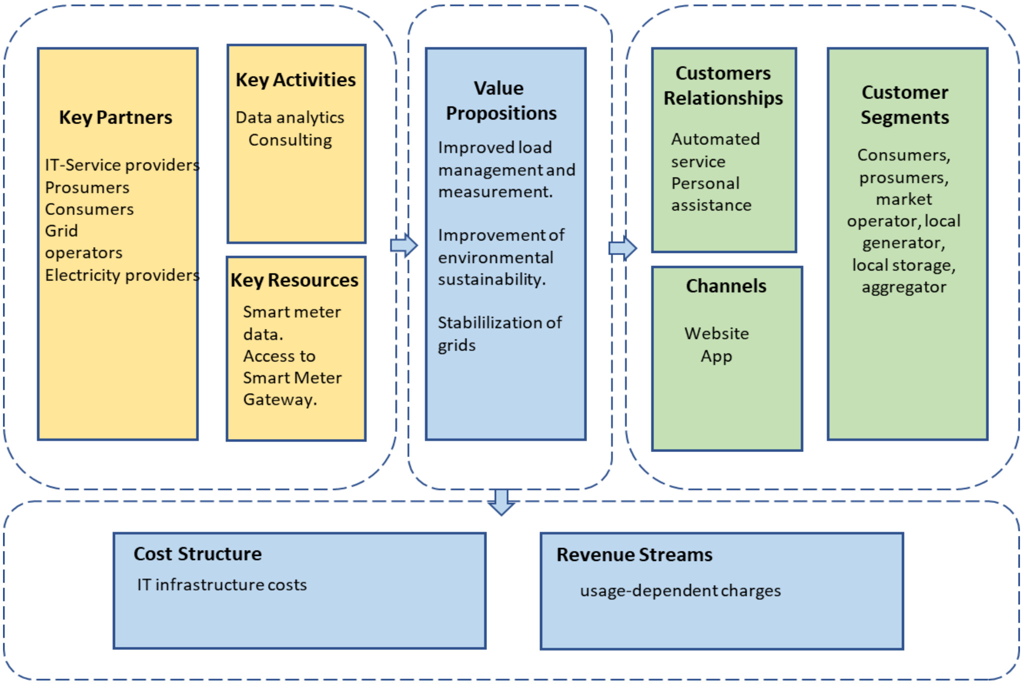

Figure 23 – Smart meter provider canvas BM.

Horizon 2020
European Union Funding
for Research & Innovation

5. Overview of the demo-sites business models

5.1 Rural Ski Village Manzaneda (Spain)

Manzaneda is a municipality in the eastern province of Ourense, in the Galicia region of north-west Spain. The site is a remote rural village and ski resort with residential properties and various commercial establishments. The resort hosts over 100.000 visitors per year and is home to around 900 permanent inhabitants. The energy community of Manzaneda is formed by different end users: private residential (163 residential private owners plus 53 owned by MEISA), commercial (Hotel Meisa and related facilities) and industrial (ski lifts, commercial area, shops, restaurant, swimming pool, multi-sports hall, water treatment plant, artificial snow guns), services users (TELEFONICA, VODAFONE, RETEGAL and more). MEISA also owns solar thermal panels that are currently installed and generate heat water for the swimming pool.

The demo site at Manzaneda is operated by Electromanzaneda DSO, whose stakeholder is MEISA, a public owned company created to operate the Manzaneda Ski Resort. Electromanzaneda DSO is also responsible for the electrical energy supply to the ski resort and the operation and maintenance of the distribution grid. The scope is to increase the percentage of RES in the local grid.

The ski resort has also summer activities; therefore, it has a full year consumption, which allows the PV systems installation.

In the RENAISSANCE project, Exeleria will install 3 PV plants which will be connected to MEISA apartment building consumptions:

- 80 kWp in a canopy structure which will also serve as van parking shelter
- 20 KWp + 20kW battery in the ski lift storage building roof

Horizon 2020
European Union Funding
for Research & Innovation

- 50 KWp in the restaurant roof

On the one hand, Exeleria will have a contract with MEISA consisting in a PPA in which MEISA will pay a fixed price for the electrical energy consumed. On the other hand, a thermal third party will provide MEISA with thermal energy and the fuel vehicles will be replaced by the EV.

5.1.1 Electricity services

Regarding the electricity services, the current situation is represented in the following Table 12.

Current actors	Current Business Model
Consumer	NO
Grid operator (Electromanzaneda)	Value proposition: ▸ Guarantee the security and the continuous electric supply. ▸ Responsible for planning, constructing and maintaining the grid. Revenue stream: ▸ Regulated income as grid manager (charges for the grid connection) Cost structure: ▸ IT infrastructure ▸ Grid infrastructure (replacement, new grid) ▸ Grid maintenance
Retailer	The traditional retailer or the free market retailer depending on the consumer choice. Value proposition: ▸ Provide electricity to the end-consumers Revenues stream: ▸ Sell energy to the end-consumer Cost structure ▸ IT infrastructure ▸ Purchase energy into the wholesale market

Table 12 - Current electricity services BM in Manzaneda demo-site.

Horizon 2020
European Union Funding
for Research & Innovation

Within the RENAISSANCE project, MEISA has an energy purchase agreement with Exeleria at a fixed price per electricity. In this situation, new business models will come up in the rural ski Manzaneda site. An incentive program will be defined to encourage private consumers to "play the game" optimizing their common time dependence consumption with the smart contracts. The next Table 13, shows the information regarding the new actors and its corresponding BM.

Potential actors	Business Model implementation
Consumer	NO
Prosumer	Value proposition: • Promoting the renewable, local and efficient consumption of the electricity at lower end-user price. Revenue stream: • Incomes for the excess of electricity that goes to the reduction of its invoice. Cost structure: • Investment cost of the PV panels and ESS, if applied.
ESCO	Value proposition: • Provision of green energy at a low risk price Revenue stream: • Energy selling agreement at fix price (€/MWh per green energy generated) Cost structure: • Installation, operation and maintenance of the PV panels and batteries
LEC market operator	Value proposition: • Enables the possibility to exchange electricity at a lower price than the invoice and regulates the trading. Revenue stream: • Incomes for the use of the platform (for each transaction in the smart contracts receives a fee) Cost structure: • Acquisition cost of the platform. • IT infrastructure

Horizon 2020
European Union Funding
for Research & Innovation

Grid operator	Value proposition: ‣ Guarantee the security and the continuous electric supply ‣ Responsible for planning, constructing and maintaining the grid Revenue stream: ‣ Regulated income as grid manager (charges for the grid connection) ‣ Distribution facilities cost avoidance Cost IT infrastructure ‣ Grid infrastructure (replacement, new grid) ‣ Grid maintenance
Retailer	Value proposition: ‣ Provide electricity to the end-consumers Revenues stream: ‣ Sell energy to the end-consumer ‣ Flexibility balance of the LEC Cost structure ‣ IT infrastructure ‣ Purchase energy into the wholesale market and LCE markets
Aggregator	Value proposition: ‣ Group energy consumption or generation of several consumers or generators Revenues stream: ‣ Margin on purchasing or selling energy Cost structure ‣ Purchase of energy ‣ New smart grid technology
Local energy storage owner	Value proposition: ‣ Provide flexibility to the energy community Revenues stream: ‣ Sale of the energy stored Cost structure ‣ Storage deployment, operation and maintenance
Platform provider	Value proposition: ‣ Allowance that all electricity transactions can be managed and monitored Revenues stream: ‣ Sale and maintenance of the platform Cost structure ‣ Creation of new services and products

Horizon 2020
European Union Funding
for Research & Innovation

	‣ Maintenance
Smart meters provider	Value proposition: ‣ Provide the smart meter to the consumers Revenues stream: ‣ Sale of the smart meters Cost structure ‣ Manufacture of smart meters
App provider	Value proposition: ‣ Provide new applications for energy management in real-time to consumers Revenues stream: ‣ Sell of the apps (Applications) Cost structure ‣ App development

Table 13 - Future electricity services BM in Manzaneda demo-site.

In Manzaneda demo site, a third-party company provides the energy services to the members of the public company of MEISA. This global business model allows the supply of energy generated by the PV panels to the different buildings or areas as in a canopy structure which will also serve as van parking shelter, in the ski lift storage building roof and in the restaurant roof; that is to say to the energy community. The energy operation contract model, in which the third-party company is responsible for designing, financing, building, installing, operating and maintaining the PV panels, while retaining the ownership of the power plant, is based on the engagement with the client to the energy generated self-consumed in the buildings for a fixed price.

The main benefits for MEISA are the avoidance of an up-front payment in the initial investment of the PV panels, outsourcing of the operation and maintenance of the PV system by the third-party company. The customer only pays for the energy generated by the PV panels, so the financing, equipment acquisition and personal management costs are avoided.

Other results of the development of the third-party ownership model are the contribution to the enhancement and use of solar energy through PV

Horizon 2020
European Union Funding
for Research & Innovation

panels, which allow the energy community to obtain savings in the electricity bills. Furthermore, the grid operator (Electromanzaneda) can avoid new infrastructure and replacements of the distribution systems with the penetration of RES and batteries.

This LEC business model also allows the appearance of other new actors as the LCE market operator, which in this case can be done by Electromanzaneda grid operator in order to supervise the different energy services, the aggregator and local energy storage. The purchase in the acquisition of the platform and IT infrastructure is necessary. For this reason, some products are necessary to implement the new energy trading services which are as follows:

- Local energy exchange market platform, in which the provider supports the platform, the maintenance service for the platform and provides the updates for the platform.
- Digital interface service, in which the providers supplies, firstly the apps and web application to allow the interaction between the local platform and the members of the community, secondly the maintenance service for the platform and, finally provides the updates for the platform.
- Consumption and generation service, in which this agent provides information around the prediction of electricity demand or generation of an individual prosumer/consumer, groups of prosumers/consumers or the global community.
- Smart-meters in which the provider supplies the smart-meters to the Local Energy Community.

Horizon 2020
European Union Funding
for Research & Innovation

Additionally, in this new context (see Figure 24), new energy scenarios appear, which allow the following energy markets:

- Peer-to-peer
- Energy storage capacity
- Local power demand side management
- Control of power exchange with the main grid
- Flexibility services to the external DNO (Distribution Network Operator)

Horizon 2020
European Union Funding
for Research & Innovation

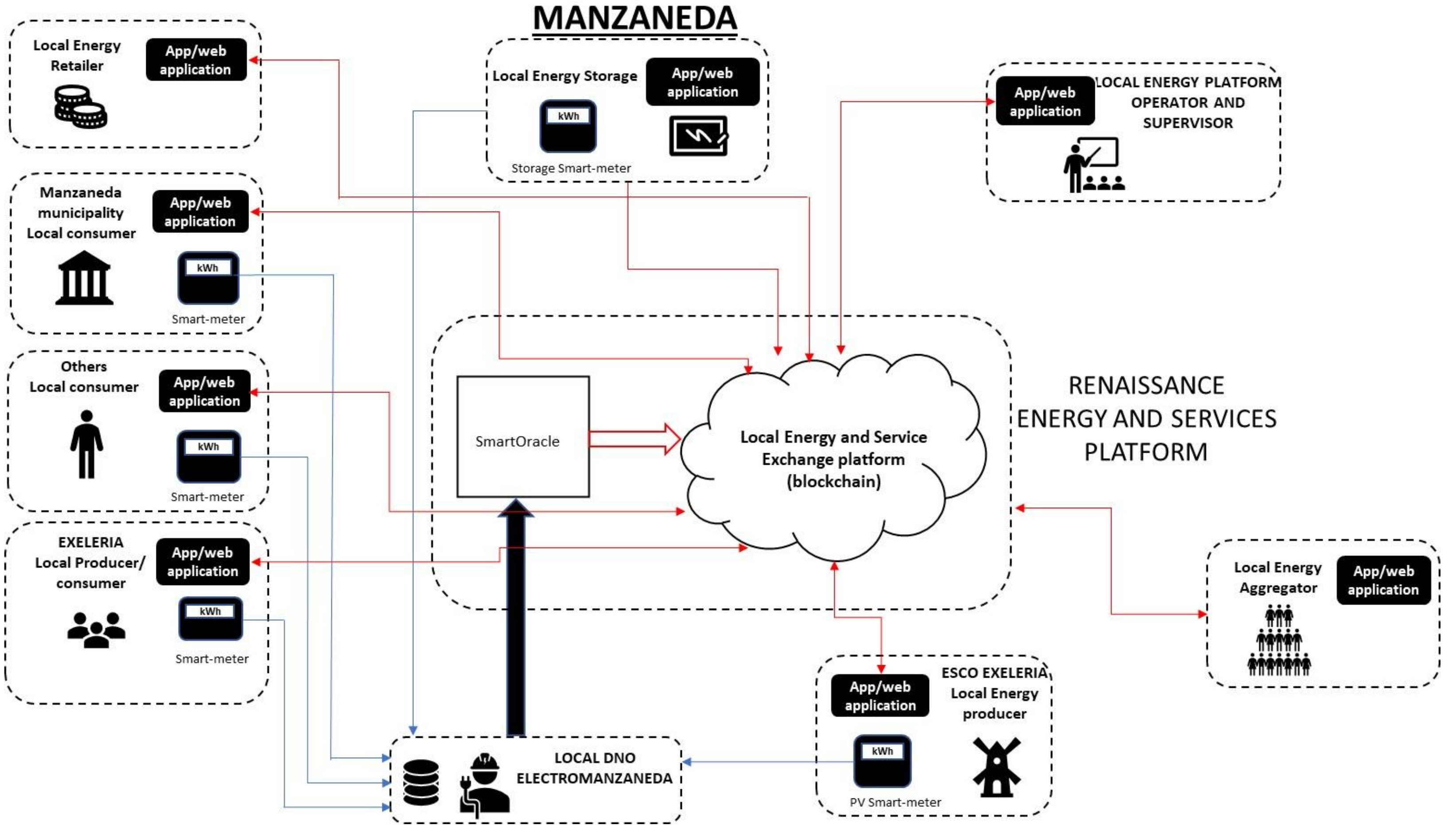

Figure 24 – Energy service scenarios representation in Manzaneda.

Horizon 2020
European Union Funding
for Research & Innovation

Peer-to-peer

The P2P (Peer-to-Peer) energy market includes the buying and selling process of energy inside a local energy community. This market includes auctions (for selling or buying) and bids in order to try to be the winner of the auction.

The actors involved in the P2P energy market are gathered in Figure 25:

- **Local Energy Market supervisor**: this agent supervises the P2P auctions and imposes technical limits or restrictions to these transactions. This agent manages the list of members of the local energy market.
- **Prosumer**: this agent is a local prosumer that can act as an energy producer (selling the right to consume its energy in the local energy market and receiving Ecoins (Energy coins) from the buyer) or an energy consumer (has an energy contract with the local retailer -out of the local energy market- and can buy energy in the local energy market).
- **PV Generator**: this agent is a local renewable energy producer and sells the right to consume its energy in the local energy market. The producer receives Ecoins from the buyer.
- **Local energy retailer**: this agent has contracts with consumers providing them with energy acquired in the pool market. To bill consumers, the retailer considers contracts made in the community between energy producers and local consumers. In addition, the local retailer is the guarantor of the balance of the energy exchange contracts between producers and consumers, covering the production deficits that the producer may have. The local retailer receives Ecoins from the prosumer or PV generator when it must cover the generation deficits.
- **Aggregator**: This agent manages many small clients (consumers, prosumers, generators) in order to buy or sell energy in the local energy market.
- **Consumers**: This agent buys energy on the local energy market.

Horizon 2020
European Union Funding
for Research & Innovation

In practice, the PV generator, the producers and the aggregator as producer can be all considered as producers. Equally, the consumers and the aggregator as a consumer can be both considered as consumers. For this reason, the actors involved in the P2P market can be summarized to:

- Producer (or seller)
- Consumer (or buyer)
- Supervisor
- Local Retailer

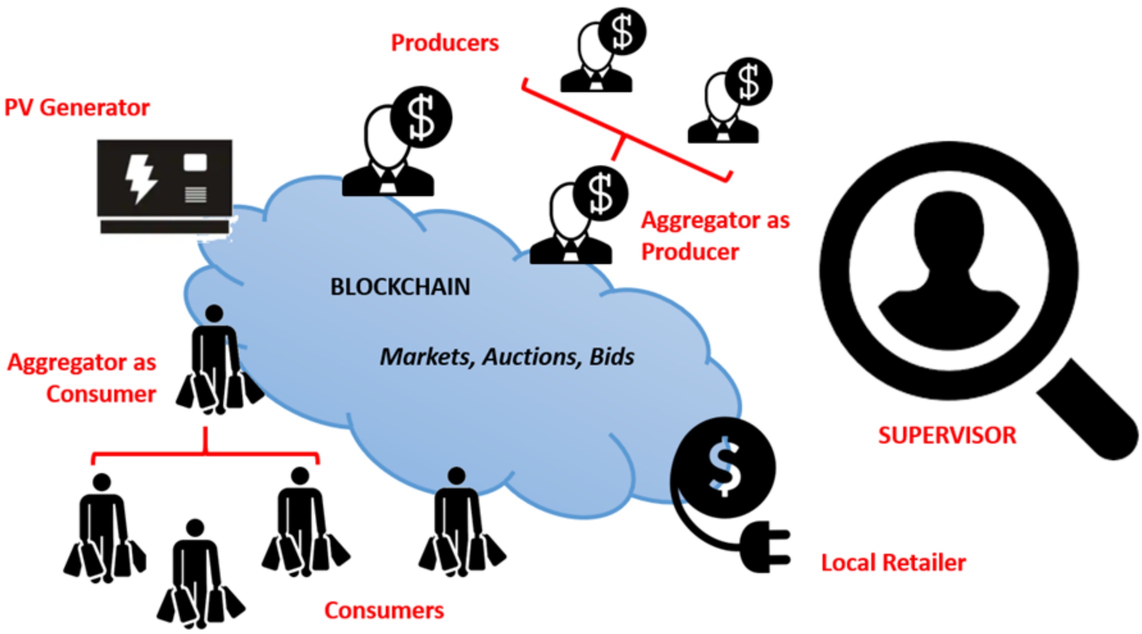

Figure 25 – P2P energy service actors.

With the aim to implement the P2P energy market a selling auction can be implemented. A producer (or seller) wants to sell its energy and opens an auction. Several consumers can bid for that energy during an auction predefined time or until the producer desired price is offered. If an energy deficit from the producer occurs, the local retailer will give its energy and the producer will pay for that energy.

Horizon 2020
European Union Funding
for Research & Innovation

Energy storage market

The energy storage capacity market includes the buying of "space of storage" of an energy storage system owned by a third party. The solution includes the performance of an energy storage capacity auction for the individual prosumer in the local energy community for the lifetime of the storage.

The actors involved in the energy storage capacity smart contract service are gathered in Figure 26.

- **Local Energy Exchange Market Supervisor**: this agent supervises the energy storage smart contract performance and imposes economical limits and technical limits or restrictions to the battery operation based on the information sent by the storage owner. This agent manages the list of members of the local energy storage smart contracts.
- **Storage owner**: this agent is the owner and purchaser of the energy storage system. This agent sells a storage value capacity in kWh in Ecoins for being used by the prosumers.
- **Prosumer**: this agent is a local prosumer that can buy "space of storage" from an energy storage system buying capacity and paying Ecoins to the storage owner. The prosumer wants to store the excess generation in the energy storage system and to withdraw it at any desired time interval. For that, a smart contract is needed to certify the prosumer decision to store and withdraw the energy.
- **PV Generator**: this agent is a local generator that can also buy "space of storage" from an energy storage system buying capacity. In the same manner, as the prosumer, the PV generator can withdraw the energy stored at any desired time interval in order to supply the consumers at that time via other contracts.

Horizon 2020
European Union Funding
for Research & Innovation

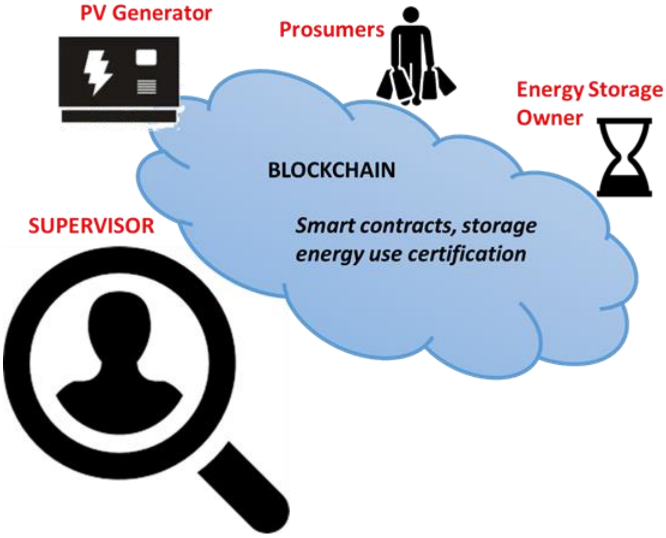

Figure 26 – Energy storage capacity actors.

In practice, the PV generator and the prosumers can be all considered as producers. For this reason, the actors involved in the energy storage smart contract scenario can be summarized as:

- Energy Storage Owner
- Producer
- Consumer
- Supervisor

Initially, the storage owner determines the capacity that can be used as a “space” for the prosumers’ usage. After the storage owner determines the capacity available for the prosumers, an auction is established to sell “space of storage” for a specified period of time with a maximum number of FECS (Full Equivalent CycleS), until the total energy storage capacity is matched. That means that the prosumers who bid at the higher price will match the auction and they can use the space of storage offered.

Horizon 2020
European Union Funding
for Research & Innovation

Local power demand side management

The local power demand energy scenario includes the process of reducing the amount of power consumption to the consumers/aggregators. The local DNO wants to limit the power at the connection point during a period of time. For that, he opens an auction where the consumers and aggregators can bid to meet the requirements to reduce power.

The actors involved in the local power demand side management scenario are gathered in Figure 27.

- **Supervisor**: this agent supervises the local power demand side management auction and imposes technical limits or restrictions to these transactions (Ecoins, kW). This agent manages the list of members of the local power demand side management scenario.
- **Local DNO**: this agent offers Ecoins to the consumers or aggregators that do not consume more than a defined value for a period of time.
- **Consumer:** this actor takes advantage of the bonus offers by the local DSO reducing their consumption level.
- **Aggregator**: the aggregator takes advantage of the bonus offered by the Local DNO. The bonus is transferred to its clients that reduce their consumption level. The clients pay a fee for having an aggregator.

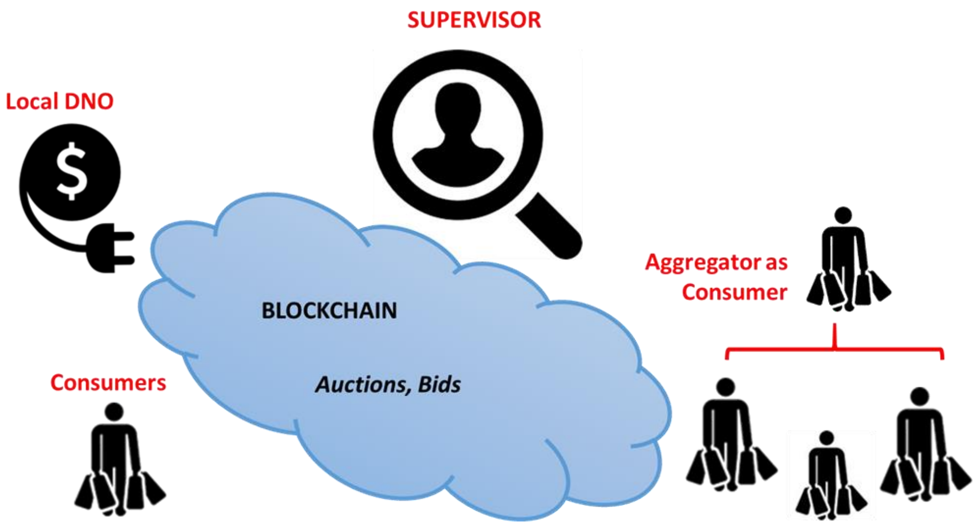

Figure 27 – Power load side management energy service actors.

Horizon 2020
European Union Funding
for Research & Innovation

In practice, the PV generator, the producers and the aggregator as a producer can be all considered as producers. Equally, the consumers and the aggregator as a consumer can be both considered as consumers. For this reason, the actors involved in the P2P scenario can be summarized to:

- Consumer
- Supervisor
- DNO

In order to implement the power load demand side management, the local DNO opens an auction with the requirement of reducing the total local community power to a value at a desired price. Several consumers can bid for that energy during an auction predefined time or until the total local community power is offered.

<u>Control of power exchange with the main grid</u>

This smart contract contributes to the service of maintaining a power level at the desired value at the PCC (Point of Common Coupling) between the local community and the main grid. For that, an auction is established where the storage owner can bid in order to meet the requirements of the local DNO.

The actors involved in the power exchange with the external grid smart contract are gathered in Figure 28.

- **Supervisor:** This agent supervises the auction and imposes technical limits or restrictions to these market transactions. This agent manages the list of members that can participate in the power exchange with the main grid scenario.
- **Local DNO:** this agent offers Ecoins to the local storage owners in order to fulfil with requirements from the main grid.
- **ESS Owners:** This actor provides the power required for the local DNO to support the external main grid.

Horizon 2020
European Union Funding
for Research & Innovation

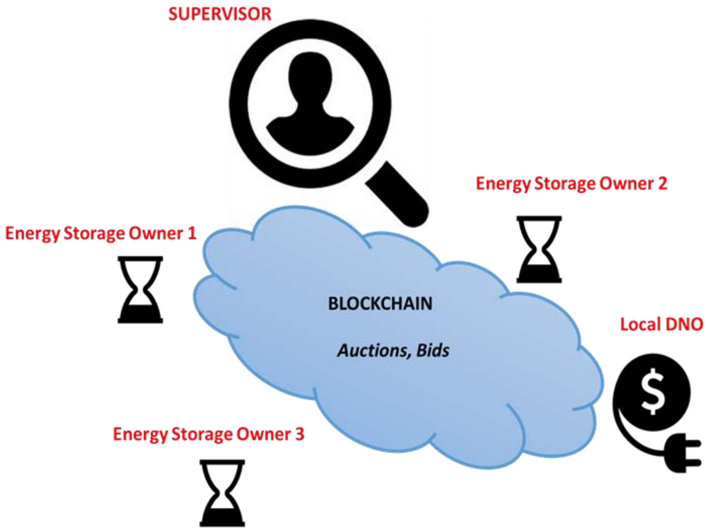

Figure 28 – Power management exchange scenario actors.

In the control of power exchange, the local DNO opens an auction with the requirement of the main grid. In one hand, if the DNO needs to decrease power in the network, the local energy storage owners bid in order to provide this service by storing energy from the grid. In the other hand, if the DNO needs to increase power in the network, the local energy storage owners bid in order to provide this service by withdrawing energy from the storage.

Flexibility services to the external DNO

This energy service includes the management of the flexibility services with the external DNO to maintain the stability of the network. Therefore, the external DNO launches an auction for the local DNOs in order to keep a required power value at the PCC (Point of Common Coupling) between the local community and the main external grid.

Horizon 2020
European Union Funding
for Research & Innovation

The actors involved in the flexibility services to external DNO scenario are gathered in Figure 29.

- **Supervisor**: This agent supervises the flexibility services to external DNO smart contract imposing technical limits or restrictions to these transactions. This agent manages the list of members of the flexibility services with the external grid scenario.
- **Local DNOs**: this agent commits with the flexibility services with the external DNO through managing the services internally in the local community as local power side management and control of power exchange with the main grid.
- **External DNO**: this agent offers Ecoins to the local DNO in order to maintain the local distribution network at the desired power value.

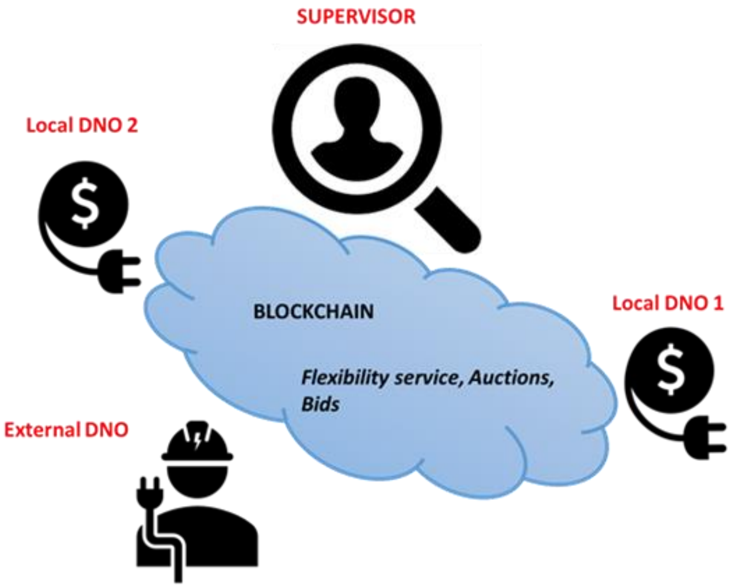

Figure 29 – Flexibility services to external DNO scenario actors.

The external DNO opens an auction with the requirement of establishing a power at a certain value at the PCC between the local community and the main grid. The auction is launched by the external DNO fulfilling the requirements of the smart contract supervisor. If the external DNO needs to decrease or increase the power in the PCC, the local DNOs bid if they want in order to provide this service.

Horizon 2020
European Union Funding
for Research & Innovation

5.1.2 Thermal services

Regarding the thermal services, the current situation is that one utility is in charge of generating, distributing and retailing the heat to the end-users as explained below (Table 14).

Current actors	Current Business Model
Vertical thermal utility	Value proposition: ▸ The thermal utility generates, distributes and retails the heat at a fixed price to the consumers Revenues stream: ▸ Sell heat to the end-consumer Cost structure: ▸ Heat generation and distribution infrastructure

Table 14 - Current thermal services BM in Manzaneda demo-site.

Within the LEC framework, new business models (Table 15) will come up for the new thermal retailers that offer dynamization of the tariff prices for the energy, the platform provider and the app provider.

Potential actors	Business Model implementation
Prosumer	Value proposition: ▸ Promoting the self-consumption of thermal energy Revenue stream: ▸ Incomes for the sale of thermal energy Cost structure: ▸ Investment cost of the solar thermal panels
Vertical thermal utility	Value proposition: ▸ The thermal utility establishes different modalities of contracts and different tariffs to the end-users. Revenues stream: ▸ Sell heat to the end-consumer Cost structure ▸ Biomass heat provision from the traditional vertical utility

Horizon 2020
European Union Funding
for Research & Innovation

Thermal retailer	Value proposition: The thermal utility establishes different modalities of contracts and different tariffs to the end-users. Revenues stream: Sell heat to the end-consumer Cost structure Installation, operation and maintenance costs
LEC market operator	Value proposition: ▸ Enables the possibility to exchange heat in the platform. Revenue stream: ▸ Incomes for the use of the platform (for each transaction in the smart contracts receives a fee) Cost structure: ▸ Acquisition cost of the platform.
Platform provider	Value proposition: ▸ Allowance that all thermal transactions can be managed and monitored Revenues stream: ▸ Sale and maintenance of the platform Cost structure ▸ Provide the platform for thermal services ▸ Maintenance
App provider	Value proposition: ▸ Provide new applications for thermal management Revenues stream: ▸ Sale of the Apps Cost structure ▸ App development

Table 15 - Future thermal services BM in Manzaneda demo-site.

In Manzaneda, MEISA owns the solar thermal panels which are installed in the swimming pool and operated to generate heat water for the pool. Moreover, a vertical thermal utility sells the thermal kWh at a fixed price to the customers. In the Renaissance context, the vertical thermal utility could offer other ways of tariffs and modalities for incentive the thermal demand

Horizon 2020
European Union Funding
for Research & Innovation

response. In addition, new retailers can also supply the LEC with thermal energy considering other formulas of pricing. The LEC market operator will also benefit by the fees received from the users due to the thermal transactions. In the same way, as in the electricity vector, other actors as the platform and app providers will facilitate the thermal transactions via smart contract.

This LEC business model allows also the appearance of other new actors as the LEC market operator. The purchase in the acquisition of the platform and IT infrastructure is necessary. For this reason, some products are necessary in order to implement the new energy trading services which are as follows:

- Local energy exchange market platform, in which the provider supports the platform, the maintenance service for the platform and provides the updates for the platform.
- Digital interface service, in which the providers' supplies, firstly the apps and web application to allow the interaction between the local platform and the members of the community, secondly the maintenance service for the platform and, finally provides the updates for the platform.
- Consumption and generation service, in which this agent provides information around the prediction of thermal demand or generation of an individual prosumer/consumer, groups of prosumers/consumers or the global community.
- Smart-meters in which the provider supplies the thermal smart-meters to the Local Energy Community.

Horizon 2020
European Union Funding
for Research & Innovation

5.1.3 Mobility services

In the mobility service, the transportation between the resort and Manzaneda personnel from the nearest town to Manzaneda is done currently via fuel vehicles (see Table 16).

Current actors	Current Business Model
Transport leasing provider	NO

Table 16 - Current electromobility services BM in Manzaneda demo-site.

In the framework of RENAISSANCE project, potentially the fuel vehicles could be changed to electric vehicles, so new business models (Table 17) could be designed.

Potential actors	Business Model implementation
Transport leasing provider (EV owner)	Value proposition: ▸ Electromobility services to the customers and staff Revenues stream: ▸ Income for vehicle rental Cost structure ▸ Replacement of fuel vehicles with electric vehicles ▸ Electric charging energy purchase
EV consumer	NO
LEC market operator	Value proposition: ▸ Enables the possibility to exchange mobility services in the platform. Revenue stream: ▸ Incomes for the use of the platform (for each transaction in the smart contracts receives a fee) Cost structure: ▸ Acquisition cost of the platform.
Platform provider	Value proposition: ▸ Allowance that all mobility transactions can be managed and monitored Revenues stream: ▸ Sale and maintenance of the platform

Horizon 2020
European Union Funding
for Research & Innovation

	Cost structure ‣ Provide the platform for electromobility services ‣ Maintenance
App provider	Value proposition: ‣ Provide new applications for mobility management Revenues stream: ‣ Sale of the Apps Cost structure ‣ App development

Table 17 - Future electromobility services BM in Manzaneda demo-site.

Due to the penetration of EV in Manzaneda, new actors will come up in the LEC. The EV transport leasing provider can rent the EV vehicles for the staff and customers of the ski resort by using the smart contracts obtaining an income and reducing the initial investment in the purchase of the EV.

So, in electromobility a new energy service appears which is the electric vehicle renting. The electric vehicle owner offers their EV for a period and receives Ecoins from the consumer of this service and the EV consumer uses the EV and pay Ecoins for this service.

The electric vehicle renting service includes the process of how a customer can rent an electric vehicle. The main point is to consider that electric vehicles are smart, so the consumer can get information about the different cars renting prices. Once the customer selects an electric vehicle during a specified time, the renting market is launched, and it finishes when the customer gives the electric car back to the smart renting shop. At that moment, the amount of the specific car renting price is transferred to the owner and if there is no penalty this is included in the transference. Finally, the EV owner is responsible to charge the EV when it is necessary.

Horizon 2020
European Union Funding
for Research & Innovation

5.2 Kimmeria Student Buildings, Xanthi (Greece)

The pilot site is located in a rural area about 1 km west of the city of Xanthi and 1 km east of the Kimmeria Village, in North Greece. It includes a building complex owned by Democritus University of Thrace and it is used for the accommodation of its students. It consists of 11 buildings of 15.000 m2 area that include 8 students' residences buildings, 1 electromechanical equipment building, 1 restaurant and 1 amphitheater. Students' residences are provided free of charge, therefore characterizing the buildings as social housing. Students enter the student housing facilities based on economic criteria and services are offered free of charge. The building complex is constructed in two phases, one completed in 1990 and one completed in 1999. The students' residences include 535 double rooms, 24 single rooms and 9 rooms for disabled students.

The heating and domestic hot water (DHW) of the buildings is performed centrally and through the extensive piping network. This network serves all students' residences and the amphitheatre, while the restaurant has a specific heating and domestic hot water system. The heating network consists of 5 branches that use a specific circulation pump. Each student's residences building has a hot water storage tank of 2,500 liters in order to cover its domestic hot water demand. The amphitheatre is the only building that is being cooled.

DUTH University has invested in RES and thermal plants in order to reduce the CO2 emissions and benefit in the reduction of the energy bills. In terms of electricity, the building complex is connected through a substation of 750 kVA with the medium voltage national grid operated by DEDDIE S.A.

Horizon 2020
European Union Funding
for Research & Innovation

5.2.1 Electricity services

Regarding the electricity services, the current situation is represented in the following Table 18.

Current actors	Current Business Model
Consumer	NO
Grid operator (DEDDIE)	Value proposition: ▸ Guarantee the security and the continuous electric supply. ▸ Responsible for planning, constructing and maintaining the grid. Revenue stream: ▸ Regulated income as grid manager (charges for the grid connection) Cost structure: ▸ IT infrastructure ▸ Grid infrastructure (replacement, new grid) ▸ Grid maintenance ▸ Quality and continuity of supply of electricity ▸ Measurement of electricity consumption
Retailer	The traditional retailer or the free market retailer depending on the consumer choice. Value proposition: ▸ Provide electricity to the end-consumers generally at flat tariff rate Revenues stream: ▸ Sell energy to the end-consumer Cost structure ▸ IT infrastructure ▸ Purchase energy into the wholesale market

Table 18 - Current electricity services BM in DUTH demo-site.

Before the installation of the RES assets, DUTH was paying from its yearly budget the energy consumed in the student housing facilities. The RES assets reduce the energy bills for DUTH. Within the Renaissance framework, an innovative credit-incentive program to the students is going to be implemented and validated.

Horizon 2020
European Union Funding
for Research & Innovation

DUTH has invested in wind turbines and PV with the purpose to reach social, environmental and economic objectives:

1. Promote social innovation in student housing
2. Reduce primary energy consumption and CO_2
3. Reduce the cost of energy for student

The next table shows information regarding the new actors and new business models.

Potential actors	Business Model implementation
Consumer	NO
Prosumer: -DUTH -Xanthi -Local industry	Value proposition: ‣ Promoting the renewable, local and efficient consumption of the electricity at lower end-user price. Revenue stream: ‣ Incomes for the excess of electricity that goes to the reduction of its invoice ‣ Invoice reduction due to the demand response programs. Cost structure: ‣ Investment cost of the RES. ‣ Acquisition cost of the platform. ‣ IT infrastructure.
Grid operator (DEDDIE)	Value proposition: ‣ Guarantee the security and the continuous electric supply. ‣ Responsible for planning, constructing and maintaining the grid. Revenue stream: ‣ Regulated income as grid manager (charges for the grid connection). Cost structure: ‣ IT infrastructure ‣ Grid infrastructure (replacement, new grid) ‣ Grid maintenance ‣ Quality and continuity of supply of electricity ‣ Measurement of electricity consumption

Horizon 2020
European Union Funding
for Research & Innovation

LEC market operator (DUTH)	Value proposition: ‣ Enables the possibility to exchange electricity in the platform. Revenue stream: ‣ No revenues Cost structure: ‣ Acquisition cost of the platform.
Retailer	The traditional retailer or the free market retailer depending on the consumer choice. Value proposition: ‣ Provide electricity to the end-consumers Revenues stream: ‣ Sell electricity to the end-consumer ‣ Flexibility balance of the LEC Cost structure ‣ IT infrastructure ‣ Purchase electricity into the wholesale market and LEC markets
Platform provider	Value proposition: ‣ Allowance that all electricity transactions can be managed and monitored Revenues stream: ‣ Sale and maintenance of the platform Cost structure ‣ Creation of new services and products ‣ Maintenance
Smart meters provider	Value proposition: ‣ Provide the smart meter to the consumers Revenues stream: ‣ Sale of the smart meters Cost structure ‣ Manufacture of smart meters
App provider	Value proposition: ‣ Provide new applications for energy management in real-time to consumers Revenues stream: ‣ Sell of the Apps Cost structure ‣ App development

Table 19 – Future electricity services BM in DUTH demo-site.

Horizon 2020
European Union Funding
for Research & Innovation

In Kimmeria village, DUTH University is the owner of the RES, both for electricity and thermal generation, with the purpose to reduce the cost of the energy while at the same time be sustainable. Within the pilot site, each building is connected to the main distribution pillar through exclusive electrical cable (line). This internal electricity network operates at low voltage (400V) and responsible for its maintenance is DUTH. In this demo site, the global business model allows the reduction of DUTH costs through self-consumption. In order to carry out this reduction, DUTH will incentivise the students in different ways: 1) consume from the green energy in situ of the energy community at the times when this energy is producing, 2) save energy, that is, reduce its consumption and vary its demand profile, that is, demand response. DUTH will be responsible to manage this incentive program through smart contracts.

Other results of the development of the customer-owned RES assets model is the sale of the excess of the energy to the city of Xanthi or to the closest intensive industries, which allows the energy community to obtain savings in the electricity bills. A LEC market operator can act as a supervisor enabling the possibility to exchange heat in the platform, receiving a fee for the use of the platform that has acquired previously.

Other sub-business models are the distribution system operator and the retailer, in which their new business models do not vary so much. In the first one, the revenue and cost structure is the same, however the values of incomes and costs can be both be reduced due to the existence of a LEC. In the case of the retailer, different tariffing ways can appear depending on the consumption and it can also acts balancing the microgrid in case there is not so enough self-consumption supplying the electricity that comes from the external grid through the wholesale market. Other actors, the same as in Manzaneda, are the providers of new products and applications for the good performance of the collective self-consumption and the energy exchange in the energy community which are as follows:

Horizon 2020
European Union Funding
for Research & Innovation

- **Local energy exchange market platform**, in which the platform provider supports the platform, the maintenance service for the platform and provides the updates for the platform.
- **Digital interface service**, in which the Apps and web application supplies the apps and web application to allows the interaction between the local platform and the member of the community, the maintenance service for the platform and provides the updates for the platform.
- **Consumption and generation service**, in which this agent provides information around the prediction of demand or generation of an individual prosumer/consumer, groups of prosumers/consumers or the global community.
- **Smart-meters** in which the provider supplies the smart-meters to the Local Energy Community.

Additionally, in this new context, it appears new energy or service scenarios (see Figure 30) which are the following ones:

- Social electricity supply
- Non-energy services

P2P (surplus of the in situ green energy)

Horizon 2020
European Union Funding
for Research & Innovation

DUTH

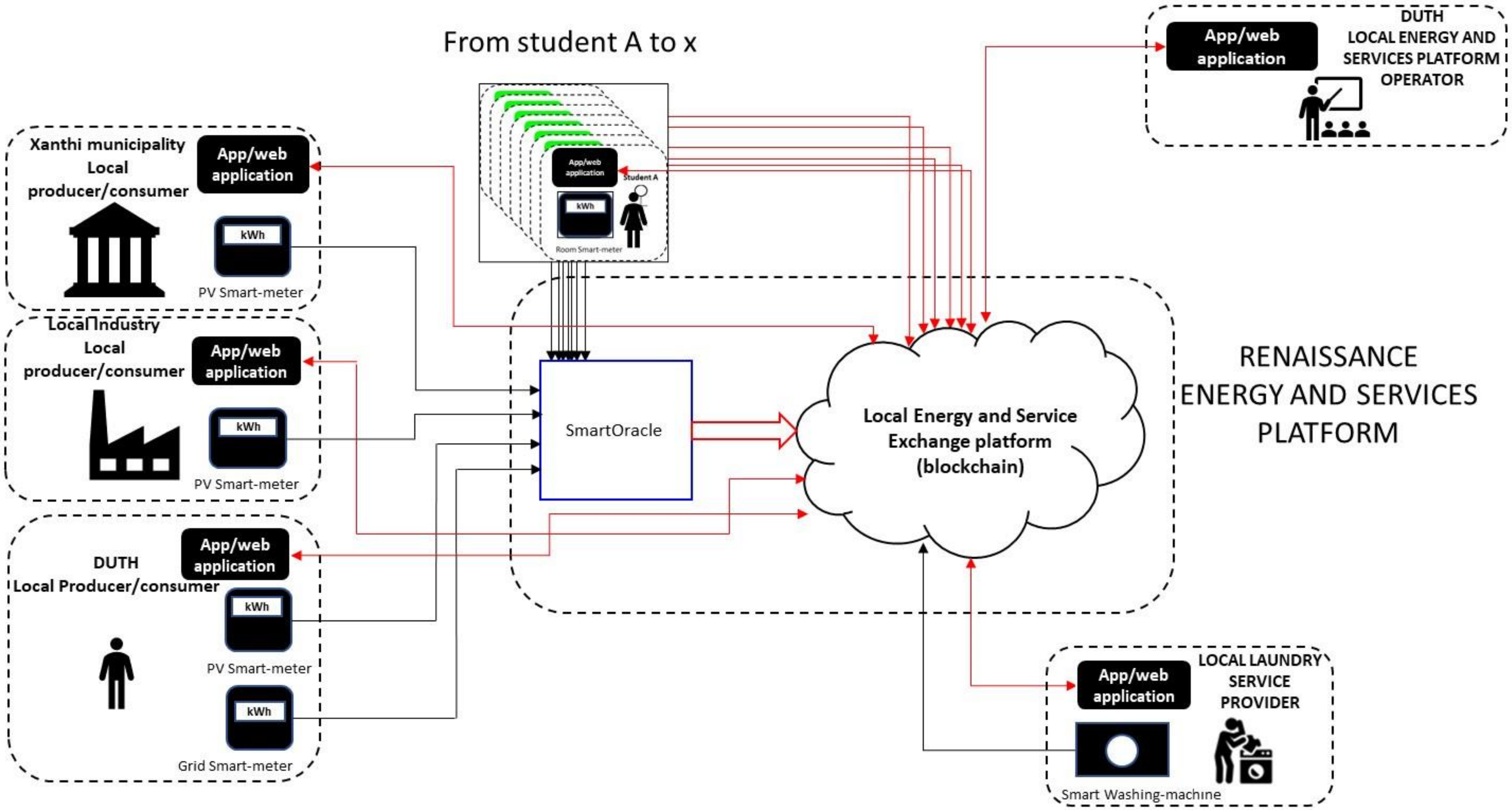

Figure 30 – Energy service scenarios representation in DUTH.

Horizon 2020
European Union Funding
for Research & Innovation

Peer-to-peer

In this market, DUTH supervises the Ecoins transactions and imposes the limits and restrictions to these transactions (Ecoins, kWh). The local prosumers, Xanthi municipality and the local industry, provide Energy (virtual) to DUTH. This energy is later distributed to the DUTH's internal consumers (students). This market will be designed more in detail in the next version of this document.

Social electricity supply

Here we instantiate the general smart contract form explaining the process of energy units transfer at the student housing facilities of DUTH. Each student, resident of the DUTH student housing facilities at Kimmeria, Xanthi, will be credited once entering the facilities every year with a predefined number of energy coins (Initial Energy Coins – IEC).

The microgrid of the DUTH student housing community will consist of:

a) Energy consumers that are mainly the students of the dorms, the industry (Techni A.E.) and the Municipality of Xanthi
b) Energy producers/providers as stakeholders:
    i. DUTH community of RES energy production (in situ green energy producers) **(A)**
    ii. The Municipality of Xanthi and local industry (out situ energy producers) **(B)**
    iii. The national grid **(C)**

Different pricing will apply for energy coins (representing kWh consumed) depending on who delivers the energy consumed within the community. Specifically:

- If the consumed energy comes from DUTH (A), then each kWh equals to 0.7 Energy Coins. In this case, the students will "pay" less for kWh consumed from the DUTH Energy Community i.e. RES. It is very important to raise student's awareness of changing their behaviours to consume thermal and electricity when RES is mostly available.

Horizon 2020
European Union Funding
for Research & Innovation

- If the consumed energy comes from the Municipality or the local industry (B), then each kWh corresponds to 1 Energy Coin (EC).
- If the consumed energy comes from the national grid (C), then each kWh corresponds to 1,5 Energy Coins. This means that students will be charged more if they consume from the grid.

The total IECs to be distributed evenly and equally to the students at the beginning of each academic year will represent 80% of the annual RES production (kWh). The rest 20% will be reserved as a backup to cover excess energy needs when required.

For the distribution of IECs the following conditions shall be considered:

- Each student must have a unique identification password. This password will be used for his/her identification and will be linked to the energy consumption behaviour of each student room.
- Each student, during each academic year, will be credited with several IECs. IECs total credits will be affected by the energy consumption behaviour. For example, if a student ends a year with a positive balance of ECs, then she/he will be credited an equal amount of intermediate Energy Coins (iECs) that can only be exchanged for services. Thresholds linked with KPIs will be set for classifying "very good energy behaviour", "good energy behaviour", "bad energy behaviour".

<u>Non-energy services</u>

Services that can be exchanged for ECs include the following ones:

- Electric bicycles renting
- Local businesses service
- Laundry service

In the electric bicycles renting service, the intermediate ECs can be exchanged with time for using these bicycles.

In the local businesses service, the intermediate ECs can be exchanged with discount coupons exchanged at local businesses that are in DUTH, such as restaurants and bookstores.

Horizon 2020
European Union Funding
for Research & Innovation

In the laundry service, another actor comes up under this energy scenario, which is the local laundry service provider who receives Ecoins from the consumer of this service and the social consumer who is the laundry service user pays Ecoins for this service.

5.2.2 Thermal services

Regarding the thermal services, the current situation (Table 20) is that one heat provider (DUTH) is in charge of generating, distributing and retailing the heat to the end-users as explained below. In the campus of DUTH pilot site, there are several heat sources: a biomass boiler, hot water storage, an absorption chiller and geothermal heat pumps.

Current actors	Current Business Model
Heat provider (DUTH)	Value proposition: ▸ The thermal utility generates, distributes the heat Revenues stream: ▸ No revenues (public financing) Cost structure ▸ Heat generation and distribution infrastructure

Table 20 - Current thermal services BM in DUTH demo-site.

Within the LEC framework, new business models (Table 21) will come up as the thermal retailer, platform provider and app provider. As indicated above in the electricity service, the global business model allows the reduction of DUTH invoice, including thermal, through the self-consumption. In order to carry out this reduction, DUTH will incentive the students to consume self-generation, so it is important to consume when there is generation. The business models of the LEC market operator, app and platform provider as the same as explained in the electricity service section.

Potential actors	Business Model implementation
Heat provider	Value proposition:

Horizon 2020
European Union Funding
for Research & Innovation

(DUTH)	‣ Offer thermal energy encouraging the rational use of energy Revenues stream: ‣ No revenues (public financing) Cost structure ‣ Heat generation and distribution infrastructure
LEC market operator (DUTH)	Value proposition: ‣ Enables the possibility the heat supply performs correctly in the platform. Revenue stream: ‣ No revenues. Cost structure: ‣ Acquisition cost of the platform.
Platform provider	Value proposition: ‣ Allowance that all thermal transactions can be managed and monitored Revenues stream: ‣ Sale and maintenance of the platform Cost structure ‣ Provide the platform for thermal services ‣ Maintenance
App provider	Value proposition: ‣ Provide new applications for thermal management Revenues stream: ‣ Sale of the Apps Cost structure ‣ App development

Table 21 – Future thermal services BM in DUTH demo-site.

In the same way as in the electricity services, in the new context it appears new energy services which are the following ones:

- Social energy supply
- Non-energy services
- P2P (surplus of the in situ green energy).

These perform in the same way as the electricity services explained in Section 5.2.1.

Horizon 2020
European Union Funding
for Research & Innovation

5.2.3 Mobility services

Regarding the electromobility services, in Renaissance framework the intermediate ECs can be exchanged by renting the electric bicycles for a while.

5.3 Eemnes (The Netherlands)

The town of Eemnes is located in the centre of the Netherlands, 35 kms from Amsterdam, with 3.600 households. Eemnes seeks to be energy neutral by 2040. This demonstrator aims to validate a local, blockchain enabled, peer-to-peer energy market in an operational environment. During the first three years, the demonstrator size will be between 100-200 participants consisting of households, local business and farmers. The ambition is to scale up to 1.000 participants within Eemnes over a period of 10 years.

Eemnes will implement and validate a blockchain enabled, peer2peer energy market environment. The municipality has also been granted an exemption from the Dutch Electricity Laws by the Ministry of Economic Affairs for a period of ten years.

Eemnes has its own electrical grid: Energie cooperative has contemplated the energy trading project plan. The grid system will localise energy usage through a smart grid, enabling local households and businesses to become 'prosumers'. In addition, due to the nature of blockchain software, all data from the municipality is safe and secure.

The proposed measurement infrastructure will let the connection between the local energy market and the national energy market by creating a gateway connection that complies with the locally supported DSO flexibility market in Eemnes. The i.LECO platform enables overall the Eemnes smart local energy community and delivers this towards the LEC SP (Local Energy Community Service Provider) which deals with the end customers both in digital and in human interaction.

Horizon 2020
European Union Funding
for Research & Innovation

The demonstrator will include high energy efficient dwellings, a local solar farm. The work will be facilitated by member-driven energy cooperation, a local energy market (exception from Dutch regulation: permission for peer-to-peer electricity trading received by Ministry of Economic Affairs, that will become operational under RENAISSANCE), and co-creation of a financing instrument and investments in e-vehicle charging points.

5.3.1 Electricity services

There are currently no electrical production assets installed in this Pilot Site, as each individual household joining the pilot will bring along their own generation assets, mainly PV panels.

Regarding the electricity services, the current situation is represented in the following Table 22.

Current actors	Current Business Model
Consumer	NO
Retailer	The traditional retailer or the free market retailer depending on the consumer choice. Value proposition: ‣ Provide electricity to the end-consumers Revenues stream: ‣ Sell energy to the end-consumer Cost structure ‣ IT infrastructure ‣ Purchase energy into the wholesale market

Table 22 - Current electricity services BM in Eemnes demo-site.

Horizon 2020
European Union Funding
for Research & Innovation

Within the Renaissance framework, in Eemnes pilot site a member-owned customer cooperative is responsible for the management of the LEC. It is a non-profit entity of green energy consumption who promotes a renewable model, which performs the same activities as any other retailer. The cooperative only supply energy to its community members.

Currently, Eemnes is planning to install a battery system for energy storage. The size of the battery is yet to be known, as negotiations with the provider are still ongoing. This storage facility fits in the municipality's vision to become carbon neutral by 2030, as it will help balance the energy demand and supply even more. With the degasification of the Netherlands, renewables will provide a bigger portion of the energy supply. Aside from the benefits, this will also pose difficulties due to the intermittency of renewable energy production. Energy storage is needed to reduce the imbalance between demand and supply.

Another step will be connecting the municipal building and their installed PV. This will strengthen the local energy supply and is also expected to serve as an incentive for the current consumers to install more PV themselves.

The following Table 23 shows the information regarding the new actors and new business models.

Potential actors	Business Model implementation
Consumer	NO
Prosumer	Value proposition: ‣ Promoting the renewable, local and efficient consumption of the electricity at a lower end-user price. Revenue stream: ‣ Incomes for the excess of electricity that goes to the reduction of its invoice. Cost structure: ‣ Investment cost of the PV panels and ESS, if applied.
Local generator	Value proposition: ‣ Provision of green energy at a low risk price

Horizon 2020
European Union Funding
for Research & Innovation

	Revenue stream: ‣ Energy selling Cost structure: ‣ Installation, operation and maintenance of the PV panels and batteries
LEC market operator	Value proposition: ‣ Enables the possibility to exchange electricity at a lower price than the invoice and regulates the trading. Revenue stream: ‣ Incomes for the use of the platform (for each transaction in the smart contracts receives a fee) Cost structure: ‣ Acquisition cost of the platform.
Energy retailer cooperative	The traditional retailer or the free market retailer depending on the consumer choice. Value proposition: ‣ Provide electricity to the end-consumers ‣ Promotes and finance collective renewable energy Revenues stream: ‣ Sell energy to the end-consumer ‣ Flexibility balance of the LEC ‣ Membership fee Cost structure ‣ PV investment ‣ IT infrastructure ‣ Purchase energy into the wholesale market and LEC markets ‣ Maintenance of RES installations
Aggregator	Value proposition: ‣ Group energy consumption or generation of several consumers or generators Revenues stream: ‣ Margin on purchasing or selling energy Cost structure ‣ Purchase of energy ‣ New smart grid technology
Local energy storage owner	Value proposition: ‣ Provide flexibility to the energy community

Horizon 2020
European Union Funding
for Research & Innovation

	Revenues stream: ‣ Sale of the energy stored Cost structure ‣ Storage deployment, operation and maintenance
Platform provider	Value proposition: ‣ Allowance that all electricity transactions can be managed and monitored Revenues stream: ‣ Sale and maintenance of the platform Cost structure ‣ Creation of new services and products ‣ Maintenance
Smart meters provider	Value proposition: ‣ Provide the smart meter to the consumers Revenues stream: ‣ Sale of the smart meters Cost structure ‣ Manufacture of smart meters
App provider	Value proposition: ‣ Provide new applications for energy management in real-time to consumers Revenues stream: ‣ Sell of the Apps Cost structure ‣ App development

Table 23 – Future electricity services BM in Eemnes demo-site.

Some products are necessary in order to implement this new energy trading services which are:

- Local energy exchange market platform, in which the platform provider supports the platform, the maintenance service and likewise provides the updates of it.
- Digital interface service, in which App provider supply the apps and web application to allows the interaction between the local platform and the member of the community, the maintenance service for the platform and provides the updates for the platform.

Horizon 2020
European Union Funding
for Research & Innovation

- Consumption and generation service, in which this agent provides information around the prediction of demand or generation of an individual prosumer/consumer, groups of prosumers/consumers or the global community.
- Smart-meters in which the provider supplies the smart-meters to the Local Energy Community.

Additionally, in this new context, it appears new energy service scenarios (see Figure 31), which are the following energy markets:

- Peer-to-peer
- Energy storage market
- Local demand side management
- Control of power exchange with the main grid

Flexibility services to the external DNO

Horizon 2020
European Union Funding
for Research & Innovation

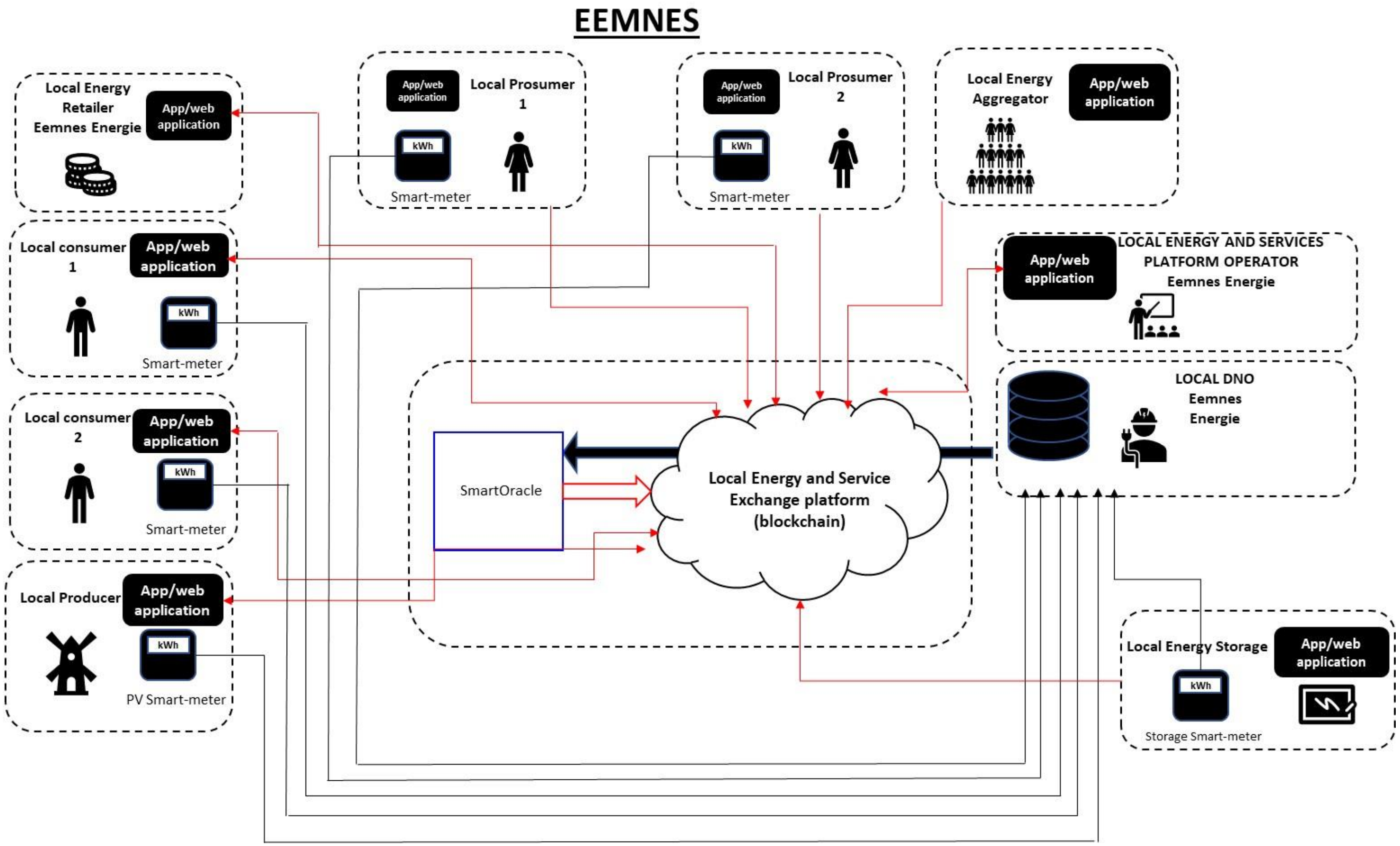

Figure 31 – Energy service scenarios representation in Eemnes.

Horizon 2020
European Union Funding
for Research & Innovation

These energy markets are similar to the ones described for Manzaneda demo site, linked to the subsection 5.1.1.

5.3.2 Thermal services

Currently, no thermal installation is connected to the smart grid. Plans for a new thermal plan are being discussed. This plant will reach up to 2km deep and will provide heat storage. Multiple reports (TNO, McKinsey, CE Delft) show enormous potential for smart heat storage in the Netherlands. Underground heat storage will provide a long-term, climate-friendly option to reduce gas-fuelled water heating. An underground thermal storage facility fits perfectly in the vision to make Eemnes carbon neutral.

Potentially, in the same way, as described for Manzaneda, in Eemnes a thermal dynamic service could be interesting.

5.3.3 Mobility services

In the mobility service, the transportation in the town of Eemnes is done currently via fuel vehicles (Table 24).

Current actors	Current Business Model
Transport leasing provider	NO

Table 24 - Current electromobility services BM in Eemnes demo-site.

The fuel vehicles could be changed to electric vehicles, so new business models (Table 24), can be potentially relevant in LEC.

It is foreseen that this change will take place in the future, however, such developments might fall out of the RENAISSANCE project timeframe.

The potential electrical mobility services that can be implemented in Eemnes demo site are the same as the ones described in Manzaneda, chapter 5.1.

Horizon 2020
European Union Funding
for Research & Innovation

5.4 Brussels Health Campus (Belgium)

The Brussels Health Campus containing the university Hospital (Universitair Ziekenhuis Brussel UZB-VUB) and part of the Vrije Universiteit Brussel (VUB), is a well-advanced energy island owning and running a state-off the art microgrid that can work in island mode for five (5) consecutive days. It includes a thermal and electricity grid, wastewater recovery, a high-speed glass-fibre telecom network and a total of 33 HV transformers divided over HV 18 substations. Energy production and storage include photovoltaics (817 kWhp), CHP 2.8MW, and 3 emergency generators (5.25 MVA), and a total capacity of 2,5 MWh in battery storage, mainly under the form of UPS. The microgrid serves the hospital complex, 250 student dwellings, the faculty of health sciences, a primary school and a fitness centre. During the 2018 -1019 the site will be further extended with 1.20 kWp photovoltaics and a 20MWh ice buffer, additionally in 2022, a Borehole Thermal Energy Storage (BTES) of 1.6MWh system will be installed. The microgrid contains about 1000 smart meters that are included in a PRIVA Building Management System. Power generation is controlled by a DEIF systems, and the switchboards and controllers for load-balancing and emergency scenarios in the HV Grid are controlled by Siemens Software, the whole is and programmed by SDME. The microgrid system is conceived to go in island mode with the complete automatic transition in max. 15s to critical need and 3 min to comfort need. The financial bookkeeping and billing to the different consumers in the microgrid is carried out through ERBIS software platform. Cutting edge control technology and maximal reliability are the focus points of this demonstration site.

The stakeholder ecosystem comprehends the hospital (UZB) , the Brussels Health campus dwellings, university Faculty of Medicine (VUB), the Red Cross, the Erasmus High School, a primary school (Theodoortje), a children day care (Kinderdagverblijf) , the parksite operator (APCOA), Villa Samson, a fitness centre and the Macdonalds House for taking care of young children

Horizon 2020
European Union Funding
for Research & Innovation

with cancer. UZB acts as the local DSO as well as energy supplier. Whatever UZB cannot deliver from its own generation (solar, cogeneration), it will buy from the grid and retail it to all stakeholders. For that service UZB asks a fee (% of energy bill). However due to the larger volumes UZB manages to obtain better prices from the retailer, so that it remains cheaper for the other stakeholders to buy energy from UZB then to buy from a retailer directly. In addition, the UZB delivers heat to all stakeholders in the community, except student houses.

5.4.1 Electricity services

Regarding the electricity services, the current situation is represented in the following Table 25. Already several actors are involved, but no smart contracting is applied, and rates are simply proportionate to consumed energy.

Actors	Business Model implementation
Prosumers: Currently UZB-VUB, and partially VUB faculty due to co-investment in CHP	Value proposition: • Promoting the renewable, local and efficient consumption of the electricity at lower end-user price. Revenue stream: • Incomes for the excess of electricity that goes to the reduction of its invoice • Sales of energy to other stakeholders in community • Reserve markets Cost structure: • Investment cost of the PV panels and ESS. CHP, if applied.
LEC market operator UZB-VUB	Value proposition: • Aggregator, lower prices of energy • Servicing local grid, ensure energy supply 24/7 Revenue stream: • Incomes energy sales • Cost structure: ○ Maintenance costs grid

Horizon 2020
European Union Funding
for Research & Innovation

	○ Billing costs
Retailer	The traditional retailer or the free market retailer depending on the consumer choice. Value proposition: ▸ Provide electricity to the end-consumers Revenues stream: ▸ Sell energy to the end-consumer Cost structure ▸ IT infrastructure ▸ Purchase energy into the wholesale market and LEC markets
Local energy storage owner (UZ-VUB)	Value proposition: ▸ Provide flexibility to the energy community Revenues stream: ▸ Sale of the energy stored Cost structure ▸ Storage deployment, operation and maintenance
Platform provider, currently Van Beek Engineering providing bookkeeping platform (ERBIS) to UZ VUB	Value proposition: ▸ Monitoring of electricity Revenues stream: ▸ Sale and maintenance of the platform Cost structure ▸ Creation of new services and products ▸ Maintenance
Several Smart meters providers to UZB-VUB, integrated in a data capturing platform by Priva	Value proposition: ▸ Provide the meters and data monitoring platform to local Microgrid Manager UZB-VUB Revenues stream: ▸ Sale of the smart meters and data monitoring Cost structure ▸ Manufacturing of smart meters and acquisition tools
Provider Solar Panels	Value Proposition ▸ Free energy for 10 years ▸ Panel property after 10 years Revenue stream ▸ Green certificates ▸ Avoiding cost right of superficies Cost structure ▸ Capex + Opex solar panels

Table 25 - Current electricity services BM in UZB-VUB demo-site.

Horizon 2020
European Union Funding
for Research & Innovation

During the renaissance project, two main changes will be investigated and assessed. Three stakeholders may change their role in the ecosystem. First of all, the current consumers Student Dwellings and Fitness Centre may change to active prosumers. The Business Model to be applied needs to be investigated through modelling. UZB-VUB could co-invest in the Solar Panels and as such become a co-prosumer. Alternative model could be that UZB-VUB peer-to-peer trades with the Fitness Centre and the agency of the student Dwellings. The possibility for a potential energy coin can be investigated if the latter case seems the most viable, but will not be implemented during the project

Second change is the involvement of student as responsible consumers, students will be informed about their energy behavior through individual measurements, or per block of apartments. Energy efficient students will be rewarded with a financial incentive (e.g. free rent for a month), and as such influence positively local energy consumption. The interactive platform provider is being decided upon. The changes ae summarized in Table 26.

Actors and potentially new actors	Business Model implementation
Prosumers: Currently UZB-VUB, and partially VUB faculty due to co-investment in CHP	Value proposition: ▸ Promoting renewables, local and efficient consumption of the electricity at lower end-user price. Revenue stream: ▸ Incomes for the excess of electricity that goes to the reduction of its invoice ▸ Sales of energy to other stakeholders in community ▸ Reserve markets Cost structure: ▸ Investment cost of the PV panels and ESS. CHP, if applied.
New Prosumers	Value proposition: ▸ Renewable energy potentially at lower price,

Horizon 2020
European Union Funding
for Research & Innovation

Fitness Centre and student houses	Revenue stream: ‣ Incomes for the excess of electricity that goes to the reduction of its invoice ‣ Sales of energy to other stakeholders in community Cost structure: Investment cost of the PV panels and
LEC market operator UZB-VUB	Value proposition: ‣ Aggregator, lower prices of energy ‣ Servicing local grid, ensure energy supply 24/7 Revenue stream: ‣ Incomes energy sales ‣ Cost structure: ‣ Maintenance costs grid ‣ Billing costs
Retailer	The traditional retailer or the free market retailer depending on the consumer choice. Value proposition: ‣ Provide electricity to the end-consumers Revenues stream: ‣ Sell energy to the end-consumer Cost structure ‣ IT infrastructure ‣ Purchase energy into the wholesale market and LEC markets
Local energy storage owner (UZ-VUB)	Value proposition: ‣ Provide flexibility to the energy community Revenues stream: ‣ Sale of the energy stored Cost structure ‣ Storage deployment, operation and maintenance
Platform provider, currently Van Beek EngineerinG providing bookkeeping platform (ERBIS) to UZ VUB	Value proposition: ‣ Monitoring of electricity Revenues stream: ‣ Sale and maintenance of the platform Cost structure ‣ Creation of new services and products ‣ Maintenance
Several Smart meters providers to UZB-	Value proposition:

Horizon 2020
European Union Funding
for Research & Innovation

VUB, integrated in a data capturing platform by Priva	‣ Provide the meters and data monitoring platform to local Microgrid Manager UZB-VUB Revenues stream: ‣ Sale of the smart meters and data monitoring Cost structure ‣ Manufacturing of smart meters and acquisition tools
Student Community	Value Proposition ‣ Less energy consumption Revenue Creation ‣ Incentives
App provider: TBD	Value proposition: ‣ Provide new applications for energy management in real-time to consumers Revenues stream: ‣ Sell of the Apps Cost structure ‣ App development
Provider Solar Panels	Value Proposition ‣ Free energy for 10 years ‣ Panel property after 10 years Revenue stream ‣ Green certificates ‣ Avoiding cost right of superficies Cost structure Capex + Opex solar panels

Table 26 - Future services BM and stakeholders in UZB-VUB demo-site.

For thermal services no changes are foreseen in the near future. However, the Brussels Health Campus can be seen as a data lake on which partners can model feasibility of potential new business cases. e.g. VUB will model the business potential of using storage in the Frequency regulation market.

Horizon 2020
European Union Funding
for Research & Innovation

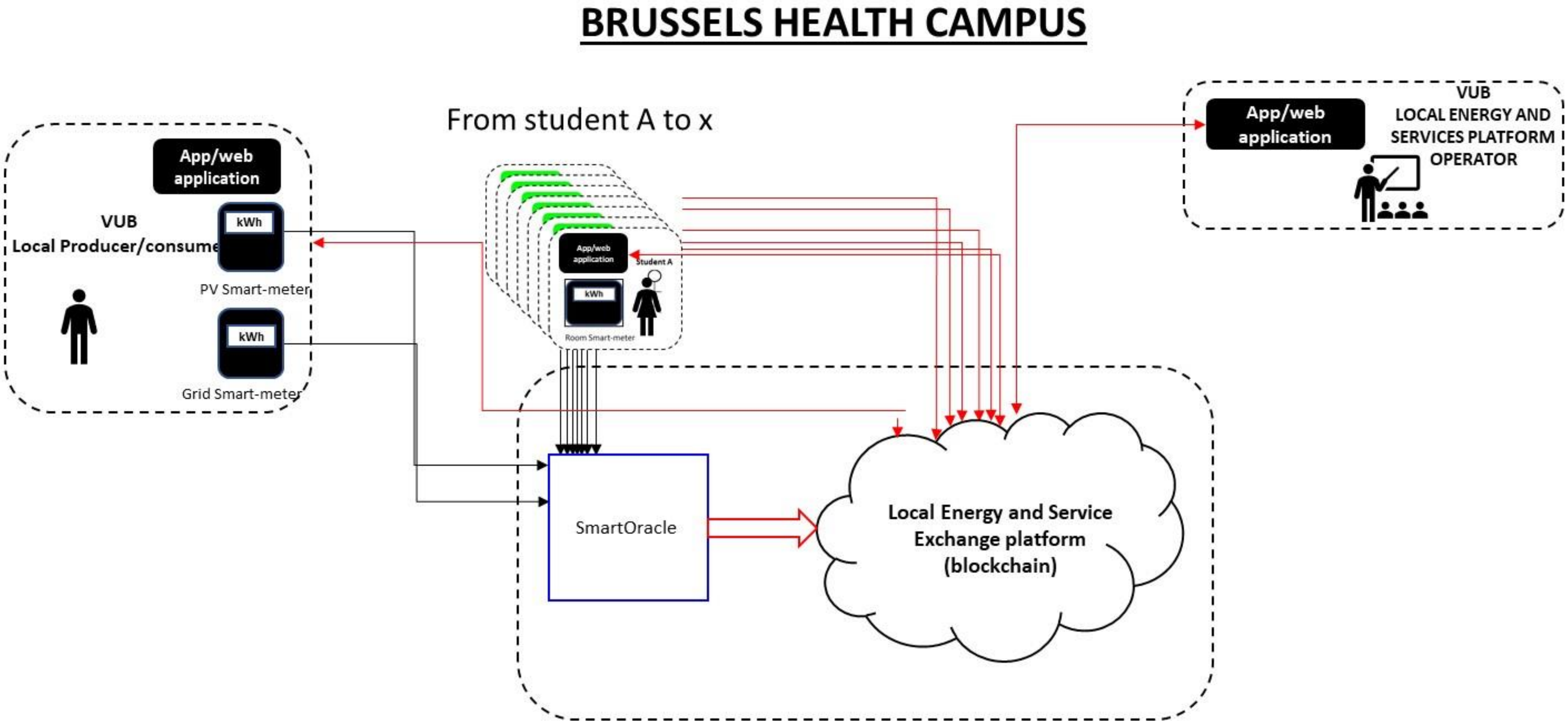

Figure 32 - Energy service scenarios representation in UZB-VUB.

Horizon 2020
European Union Funding
for Research & Innovation

References

[i] PwC, 2013 https://www.pwc.es/es/publicaciones/energia/assets/13-encuesta-mundial-sector-electrico.pdf .

[ii] Sioshansi, F. P., "Electricity utility business not as usual", Economic Analysis and Policy, 2015, 48, 1-11.

[iii] Debor, S., "The socio-economic power of renewable energy production cooperatives in Germany: results of an empirical assessment", Technical report, Wuppertal Inst. for Climate, Environment and Energy, 2014, https://nbn-resolving.org/urn/resolver.pl?urn:nbn:de:bsz:wup4-opus-53644.

[iv] Sanz, J. F.; Matute, G.; Bludszuweit, H. & Laporta, E., "Microgrids, a new business model for the energy market", in Proc. of ICREPQ'14, 2014.

[v] DaSilva, C. M., & Trkman, P. (2014). Business Model: What It Is and What It Is Not. *Long Range Planning*, *47*(6), 379-389. https://doi.org/10.1016/j.lrp.2013.08.004

[vi] Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying Business Models: Origins, Present, and Future of the Concept. *Communications of the Association for Information Systems*, *16*. https://doi.org/10.17705/1CAIS.0160.

[vii] Fielt, E., 'Conceptualising Business Models: Definitions, Frameworks and Classifications', Journal of Business Models, 2013.

[viii] Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial & Corporate Change*, *11*(3), 529-555. https://doi.org/10.1093/icc/11.3.529.

[ix] Fleming, L., & Waguespack, D. M. (2007). Brokerage, Boundary Spanning, and Leadership in Open Innovation Communities. *Organization Science*, *18*(2), 165-180.

Horizon 2020
European Union Funding
for Research & Innovation

[x] Osterwalder, A., & Pigneur, Y. (2010). *Business model generation: a handbook for visionaries, game changers, and challengers*. John Wiley & Sons.

[xi] Lechner, U., & Hummel, J. (2002). Business Models and System Architectures of Virtual Communities: From a Sociological Phenomenon to Peer-to-Peer Architectures. *International Journal of Electronic Commerce*, *6*(3), 41–53. https://doi.org/10.1080/10864415.2002.11044242.

[xii] Goos, G., Hartmanis, J., van Leeuwen, J., Hutchison, D., Kanade, T., Kittler, J., … Steffen, B. (2009). *Lecture Notes in Computer Science*.

[xiii] Talmar, M., Walrave, B., Podoynitsyna, K. S., Holmström, J., & Romme, A. G. L. (2018). Mapping, analyzing and designing innovation ecosystems: The Ecosystem Pie Model. *Long Range Planning*, S0024630118304667. https://doi.org/10.1016/j.lrp.2018.09.002.

[xiv] Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, *65*, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

[xv] Stubbs, W., & Cocklin, C. (2008). Conceptualizing a "Sustainability Business Model." *Organization & Environment*, *21*(2), 103–127. https://doi.org/10.1177/1086026608318042

[xvi] Burger, S. P., & Luke, M. (2017). Business models for distributed energy resources: A review and empirical analysis. *Energy Policy*, *109*, 230–248. https://doi.org/10.1016/j.enpol.2017.07.007

[xvii] Geissdoerfer, M., Vladimirova, D., & Evans, S. (2018). Sustainable business model innovation: A review. *Journal of Cleaner Production*, *198*, 401–416. https://doi.org/10.1016/j.jclepro.2018.06.240

[xviii] Geissdoerfer, M., Vladimirova, D., & Evans, S. (2018). Sustainable business model innovation: A review. *Journal of Cleaner Production*, *198*, 401–416. https://doi.org/10.1016/j.jclepro.2018.06.240

[xix] Peltoniemi, M., & Vuori, E. (2008). *Business ecosystem as the new approach to complex adaptive business environments*. 16.

[xx] Moore, J. F. (2006). Business ecosystems and the view from the firm. *Antitrust Bulletin*, *51*(1), 31–75.

[xxi] Lansiti, M., & Levien, R. (2004). Strategy as ecology. Harvard Business Review, 82(3), 68-81.

[xxii] Geissdoerfer, M., Vladimirova, D., & Evans, S. (2018). Sustainable business model innovation: A review. *Journal of Cleaner Production*, *198*, 401–416. https://doi.org/10.1016/j.jclepro.2018.06.240

[xxiii] Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, *36*(3), 399–417. https://doi.org/10.1016/j.respol.2007.01.003

[xxiv] Boo, E., Molinero, S., Sanvicente, E., de Melo, P., Landini, A., Otal, J., … Melia, A. (2017). *Report on novel business models and main barriers in the EU energy system*. 125.

[xxv] Gancheva, M., O'Brien, S., Crook, N., Monteiro, C., & Europäischer Ausschuss der Regionen. (2018). *Models of local energy ownership and the role of local energy communities in energy transition in Europe*. Retrieved from https://doi.org/10.2863/603673

[xxvi] Adil, A. M., & Ko, Y. (2016). Socio-technical evolution of Decentralized Energy Systems: A critical review and implications for urban planning and policy. *Renewable and Sustainable Energy Reviews*, *57*, 1025–1037. https://doi.org/10.1016/j.rser.2015.12.079.

[xxvii] Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., & Walker, B. (2002). Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. *AMBIO: A Journal of the Human Environment*, *31*(5), 437–440. https://doi.org/10.1579/0044-7447-31.5.437.

[xxviii] Tronchin, L., Manfren, M., & Nastasi, B. (2018). Energy efficiency, demand side management and energy storage technologies – A critical analysis of possible paths of integration in the built environment. *Renewable and Sustainable Energy Reviews*, *95*, 341–353. https://doi.org/10.1016/j.rser.2018.06.060

Horizon 2020
European Union Funding
for Research & Innovation

[xxix] Aman, S., Simmhan, Y., & Prasanna, V. K. (2013). Energy management systems: State of the art and emerging trends. *IEEE Communications Magazine*, *51*(1), 114–119. https://doi.org/10.1109/MCOM.2013.6400447

[xxx] Bertoldi, P., Hinnells, M., Rezessy, S., & Sustainability. (2006). Liberating the power of energy services and ESCOs in a liberalised energy market. *In: Proceeding of the International Energy Efficient Domestic Appliances and Lighting Conference (EEDAL `06*, 21–23.

[xxxi] Byrne, J., & Taminiau, J. (2016). A review of sustainable energy utility and energy service utility concepts and applications: Realizing ecological and social sustainability with a community utility: Review of SEU and Energy Service Utility Concepts and Applications. *Wiley Interdisciplinary Reviews: Energy and Environment*, *5*(2), 136–154. https://doi.org/10.1002/wene.171

[xxxii] Vandermerwe, S., & Rada, J. (1988). Servitization of business: adding value by adding services. *European Management Journal*, *6*(4), 314–324.

[xxxiii] Erbach, G. (2016). *Understanding electricity markets in the EU*. 10.

[xxxiv] Gancheva, M., O'Brien, S., Crook, N., Monteiro, C., & Europäischer Ausschuss der Regionen. (2018). *Models of local energy ownership and the role of local energy communities in energy transition in Europe*. Retrieved from https://doi.org/10.2863/603673

[xxxv] De Groote, M., & Lefever, M. (2016). *Driving Transformational Change in the Construction Value Chain*. Retrieved from Buildings Performance Insitute Europe website: http://bpie.eu/wp-content/uploads/2016/01/DrivingTransformationalChangeCVC2016.pdf

[xxxvi] Mazzucato, M., & Semieniuk, G. (2018). Financing renewable energy: Who is financing what and why it matters. *Technological Forecasting and Social Change*, *127*, 8–22. https://doi.org/10.1016/j.techfore.2017.05.021

Horizon 2020
European Union Funding
for Research & Innovation

xxxvii Hall, S., Foxon, T. J., & Bolton, R. (2016). Financing the civic energy sector: How financial institutions affect ownership models in Germany and the United Kingdom. *Energy Research & Social Science*, *12*, 5–15. https://doi.org/10.1016/j.erss.2015.11.004Electricity Systems. *Procedia CIRP*, *64*, 109–114. https://doi.org/10.1016/j.procir.2017.03.032

xxxviii Hamwi, M., & Lizarralde, I. (2017). A Review of Business Models towards Service-Oriented Electricity Systems. *Procedia CIRP*, *64*, 109–114. https://doi.org/10.1016/j.procir.2017.03.032

xxxix Vandermerwe, S., & Rada, J. (1988). Servitization of business: adding value by adding services. *European Management Journal*, *6*(4), 314–324.

xl Helms, T. (2016). Asset transformation and the challenges to servitize a utility business model. *Energy Policy*, *91*, 98–112. https://doi.org/10.1016/j.enpol.2015.12.046

xli Hilke, A., & Ryan, L. (2012). *Mobilising investment in energy efficiency*. Retrieved from OECD/ IEA website: http://re.indiaenvironmentportal.org.in/files/file/Mobilising_investment_EE_FINAL.pdf

xlii Carbonara, N., & Pellegrino, R. (2018). Public-private partnerships for energy efficiency projects: A win-win model to choose the energy performance contracting structure. *Journal of Cleaner Production*, *170*, 1064–1075. https://doi.org/10.1016/j.jclepro.2017.09.151

xliii Pätäri, S., & Sinkkonen, K. (2014). Energy Service Companies and Energy Performance Contracting: Is there a need to renew the business model? Insights from a Delphi study. *Journal of Cleaner Production*, *66*, 264–271. https://doi.org/10.1016/j.jclepro.2013.10.017

xliv Shang, T., Zhang, K., Liu, P., & Chen, Z. (2017). A review of energy performance contracting business models: Status and recommendation. *Sustainable Cities and Society*, *34*, 203–210. https://doi.org/10.1016/j.scs.2017.06.018

Horizon 2020
European Union Funding
for Research & Innovation

[xlv] Okay, N., & Akman, U. (2009). *Analysis of ESCO activities using country indicators* (Vol. 14). https://doi.org/10.1016/j.rser.2010.07.013

[xlvi] Bertoldi, P., Hinnells, M., Rezessy, S., & Sustainability. (2006). Liberating the power of energy services and ESCOs in a liberalised energy market. *In: Proceeding of the International Energy Efficient Domestic Appliances and Lighting Conference (EEDAL `06*, 21–23.

[xlvii] Zhang, X., Wu, Z., Feng, Y., & Xu, P. (2015). "Turning green into gold": A framework for energy performance contracting (EPC) in China's real estate industry. Journal of Cleaner Production, 109, 166–173. https://doi.org/10.1016/j.jclepro.2014.09.037

[xlviii] Vanadzina, Mendes, Honkapuro, Pinomaa & Melkas (2019). Business models for community microgrids. 2019 16th International Conference on the European Energy Market (EEM), Ljubljana, Slovenia, 2019, pp. 1-7. DOI: 10.1109/EEM.2019.8916368

Bibliography

Bryant, S.T., Straker, K., Wrigley, C. (2018). The typologies of power: Energy utility business models in an increasingly renewable sector. Journal of Cleaner Production, 195, pp. 1032–1046. DOI: 10.1016/j.jclepro.2018.05.233.

ARUP. The Road from 2018 to 2035: Business Models.

Vine, E.L., Murakoshi, C., Nakagami, H. (1998). International ESCO business opportunities and challenges: A Japanese case study. *Energy*, 23 (6), pp. 439–447. DOI: 10.1016/S0360-5442(98)00008-5.

Horizon 2020
European Union Funding
for Research & Innovation

CIMA, IFAC, PWC (2013). Business Model, background paper for <IR>.
Buesing B., Yang M. (2013). Business Model for Local Distribution Companies to Promote *Renewable Energy Low Carbon Economy*, 4, p41-p54.
http://dx.doi.org/10.4236/lce.2013.44A005.
Accenturestrategy (2015). Power play: Three new models for growth in the utilities industry.
I. Praça, S. Ramos, R. Andrade, A. S. d. Silva and E. T. Sica (2019). Analysis and Simulation of Local Energy Markets. *16th International Conference on the European Energy Market (EEM)*, Ljubljana, Slovenia, 2019, pp. 1-5. DOI: 10.1109/EEM.2019.8916524.
K. Kotilainen, J. Valta, K. Systä, S. J. Mäkinen, P. Järventausta and T. Björkqvist (2019). Exploring the Potential of Blockchain as an Enabler for Three Types of Energy Communities. *16th International Conference on the European Energy Market (EEM)*, Ljubljana, Slovenia, pp. 1-6. DOI: 10.1109/EEM.2019.8916261.
M. d. Almansa, F. A. Campos, S. Doménech and J. Villar (2019). Residential DER Cooperative Investments. *16th International Conference on the European Energy Market (EEM)*, Ljubljana, Slovenia, pp. 1-6. DOI: 10.1109/EEM.2019.8916424.
S. Soeiro and M. F. Dias (2019). Renewable energy cooperatives: a systematic review. *16th International Conference on the European Energy Market (EEM)*, Ljubljana, Slovenia, pp. 1-6. DOI: 10.1109/EEM.2019.8916546.

Horizon 2020
European Union Funding
for Research & Innovation

R. Rocha, J. Villar and R. J. Bessa (2019). Business models for Peer-to-Peer Energy Markets. *16th International Conference on the European Energy Market (EEM)*, Ljubljana, Slovenia, 2019, pp. 1-6. DOI: 10.1109/EEM.2019.8916543.
A. Stroink and T. Wawer (2019). Impact of E-Mobility Penetration on Community Electricity Storage. *16th International Conference on the European Energy Market (EEM)*, Ljubljana, Slovenia, pp. 1-6. DOI: 10.1109/EEM.2019.8916316.
S. J. Pee, E. S. Kang, J. G. Song and J. W. Jang (2019). Blockchain based smart energy trading platform using smart contract. *International Conference on Artificial Intelligence in Information and Communication (ICAIIC)*, Okinawa, Japan, 2019, pp. 322-325. DOI: 10.1109/ICAIIC.2019.8668978.
University of Cambridge. Energy Policy Research Group (2019). Digitalisation and New Business Models in Energy Sector.
Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., McCallum, P., Peacock, A. (2019). Blockchain technology in the energy sector: A systematic review of challenges and opportunities. *Renewable and Sustainable Energy Reviews*, 100, pp. 143-174. DOI: 10.1016/j.rser.2018.10.014.

Horizon 2020
European Union Funding
for Research & Innovation