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Integrated local energy systems (Energy islands)

RENergetic

Community-empowered Sustainable Multi-Vector Energy Islands

Project Nº 957845

D7.4 - Market analysis and value and business models identification

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Executive Summary

This deliverable reports about the RENergetic initial market analysis and paves the way for identifying suitable value and business models for RENergetic solutions. Five interrelated contributions have been made in the current deliverable.

First, a stakeholder analysis is performed in section II, based on earlier work in D7.1. The key actors in the domain of local energy communities have been identified as an energy consumer, (local) energy producer, energy island manager, grid operator (TSO and DSO), service provider and policy maker. Essential business roles within energy communities express the key activities that can be taken up by one or more stakeholders. Mapping of actors and roles allows to lay out the value network and organizational model behind the energy community. Also, by using a stakeholder map, we classify the identified stakeholders in core, directly and indirectly involved stakeholders.

Next, we analyze the context for the RENergetic value offer in section III. A short overview of the enabling and regulatory framework is sketched. We set the scope of the current market analysis (linked to the RENergetic solutions currently being demonstrated) to solutions internally to the energy communities (e.g. optimization, forecasting for internal supply and demand). Although limited consolidated information is available for this market on a European level, we give some indications of the size of the market and the main countries to focus on.

The majority of the work reported in this Deliverable related to the proper articulation of the RENergetic value propositions. The trajectory followed in this regard is reported in section IV. As a clear view of the potential value propositions is essential for analyzing the market potential and proposing suitable business models, this was a major target in itself. After engaging the entire consortium in both a value proposition canvas (VPC) workshop and a business model canvas (BMC) workshop, we ended up providing an overview of generic RENergetic functional building blocks that form the basis for the RENergetic value propositions and link to the epics used throughout the project. Four main categories of building blocks have been identified: global and domain-specific optimizers, multi-vector forecasting solutions, demand-response solutions and communication and interaction strategies.

This classification of RENergetic building blocks served as the basis for the preliminary competitive analysis, as reported in section V. Using a structured interview approach, we ended up with a list of existing solutions on the market, either complementary or competing to the RENergetic solutions linked to electricity savings/efficiency, electricity supply and heat management. The encountered solutions could be classified according to the lifetime phases of the energy island they relate to, as well as according to the customer segment they target. Relating these existing solutions to the RENergetic solutions allowed us to perform a first opportunity attractiveness evaluation of the RENergetic solutions, plotting them on orthogonal axes expressing the challenge versus the potential.

Finally, some business and organizational models have been identified based on a literature review. The organization models are put in relation to business models that are driven by activities (linked to RENergetic epics) carried out by the community or energy island in section VI. RENergetic tools (based on the functional building blocks) can facilitate these activities that are essential to the business models and therefore increase the value being created, as illustrated based on an initial assessment here.

Note that the work strongly builds upon earlier reported work on the stakeholder analysis from D7.1 - Preliminary European analysis on obstacles to innovation around Energy Islands. It closely links to the implementation of the RENergetic solutions that is ongoing and reported in WP3 and implemented and demonstrated in the three pilot sites (New Docks, a residential area in Ghent – Belgium, Warta University Campus in Poznan, Poland and San Raffaele Hospital and its investigation and research campus in Segrate-Milan, Italy) as reported in WPs 4, 5 and 6, as well as the replication exercise currently carried out in WP8. Close interaction with these other WPs was ensured by involving pilot site responsibles in our VPC and BMC workshops and exchanging our proposed structure of functional building blocks (fine-tuned in relationship with WP3) to the WP8 workshop performing the SGAM mapping.

In the remainder of the project, the results of the current deliverable will form a direct basis for developing the go2market strategy in D7.7 and will be taken as an indirect input as well for the deliverables D7.5 (where some scenarios linked to identified business models will be assessed in a quantitative manner) and D7.6 (where we will explore obstacles as well as opportunities related to e.g. the external market for flexibility services that popped up as an interesting path for the future in our initial market analysis reported here).

The objective of RENergetic is to demonstrate the viability of so-called ‘urban energy islands’. Energy islands seek to achieve the highest possible degree of self-sustainability with regards to the supply of its energy demand, be it electricity or heat through local renewable resources. At the same time an urban energy island may offer ancillary services to the public grid surrounding it.

These islands place the consumer at the centre of the energy transition, giving them an active part in energy communities capable of producing their own energy, sharing the surplus with the rest of the public grid and optimizing consumption. RENergetic will demonstrate that Urban Energy Islands increase the amount of renewables in these areas as well as the energy efficiency of local energy systems. RENergetic will demonstrate the viability of this energy

islands in three site pilots, each of them of a different nature: New Docks, a residential area in Ghent – Belgium, Warta University Campus in Poznan, Poland and San Raffaele Hospital and its investigation and research campus in Segrate-Milan, Italy. The impact of the Urban Energy Islands is assured as technical, socio-economic and legal / regulatory aspects are considered while safeguarding economic viability.

RENergetic is being carried out over the stretch of 42 months involving 12 European partners: Inetum (Spain, France, and Belgium), University of Stuttgart and the University of Passau (Germany), Clean Energy Innovative Projects and Gent University (Belgium), Poznan University of Technology, Veolia and Poznan Supercomputing and Networking Center

(Poland), Ospedale San Raffaele, Comune di Segrate and University of Pavia (Italy), Seeburg Castle University and Energy Kompass GMBH (Austria).

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Actor	Stakeholder	A person with a direct or indirect concern or link to a product or service.
AI	Artificial Intelligence	Technology referring to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals.[1]

[1] European AI High Level Expert Group Definition, 2019

API	Application Programming Interfaces	An API is an interface that provides programmatic access to service functionality and data within an application or database. It can be used as a building block for the development of new interactions with humans, other applications or smart devices.
BMS	Building Management System	Also referred to as Building Automation System (BAS) or Building Management System or Building Control System) is a system that controls various electric, electronic and mechanical systems throughout a building.
Actor	Stakeholder	A person with a direct or indirect concern or link to a product or service.
CEC	Citizen energy communities	A community of consumer co-ownership for (renewable) energy production
CEIP	Clean Energy Innovative Projects	CEIP is a private equity fund, bringing new innovative technologies to demonstration level in an operational and commercial environment. CEIP showcases the integration of new sustainable technologies and services.
CPO	Charging Pole Operator	A commercial actor, building and managing different EV charging points
Demand Side Response actions		Temperature increase/decrease, change ventilation rate by closing/opening window, electricity savings during consumption peaks,….
DER	decentral energy resource	This can be a storage, a PV or an EV charging station.
DH	District Heating	DH is a way of distributing heat generated in a centralized location through a system of insulated pipes for residential and commercial heating requirements, such as space heating and domestic water heating
DHN	District Heating Network	Supply heat from a central source to consumers via a network of underground pipes carrying hot water. (to multiple buildings)
DR	Demand Response	DR is a change in the power consumption of an electric utility customer to better match the demand for power with the supply.
DSO	Distribution system operator	Operating managers (and sometimes Owners) of energy distribution networks. They are the entities responsible for distributing and managing energy from the generation

		sources (or TSO's) to the final consumers . e.g. IMEA, Fluvius etc… in Belgium (Medium voltage - Low voltage))
EC	Energy Community	EC's organise collective and citizen-driven energy actions that help pave the way for a clean energy transition.
EI	Energy Island	A geographically delimited system that is to a considerable extent self-sufficient with regards to all present energy vectors.
EM	Energy Management	EM includes planning and operation of energy production and energy consumption units as well as energy distribution and storage.
EMS	Energy Management System	In automated environments, a computer system has control over the consumption and can reduce the demand in energy by switching machines off or on, or reduce the temperature.
ESCO	Energy Service Company Provider	Offering energy related services to the party connected to grid, but not directly active in the energy value chain or the physical infrastructure itself. Like: - upcycling ESCO => recycles a waste product to something new. - A provision ESCO => offer a service to the community like charging poles. - Energy management ESCO => offer management services to the island. - Data Provider ESCO who provides information to other parties in the island.
EV's	Electric Vehicles	
Flexibility services		Flexibility services are a range of existing and developing solutions that electricity system users van provide to help balance demand and supply in the electricity network and support its efficient use.
Grid Operator		A grid operator ensures the reliable delivery of electricity to consumers, businesses and industry. It consists of TSO's and DSO's.
GUI	Graphic User Interface	Vue.js web application and Grafana dashboards for user interactions with RENergetic software
KPI	Key Performance Indicator	A quantifiable measure used to evaluate the success of an

		organisation, employee, etc… in meeting objectives for performance.
LEC	Local Energy Community	A local energy community is a community that decentralizes the energy production. The energy is produced closer to the place where it is consumed.
MuVeCo	Multi-Vector Optimizer	A functional block within RENergetic solutions (detailed description following in Section IV.4.1.)
PESTEL-analysis		PESTLE is an acronym that stands for six external factors affecting your business: political, economic, sociological, technological, legal and environmental. Each of these can have a profound effect on your business and varying implications, for example, in terms of: duration of impact - short term or long term
Prosumer		Prosumers are households or companies that both inject and take off electricity from the grid. They are consumer and producer at the same time.
PV	Photovoltaic panels	The individual solar panels and equipment installed on an individual property covered under a Lease option agreement or a lease agreement.
REC	Renewable energy communities	As CEC, a legal entity, effectively controlled by their members, with a primary objective to provide environmental, economic and social community benefits.
Regulator		Independent instance that monitors the natural monopoly of the grid operators. They guard the level-playing field in the energy market to assure free competition in production and supply. For example, the TSO's and DSO's have to apply the same tariffs for all producers and consumers who want access to the grid.
Regulatory Framework provisioning		Setting up the regulations on different levels, either on island level, national level or even more global.
RL	Reinforcement Learning	Is a machine learning training method based on rewarding desired behaviours and/or punishing undesired ones.
	Role	A role represents a specific responsibility or task

SME	Small and medium sized enterprises	
TRL	Technology Readiness Level	Is a method for estimating the maturity of technologies during the acquisition phase of a program
TSO	Transmission System Operator	Is an entity entrusted with transporting energy in the form of natural gas or electrical power on a national or regional level, using fixed infrastructure. (In Belgium: Fluxys (Gas) - Elia (Electricity) (High voltage)) The operator of the high-voltage transmission grid. The TSO maintains, reinforces and expands the high-voltage grid that transport large volumes of electricity over longer distances. The TSO is further the final responsible for secure grid operation and has to make sure that demand and generation are always in balance. Since they are natural monopoly, they operate under supervision of an independent regulator. In Belgium this is the CREG.
TSPC	Third Party Sponsored Communities	Energy Communities being financially supported by third-parties.
VP	Value Propositions	Is the full mic of benefits or economic value which a company promises to deliver to the current and future customers.
WP	Work Package	

I. Introduction

I.1. Purpose and organization of the document

The goal of the RENergetic project is to demonstrate the improvement of efficiency and energy autarky, the community involvement in and the socio-economic viability of three urban energy islands and to be able to replicate an Energy Island. These Energy Islands are self-sustainable using more and more renewable energy sources. Although these green alternatives are better for the environment and reduce the carbon emission, they demand a big financial investment.

The main objective of the research described in the current deliverable is to identify a potential business and organizational model that can be integrated into these island structures to make the investments worth their money. In other words, is it possible to have an economic viable model that drives the convergence towards more renewable energy sources?

In order to determine a viable business model, we first took some other steps.

1) Execute a stakeholder analysis: For this we have used D7.1 Preliminary European Analysis on Obstacles to innovation around Energy Islands document as an input, more specifically chapter III. Cost-Benefit Framework. Some minor alterations on stakeholders and roles took place. These are documented in section II of the current document. We provided a graphical representation by means of a stakeholder map.
2) Give an overview of the environment and scope the market relevant for RENergetic. For this we provide an overview of the enabling and regulatory market framework as well as an overview of the market for Energy Islands, in section III.
3) Determine value propositions for the solutions that were identified. For these the approach towards RENergetic value propositions and resulting functional building blocks resulting from several workshops within our consortium are described in section IV.
4) A preliminary competitive analysis was executed, based on exploratory market research and expert interviews on existing solutions on the market. Also included is the positioning of the RENergetic solutions concerning their opportunity attractiveness in the market. This can be found in section V.

Based on the above steps, we have been able to provide a preliminary Business and Organizational Model for Energy Communities in section VI. In later WP7 deliverables the most suitable business models will be refined further, based on additional market insights that will be gained in the next phase of the project and linked to the growing maturity of the RENergetic solutions that are currently still under development, as well as technological developments that may come as efficiencies in photovoltaic panels or aerothermal machines that improve performance or new solid state batteries for industries or residences to improve investment costs.

I.2. Scope and audience

This is a public deliverable. It is intended to provide a clear understanding of the current market analysis and overview of the identified business models to the entire RENergetic consortium and its reviewers. Besides that, it is set out to offer an exciting read to interested third parties, such as researchers in the domain or local energy communities or other stakeholders working in this broad domain and interested in the techno-economic or business aspects thereof.

II. Stakeholder Analysis

The RENergetic stakeholder analysis has mainly three objectives:

– Mapping functionalities and system rights with the according roles (interfacing WP3)

– Offering some basic information for the engagement of and communication with relevant stakeholders inside and in some cases outside of the EI (interfacing WP2)

– Understanding the basic interest and constraints for the creation of business models (interfacing WP7)

To achieve this, first of all, these stakeholders and their roles are listed. They will form the basis for:

- Business models
- Functionalities (for who is a functionality intended)
- System rights with roles (interfacing WP3)
- Allowing a starting point for communication and engagement (Interfacing WP2)

II.1. Overview of actors and roles

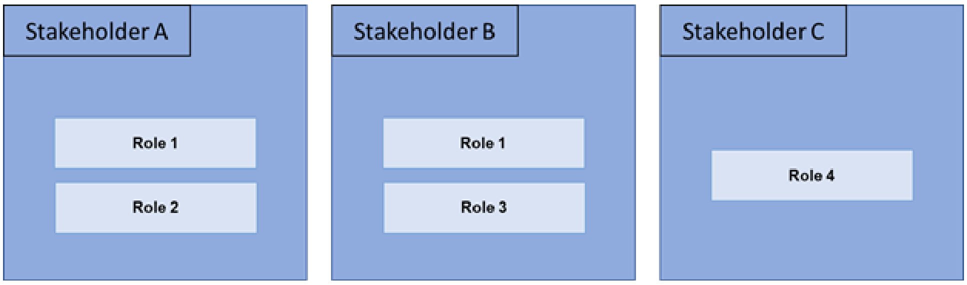
In D7.1 – Preliminary European Analysis on obstacles to innovation around Energy Islands the stakeholders and roles were already identified. Due to finding some inconsistencies of roles and names found there, we slightly changed some of the stakeholder names and definitions as well as these for the roles

In order to avoid any potential confusion, in this part of the document we give an overview on the alterations (if any) on the previously defined stakeholders (=Actors) as well as on the previously defined roles.

II.1.1. Actors in the Energy Island

The actors, in this case called the stakeholders, indicate who is performing a certain role.

A stakeholder can fulfil multiple roles and if required, multiple (similar) stakeholders can fulfil the same role. However, in the latter case, they will never perform the role together. For example, if there is a role of energy production, there can be multiple stakeholders that produce energy, but they do it independent of each other. Stakeholders can comprise different roles depending on the real site at hand.



The table below provides an overview of the name of the stakeholder as it was used in D7.1 and the new name in case it has changed. For the more complex actors/stakeholders extra information and visuals can be found below the table.

Table II-1 Overview Actors/Stakeholders

Name in D7.1	**New name**	**Definition**
Consumer or End-User	Energy Consumer	A natural or legal person who consumes or purchases energy for own use and not for wholesale or retail purposes. We can identify 3 different categories: - Heat Consumer - Electricity Consumer - Electrical Vehicle Charger
Local Energy Provider	(Local) Energy Producer	Any natural person or legal entity that owns an energy production facility which produces electricity or heat (either Classic or renewable energy).
Energy Island Manager	No change	is responsible for the energy management in the island. This can be on the whole island level or on sublevels (like a smaller organization or per building) These can be: High level business manager or high level technical manager, a Field level business manager or a field level technical manager
Sustainable Energy Evangelist	No change	Someone who believes in sustainable energy and proclaims it.
Service Provider	No change	Is providing one or multiple ESCO's. - Upcycling ESCO - Provision ESCO - Energy management ESCO - Data provider ESCO
Grid Operator	Grid Operator (TSO’s & DSO’s)	A grid operator ensures the reliable delivery of electricity to consumers, businesses and industry. It consists of TSO's and DSO's. IT can be an electricity grid operator or a heat grid operator.
	New: Policy Maker	A member of the EC, National or local government (city, region,..) or other organization who is responsible for making new rules, laws, etc…
Project Developer /Investor	Project Developer	Professional who manages the operations of a project by conducting research and creating plans that best suit the needs of the project.

	Investor	Someone who invests money in a certain project
	New: Retailer	A supplier who sells electricity to end-consumers. Or for injection: Buy.
	New: Aggregator	A company that negotiates with producers of a utility service such as electricity on behalf of groups of consumers.

II.1.1.a. Energy Consumer

In D7.1 this stakeholder was called: Consumer or End-User. We have renamed it to Energy Consumer. An Energy consumer is a natural or legal person who consumes or purchases energy for own use and not for wholesale or retail purposes. We can identify 3 different categories: Heat Consumer, Electricity Consumer, Electrical Vehicle Charger.

Contrary to the SGAM ((Smart Grid Coordination Group, 2012) and the HRM models, the setting of an EI requires a further split of stakeholders as shown in Figure II-1 – Energy Consumer which gives an overview of who we see as possible Energy Consumers, Energy Consumers can be identified as Residents or Visitors. Residents can be owners or tenants or employees of SME’s. Visitors are considered to be passer-by’s. The main difference between residents and visitors is that visitors do not come to an Energy Island on a regular base. This is a distinction that was not made yet in D7.1. In D7.1 the SME employees were also considered as visitors but now we have moved them to the ‘residents’ branch. The reason for this distinction is that these stakeholders need to be engaged and approached differently according to their objectives and constraints. E.g. an owner has the opportunity to invest into infrastructure, whereas a tenant has not – but it is up to the tenants to use infrastructure in a carbon-saving way.

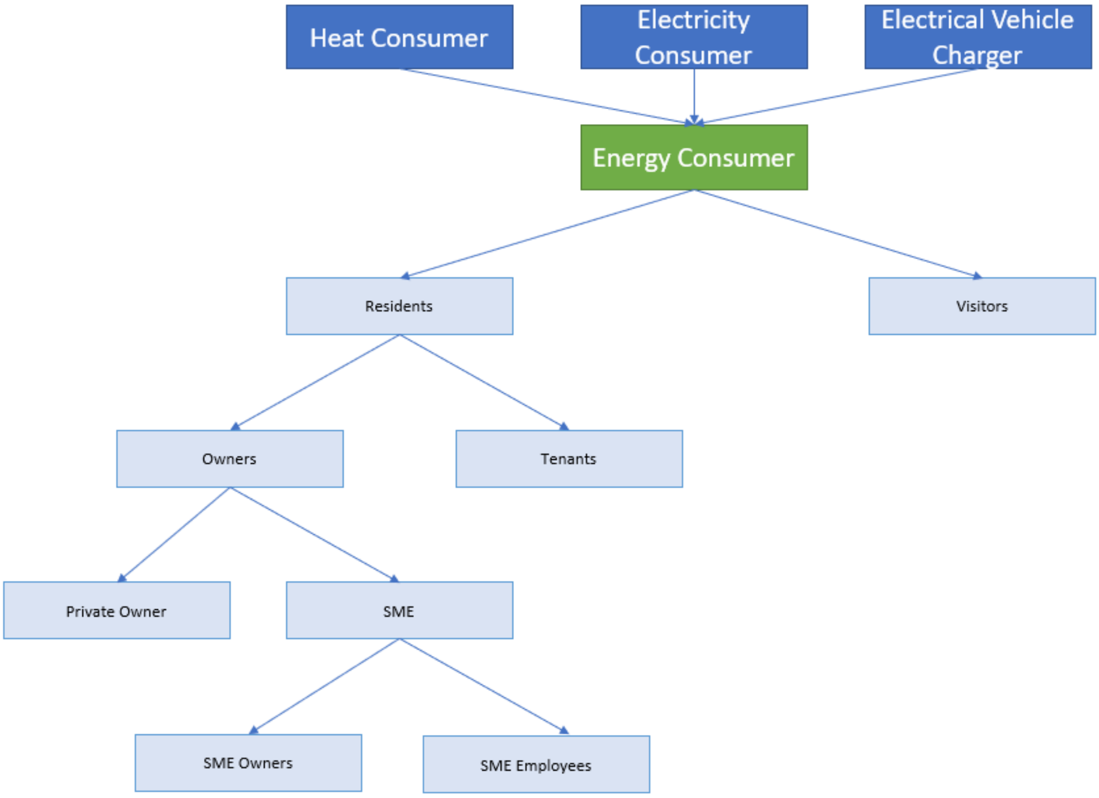


Figure II-1 – Energy Consumer

The objectives for Residents are to live in an attractive neighbourhood, take independent decisions. The constraints for residents are the knowledge communication gap, the comfort and the daily life routine they have.

For Owners it is also an objective to have a good investment.

Tenants do not want hassle with the landlord. Their constraints are: Split-incentive, they have a less durable relation with the building(s), and might have less money (not all technological feature like smart start appliances, home automation, etc..).

For SME's the objectives are the CSR image, the low cost structure and to have an attractive environment for their professional activities. Their constraints are time and expenses.

For SME employees (or students or staff when it concerns a University), the objectives are that they have a longer-term interest in community and technical environment functions, their comfort and they do not want any hassle. The constraints here are the same as with Tenants including a knowledge and communication gap.

Visitors just want to have a pleasant stay at the Energy Island.

The following constraints were identified for visitors: they won't come back if they are dissatisfied. They can be sceptic and think sustainable living is only for rich hipsters/heavily subsidized.

II.1.1.b. (Local) Energy Producer

In D7.1 this stakeholder was called: Local Energy Provider. We have renamed it to (Local) Energy Producer. Since the energy does not necessarily need to be produced locally.

The reason to switch from Provider to Producer was that the term Provider led to misunderstandings since a provider was not always seen as a 'producer'. So to make a clear distinction between someone who just 'sells' energy and someone who 'produces' energy we decided to rename it to (Local) Energy Producer and use the term 'Retailer' for the supplier who sells electricity etc… to end-users.

A (Local) Energy producer is any natural person or legal entity that owns an energy production facility which produces electricity or heat (either Classic or renewable energy). The image below gives an overview of who we see as possible (Local) Energy Producers:

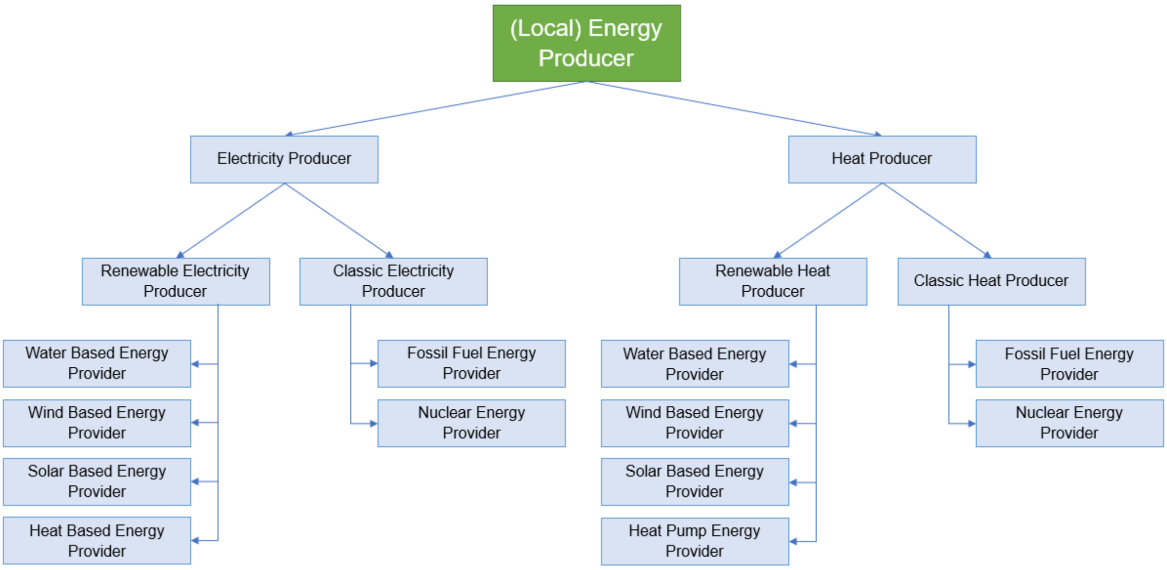


Figure II-2 – (Local) Energy Producer

For external heat producers the main objectives are creating a green image for their company and creating extra value (e.g. by selling heat or by buying recyclable water).

Their constraints are: existing legal framework, the min/max temperature range of the residents and invest in high IRR investments.

The objectives of the (local) energy producer are the financial viability but also the societal reputation (definitely when it is a local energy producer)

II.1.1.c. Energy Island Manager

No changes on this stakeholder.

An Energy Island Manager is responsible for the energy management in the island. This can be on the whole island level or on sublevels (like a smaller organization or per building).

These can be High level business manager or high level technical manager, a Field level business manager or a field level technical manager, As you can see in the figure below:

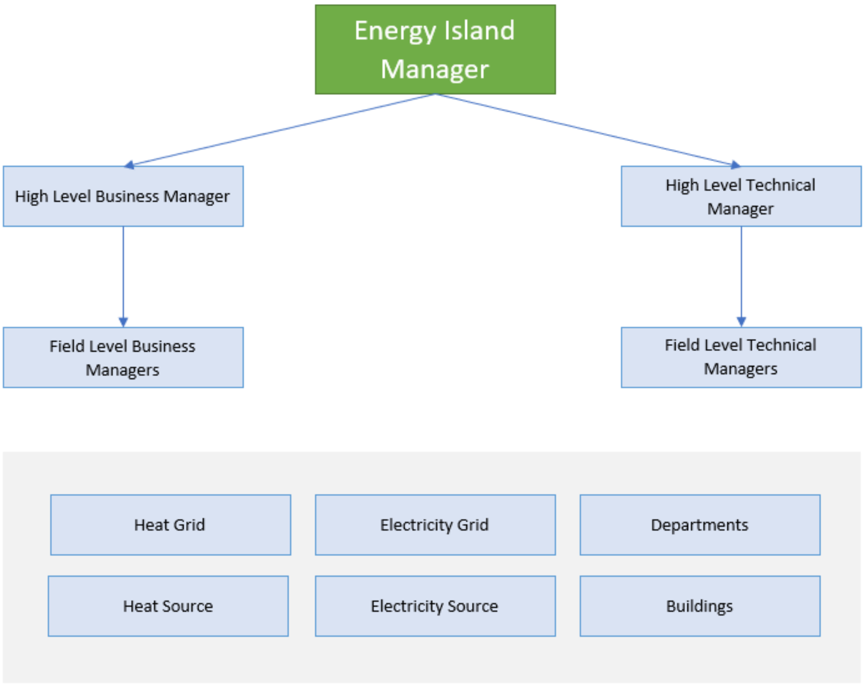


Figure II-3 – Energy Island Manager

The main objective of the Energy Island Manager is the cost/benefit control and as a result the cost is their constraint.

Other objectives related to the above are: the overall viability of the energy island and also the societal reputation.

For the technical managers this also includes the following objectives: no user complaints, reliability of energy and other services (smooth technical operation). Their constraints are education, technical/physical requirement e.g. min. temp. diameter pipes and the technology cost (customer scepsis).

II.1.1.d. Grid Operator (TSO's & DSO's)

In D7.1 this stakeholder was called: Grid Operator. We have renamed it to Grid Operator to stress that it concerns both the Transportation System Operators as well as the Distribution System Operator (TSO & DSO).

A grid operator ensures the reliable delivery of electricity to consumers, businesses and industry. It consists of TSO's and DSO's. IT can be an electricity grid operator or a heat grid operator. See figure below:

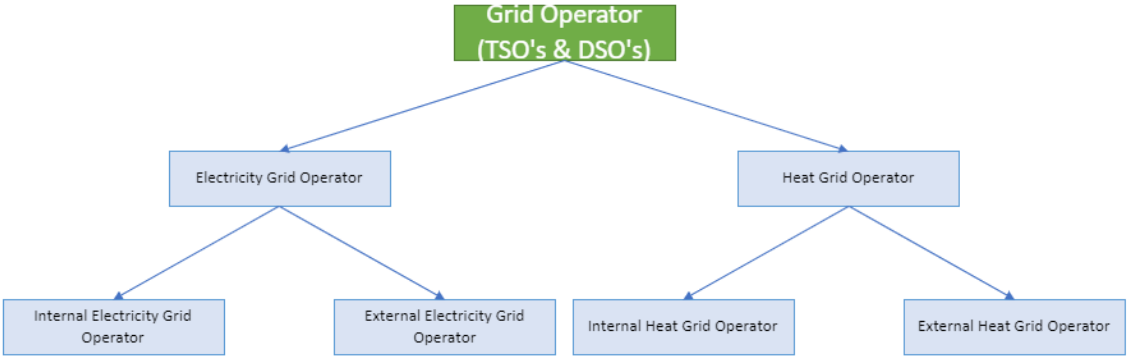


Figure II-4 – Grid Operator

For the Electricity Grid operator and the Heat Grid Operators the objectives and constraints are alike. The objectives are to maintain the grid stability and to fulfil the electricity demand at all times. Their constraints are that they have lots of assets (cupper)pipes…. In the ground: stranded assets as well as the capacity of the grid equipment.

II.1.1.e. Service Provider

No changes on this stakeholder.

The Service Provider is providing one or multiple ESCO's: Upcycling ESCO, Provision ESCO, Energy Management ESCO, Data Provider ESCO. An Energy Service Company (ESCO) is offering energy related services to the party connected to grid, but not directly active in the energy value chain or the physical infrastructure itself, see figure below:

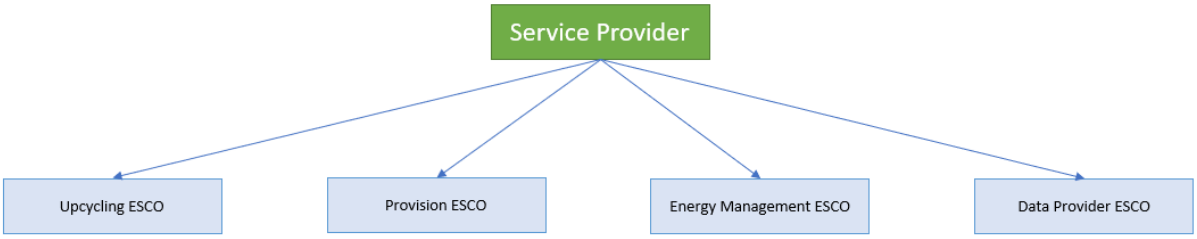


Figure II-5 – Service Provider

II.1.1.f. Policy maker

This stakeholder was not included in D7.1.

A Policy Maker is e member of the EC, National or local government (city, region,..) or other organization who is responsible for making new rules, laws, etc…, see figure below:

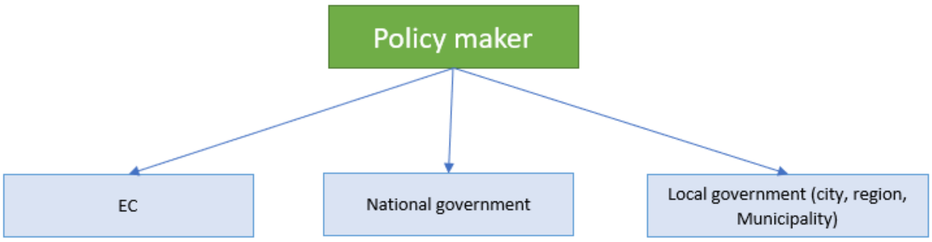


Figure II-6 – Policy Maker

The objectives for a municipality/local government (when applicable) are creating a green image for their town/city and create extra tax revenue through a striving neighbourhood

Their constraints are lack of capital and the existing legal framework.

II.1.1.g. Sustainable Energy Evangelist

No changes here.

Sustainable Energy Evangelist is someone who believes in sustainable energy and proclaims it. His objective is to save CO2 and is eager to change existing systems.

II.1.1.h. Project Developer

In D7.1 Project Developer/Investor were considered as 1 stakeholder, but we have split these up into Project Developer and Investor.

A Project Developer is a professional who manages the operations of a project by conducting research and creating plans that best suit the needs of the project.

The Project Developer wants to achieve financial benefits (e.g. ROI) but als to create a goor reputation.

Their constraints are the technology costs and is only prepared to invest in clean tech when he is pushed by the government or when the investment is highly profitable.

II.1.1.i. Investor

In D7.1 Project Developer/Investor were considered as 1 stakeholder, but we have split these up into Project Developer and Investor.

An Investor is someone who invests money in a certain project.

As a Project Developer also the investor wants to achieve financial benefits.

II.1.1.j. Retailer

A Retailer was not included yet in D7.1.

A Retailer is a supplier who sells electricity to end-consumers. Or for injection: Buy.

More specifically, they offer supply and injection contracts.

The major objective of a retailer is to maximize the benefit from selling electricity. Their constraints are of course the capacity, the volatility and the low prices in case of high harvest from RENergetic.

II.1.1.k. Aggregator

An Aggregator was not included yet in D7.1.

An Aggregator is a company that negotiates with producers of a utility service such as electricity on behalf of groups of consumers.

Once we take a look at Flexibility Services (in future deliverables) the aggregator will come in the picture.

II.1.2. Roles in the Energy Island

As mentioned in D7.1. the roles defined in the energy island are mainly based on the ones defined in the Harmonized Electricity Market Role Model (HRM) (Ebix, 2022). This HRM defines a common terminology to facilitate dialogue between energy market participants from different countries.

The roles used here are based on the ones defined in the HRM meaning that, when possible, the exact definition is used. If needed, the definition is slightly altered to cover the needs within the energy island better. The HRM is very extensive and not all the roles specified in the HRM are necessary in the context of an energy island. The reason is that HRM is targeted solely at the electricity grid, whereas energy island roles need only a subset of electricity roles (e.g. Imbalance Settlement Responsible is not needed inside the energy island). On the other hand, additional roles may be needed which are not foreseen in the HRM (e.g. roles with environmental or social objectives).

The table below gives an overview of all the roles that were identified within the study of the Energy Island and their respective names in D7.1. We renamed the roles because their initial names could be mixed up with stakeholders. Now the name of the role clearly express an activity that can be executed by one or more stakeholders.

The table below provides an overview of the name in D7.1 and the new name (if changes are applicable).

Table II-2 Overview roles in the energy island

Name in D7.1	**New name**	**Definition**
Energy Consumer	Energy Consumption	Consuming energy in the energy island. This can be an individual or bigger institution. Three sub roles can be identified: heat consumer, electricity consumer and electrical vehicle consumer.
Energy Producer	Energy Production	Producing energy in the energy island. Sub roles can be added for each type of producer that is relevant for this research. For example, different renewable sources as wind, water and sun or fossil fuels versus nuclear power plants.
Waste Producer	Waste Production	Producing waste in the energy island. Different sub roles can be created to differentiate between the source of waste. For instance, wastewater and compostable waste.
ESCO or Energy Service Provider	Energy Service Provisioning	Offering a service in the energy island. This role can be subdivided depending on what is exactly offered. An upcycling ESCO that recycles a waste product to something new. A provision ESCO who offers a service to the community, for example charging poles. Energy management ESCO who offers management services to the island. Data Provider ESCO who

		provides information to other parties in the island.
Network Development	Network Development	construction of the smart island
EMS Software Development	EMS Software Development	development of the tools to monitor and manage the energy consumption.
Regulatory Framework Provider	Regulatory Framework provisioning	setting up the regulations on different levels, either on island level, national level or even more global.
Investor or Project Developer	Investing or Project Development	This role injects capital into the island in order to support the transition towards a sustainable energy island.
Community Management	Community Management	the participation of the community is important for the success of an energy island. The community needs to understand the impact of their behaviour and be stimulated to adapt their consumption needs to a more flexible demand.
General Grid Operations	General Grid Operations	Connectivity and management of the existing grid.
Energy Management	Energy Management	In automated environments, a computer system has control over the consumption and can reduce the demand in energy by switching machines off or on, or reduce the temperature.
Energy Monitoring	Energy Monitoring	To change the behaviour or adapt the consumption overall, the consumption must be monitored.
Energy Forecasting	Energy Forecasting	In order to be able to plan energy orchestration or give behaviour recommendations, future energy demand and supply must be forecast.

II.2. Stakeholder map

In this part of the document we will visualize the different stakeholders/actors that were mentioned in II.1.1. in relation to Energy Islands. This is done in a stakeholder map.

The image below gives a high level overview of the stakeholder map for Energy Islands. We disaggregate our stakeholders in:

- Core stakeholders: These stakeholders form the core of the Energy Island
- Direct stakeholders: These stakeholders are directly involved in the day-to-day business of the Energy Island
- Indirect stakeholders: These stakeholders are indirectly involved or affected by the activities in the Energy Island

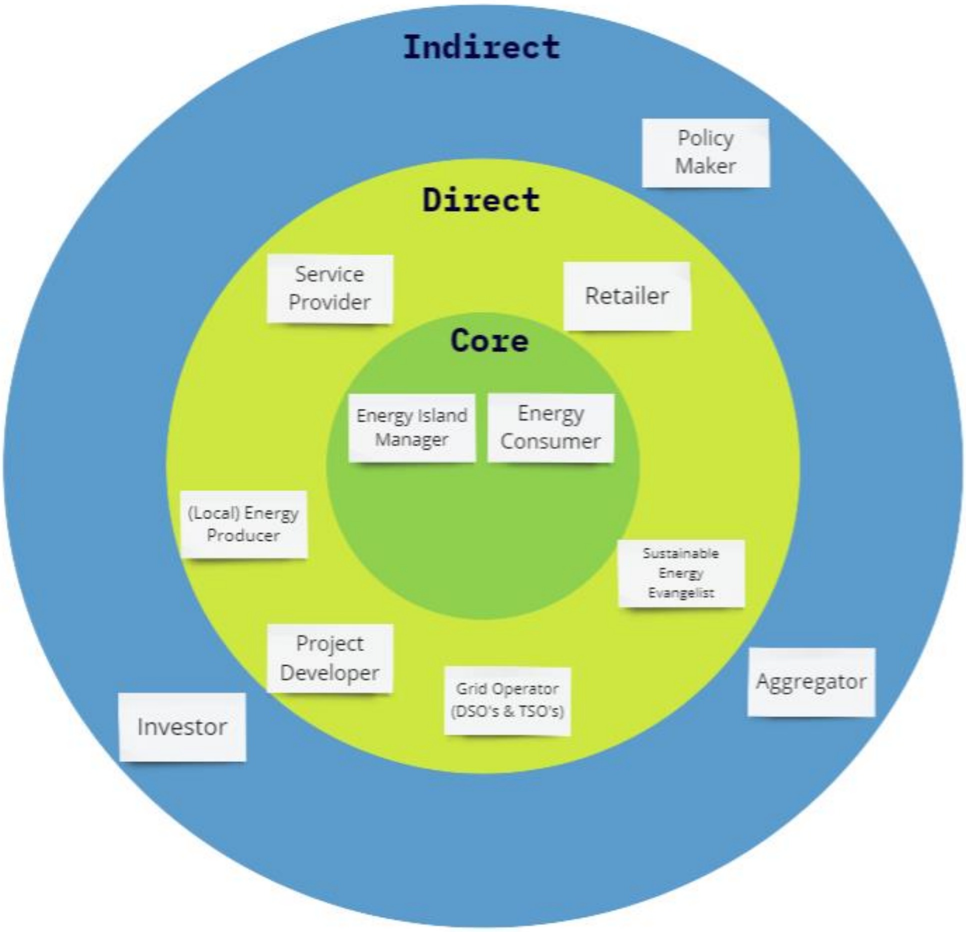


Figure II-7 – Stakeholder map – High level overview

The Core of the Energy Island stakeholders consists of the Energy Consumer and the Energy Island Manager. However not all Energy consumers can be considered as a core stakeholder. Only Tenants, Private Owners, SME Owners and SME employees are considered as a core stakeholders. Visitors are only passing by and are as a result not considered as a core stakeholder.

The Direct stakeholders are the stakeholders that are directly involved in the energy island:

- Service Providers:
  - Energy management ESCO
  - Upcycling ESCO
  - Provision ESCO
  - Data provider ESCO
- (Local) Energy Producers:
  - Electricity Producer
  - Heat Producer
- Grid Operator (DSO’s & TSO’s):
  - Electricity Grid operator
  - Heat Grid operator

- Retailer
- Sustainable Energy Evangelist is a direct stakeholders when he is involved in the Energy Island. Otherwise it is an indirect stakeholder.
- Project Developer

The following stakeholders can be defined as indirect stakeholders:

- Policy makers:
  - EC
  - National Government
  - Local Government (like municipalities, etc…) (when applicable)

  Policy makers are not directly involved in the energy islands, but they play an important role in paving the way for Energy Islands with legislative actions.
- Visitors: as mentioned they are just passing by and are not participating in the Energy Island but they are affected by it.
- Aggregators are currently considered as indirect stakeholders but when flexibility services come in the picture they will become direct stakeholders.

The above information can also be visualized in a more detailed stakeholder map overview shown in Figure II-

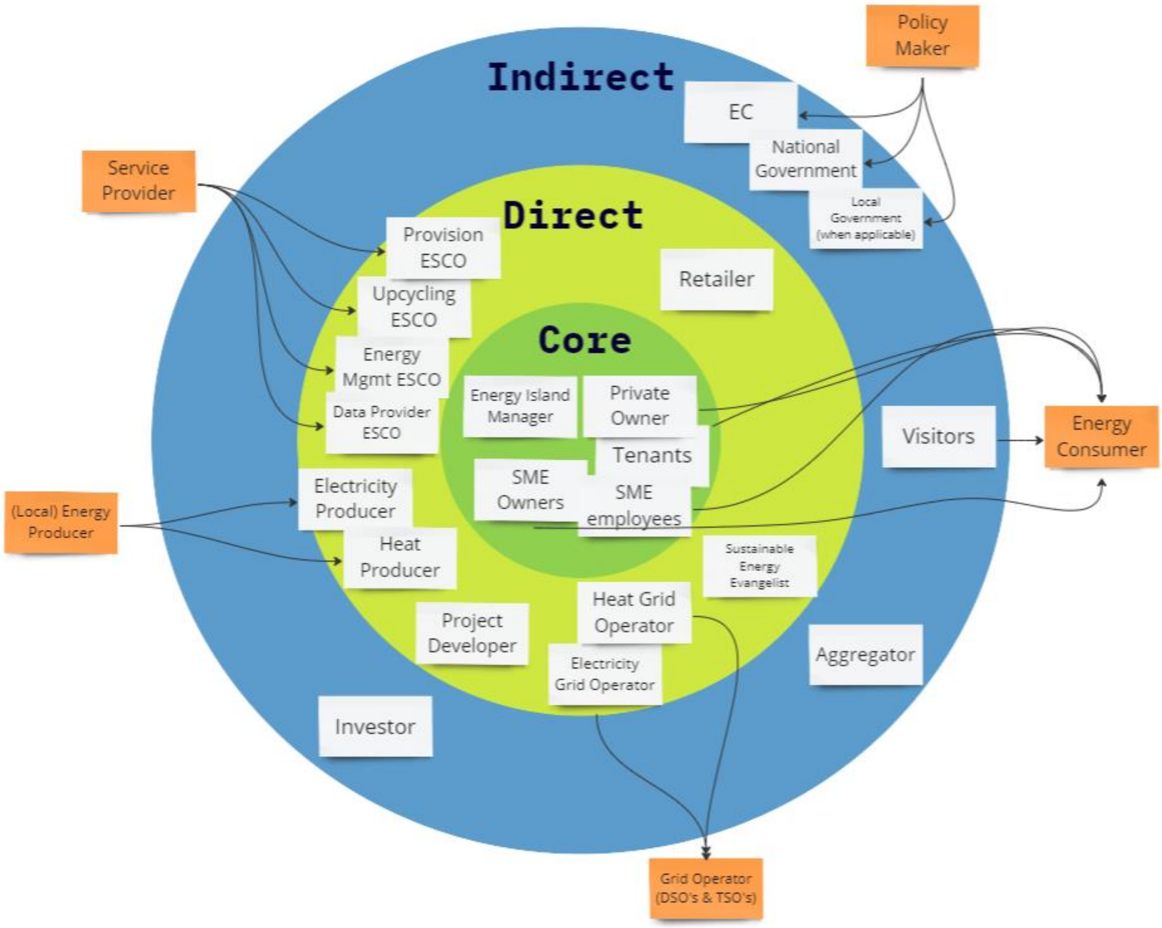


Figure II-8 – Stakeholder map – Detailed overview

We will come back to the interests of the most important stakeholders and how they relate to the functional building blocks in section VI.

III. Environment Map and Initial market analysis

The aim of the current section is to sketch the most important elements in the so-called "environment map". As stated in the RENergetic DoA an 'environment map' allows to understand the context and conditions in which the developments will enter. This is relevant in the (currently still ongoing) development phase but also in the exploitation phase (later goals of the current WP) since a clear picture of the needs and target users will be established. The framework and initial market analysis reported here will be built upon further in the Deliverable D7.7 - Go2Market results.

III.1. Enabling and regulatory market framework

Equally relevant for the market analysis is the overall enabling policy framework at the European level. In this context the Clean Energy Package with the according legal instruments constituting an enabling framework should be mentioned. Among other legal instruments, the RED II and the Electricity Recast Directive were introduced to foster the development of local initiatives and decentral actors such as the renewable energy communities or RECs (defined in Art. 22 RED II), citizen energy communities or CECs (Art. 2 (11) Electricity Directive) and active customers (Art. 2 (16) Renewable Energies Directive). These Directives aimed to foster collective self-consumption and citizen engagement within the energy communities and on the energy markets. By defining their respective rights and obligations with regards to the market participation on the electricity markets, facilitated market entry conditions for smaller market participants were created too. These include reduced tariffs, financial support, no discrimination with regards to RECS, possibility to practice energy sharing, aggregation, storing and self-consumption of energy without an extra administrative burden as well as the sale of energy on the external markets.

In this context, renewable and citizen energy communities, as well as active prosumers have the possibility to develop new innovative business models and participate on the markets which were previously less accessible to them. This trend is currently being observed in several Member States (f.eg.: Germany, Austria, Belgium, Denmark, Netherlands) (Roberts Joshua J., 2019) and shows how with new possibilities for renewable energy communities and citizens to locally produce, share and sell energy, new market for facilitating digital technologies arises. Through a creation of an empowering regulatory framework at the European level and the consequent implementation into Member States legislation, legal certainty and new economic incentives are being created, shaping the respective market.

Therefore, depending on the business model the energy communities or active customers choose (heat production, electricity production, energy-sharing, sector-coupling optimisation), new digital solutions will be needed, creating a new market for the software companies, developing such tools. These can be among others forecasting methods, AI learning methods, demand-response optimisation tools and digital dashboards, visualizing energy production and consumption. The mapping and the description of the RENergetic solutions in this regard will follow in the section IV.4. Energy communities and active customers can then be given practical tools to improve the economic and sustainability success of their chosen business model.

III.2. Scoping of the market relevant to RENergetic and initial view on the market size

Given the incentives by the European legislator by different directives and other legal instruments, member states are asked to develop an enabling framework paving the way to set up novel Business Models for local energy communities.

While the RED II and the Electricity Directives provisions on RECs and CECs have not yet been fully implemented in all Member States (Hoicka C.E., 2021), the market conditions for the decentral actors such as the RECs and CECs and active customers is changing, including a more active role of aggregators, supporting smaller actors' entry to the energy markets, reduced feed-in tariffs on self-produced and self-consumed energy and energy sharing. This allows for more attractive business models for a collective self-consumption. Energy Communities can therefore benefit from pursuing self-sufficiency and market participation through an enabling framework on the Member States Level (Art. 22 (4) RED II). Additionally, the RED II REC definition includes renewable heat energy, meaning that renewable heat production is equally to be encouraged.

In the current deliverable we will focus on **the internal market within the LECs and the solutions RENergetic provides for this purpose**. Note that everything related to the interaction of the LEC with the external grid will be the focus of later deliverables, esp. in D7.5 - Final evaluation of common demonstration results & impact and D7.6 - Final European analysis and communication of obstacles to innovation around Energy Islands.

Given the above mentioned scope, the current chapter aims at giving a view on the potential size of this market relevant to the RENergetic solutions. Therefor, we start from the definition of energy islands as we use it within the project: "An energy island is a geographical confined non-industrial area aimed at sustainability and self-sufficiency. "

In a recent survey (Mark Andreas Andor, 2022) executed in the Horizon 2020 NEWCOMERS project and processed in their deliverable D6.3, is stated that the vast majority (>80%) of the around 13500 households from nine different European countries consider renewable, community-owned energy systems to be an important or even very important element in the transition to a more sustainable energy system. This is already an indicator that there are a lot of opportunities for creating energy islands (or Energy Communities).

Unfortunately, no consolidated statistics of the current number and size of all energy communities in Europe can be found. However, there is an official Energy Communities Repository (Energy Communities Repository, 2023) where we found some numbers that help to indicate the market size. But some further research learned us that either:

- Not all energy communities (in the definition that we address them) are registered (e.g. the Ghent pilot is not listed)
- For some countries also energy sharing initiatives are registered as energy communities – which has an impact on the numbers e.g. for Germany the energy cooperatives are added and this does not correspond to the REC and CEC definition of the directive.

Nevertheless the table below gives a good indication on the trends of Energy Communities and in which European Countries they are represented the most. This was also used as a guideline for our preliminary competitive analysis as reported in the following chapter V.

Table III-1 Overview numbers of Energy Communities

Country	Number of Energy Communities[3]	Official registered Communities
Austria	374	
Belgium	108	

[3] Source: https://energy-communities-repository.ec.europa.eu/index_en

Belgium: Flanders	49	60 Officially registered Energy Communities end of 2022. (source: VREG: https://www.vreg.be/sites/default/files/document/rapp-2022-23.pdf)
Belgium: Wallonia	44	
Belgium: Brussels	15	6 => https://energysharing.brugel.brussels/energysharing/projets-derogatoires-537
Bulgaria	1	
Croatia	12	
Czechia	35	
Denmark	633	around 350 energy cooperatives especially in the heating sectors = 50 bigger social enterprises, belonging to municipalities
Estonia	129	
Finland	83	
France	343	
Germany	4848	around 847 officially registered energy cooperatives with around 220.000 members
Greece	168	
Hungary	1	
Ireland	545	
Italy	198	
Latvia	4	
Lithuania	19	
Luxembourg	66	
Malta	1	
Netherlands	987	
Norway	30	
Poland	82	
Portugal	11	
Romania	1	
Slovakia	23	
Slovenia	8	
Spain	235	
Sweden	329	
Switzerland	289	
United Kingdom	360	

IV. RENERGETIC FUNCTIONAL BUILDING BLOCKS AS A MEANS TO EXPRESS RENERGETIC VALUE POTENTIAL

IV.1. Approach towards RENergetic value propositions

A lot of the work within the RENergetic project is structured around the **RENergetic epics**. An epic brings together the research, implementation, evaluation, communication and other efforts around a certain RENergetic solution. The epics therefore indicate for which solutions RENergetic will deliver value that can potentially also live beyond the project duration, in the form of RENergetic solution brought to the market (to be reported in the upcoming Deliverable D7.7 – GotoMarket Strategy) or by replicating these solutions (to be reported in the upcoming Deliverable D8.2 and D8.3).

As the current deliverable develops an initial market analysis for RENergetic solutions, the epics form the starting point. However, the description of the epics turned out not to be specific enough to base the market analysis thereon. For that reason, we took several steps to develop the actual RENergetic **value propositions**, as described in the current section. First, we tried to map the epic directly to the value proposition concept developed by Osterwalder in a value proposition canvas workshop, see subsection IV.2. . Based on this approach, we have been able to show value within the different epics for several involved stakeholders. Next, we tried to use the epic-based value propositions in order to fill the Osterwalder business model canvas (see subsection IV.3.), adding more focus, e.g., on the resources and activities needed to develop the value propositions. By doing so, it became clear that we needed a more fine-grained view on potential RENergetic value propositions. Combining the epics view, the results of both value proposition and business model canvas workshop and the structural view on the RENergetic implementations ongoing in WP3, we decided to organize the work around so-called **RENergetic functional building blocks** (see subsection IV.4.) These have the required level of detail to be used when comparing RENergetic solutions to other existing solutions on the market. The initial market analysis reported later on in this Deliverable is therefore based upon these functional RENergetic building blocks (that act as RENergetic value propositions).

IV.2. Value Proposition Canvas workshop

Value proposition canvas (VPC)

The value proposition canvas is considered a strategic tool used by companies to conceive, analyze, and improve their value proposition based on the book on value proposition design.

According to Alex Osterwalder , the value proposition is the reason why customers turn to one company rather than another. It solves the customer's problem or satisfies their need. Each value proposition consists of a set of selected products and/or services that meet the requirements of a specific customer segment. In this sense, the value proposition is an aggregation, or set, of benefits that a company offers to its customers. In fact, companies design products and services to meet certain kinds of requirements. However, most innovative catered services and products fail to deliver on expectations (around 72% fail based on the global strategy consultancy Simon-Kucher & Partners in collaboration with the independent Professional Pricing Society (PPS) (Simon-Kucher, 2014). The value proposition canvas is developed to ensure a better match between innovative services and products on the one hand side and customer expectations on the other hand side. This is reflected in the two parts of the value propositions canvas, as revealed in Figure IV-1:

1- Customer profile side that takes the customers' space viewpoint and its different needs

2- Value Proposition side that focusses on the business viewpoint and what are the main services and products to be implemented in order to meet the customer side requirements

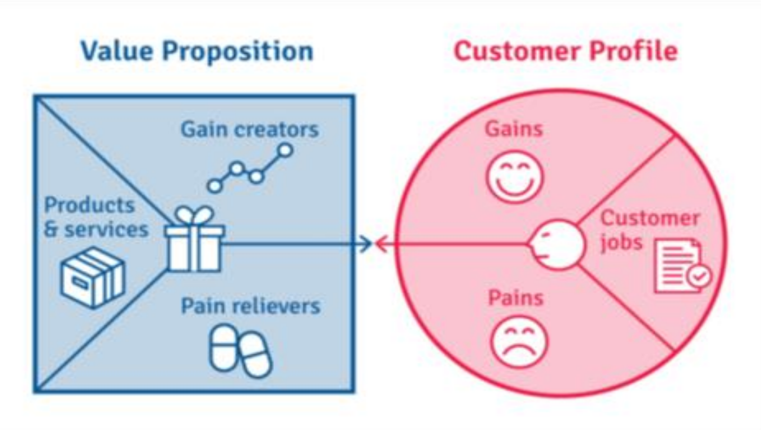


Figure IV-1 A Graphical Depiction for the Value Proposition Canvas and its Components

On the right-hand side, the customer profile shows the customer's jobs to get done. The jobs can be interpreted as functional/operative, social, or emotional. In addition to the customer jobs, pains are explicitly pinpointed under the customer profile. In this context, the pains can be defined as negative outcomes that a customer hopes to avoid such as discontentment with the existing solutions and challenges, frustrations, risks, or obstacles towards fulfilling a job. The final component under the customer profile describes the customer gains. Indeed, gains are positive outcomes that customers hope to achieve such as concrete added value in a certain way, benefits, and aspirations.

The left-hand side is the value proposition side. There we first see a listing of the product(s) and service(s) being offered. Next, we see the impact of the product and services offered in relieving the pains depicted in the customer profile. This subpart is therefore called pain relievers. The last sub-part within the value proposition side shows the gains creators where the different services/products are meant to maximize the gains for the customers. Note that the canvas is to be tested and re-iterated so that the value is improved and mapped hand in hand with the right-hand side (the three components of the customer profile).

Table IV-1 Value Proposition Canvas Components and Meaning

Component	Scale	Description
The customer profile		• It describes a specific customer segment in a more structured and detailed way by breaking down the profile into jobs to be done, pains and gains. • It helps to assess these characteristics to be studied and observed on customers.
Jobs to be done (Customer Jobs)	Important Insignificant	It describes what customers are trying to achieve in their work, their lives as expressed in their own words. (Functional, social, emotional, supporting jobs)
Pains	Extreme Moderate	It describes bad outcomes, risks and obstacles related to customers jobs
Gains	Essential	It describes the outcomes customers want to achieve or the concrete benefits they are seeking.

	Nice to have	(Tangible description: how many euros, how many minutes, …)
Value Proposition Map		• It describes the features of a specific value proposition in the business model. • It breaks the value proposition down into products and services, pain relievers and gain creators. • It is the set of benefits designed to attract customers.
Products & Services		It is the list of all the products and services the value proposition is built around. (Physical, intangible, digital, financial)
Pain relievers		They describe how products and services alleviate customer pains.
Gain creators		They describe how your products and services create customers gains.

VPC workshop carried out by RENergetic consortium members

The RENergetic value proposition workshop took place in Passau during the PMB meeting on 10/10/2022 and took about 2.5 hours. It was structured around the RENergetic epics as a first iteration on the potential RENergetic value propositions.

Concerning the workshop organization, it started by giving all participants a brief introduction to the value proposition design (based on a short intro video , followed by sketch of the goals and the setup of the workshop. We focused on the 4 most advanced epics at that time. The selected epics are:

- Automated Heat Demand Response
- Manual EV Demand Response
- Manual Heat Demand Response
- Automated EV Demand Response

The PMB participants were split into 4 teams, each team tackling one epic and taking up one particular position in the room. Each position being equipped with the following: several clean value proposition templates, a pile of post-its, an overview of the personas (first view on RENergetic stakeholders), an overview of the methodology. The distribution of the participants over the teams was based on interest and the expertise within the different domains (based on the epics). Indeed, one" epic owner" per team acted as the key person in that team.
The VPC canvasses were filled in several rounds based on brainstorming within the team, where in subsequent rounds one team tackled the same epic from the perspective of different stakeholders. About 40 minutes were allocated per round and example outcome of such a round is shown inFigure IV-2 Instance of the Value Proposition Canvas Developed at the Passau WorkshopFigure IV-2.

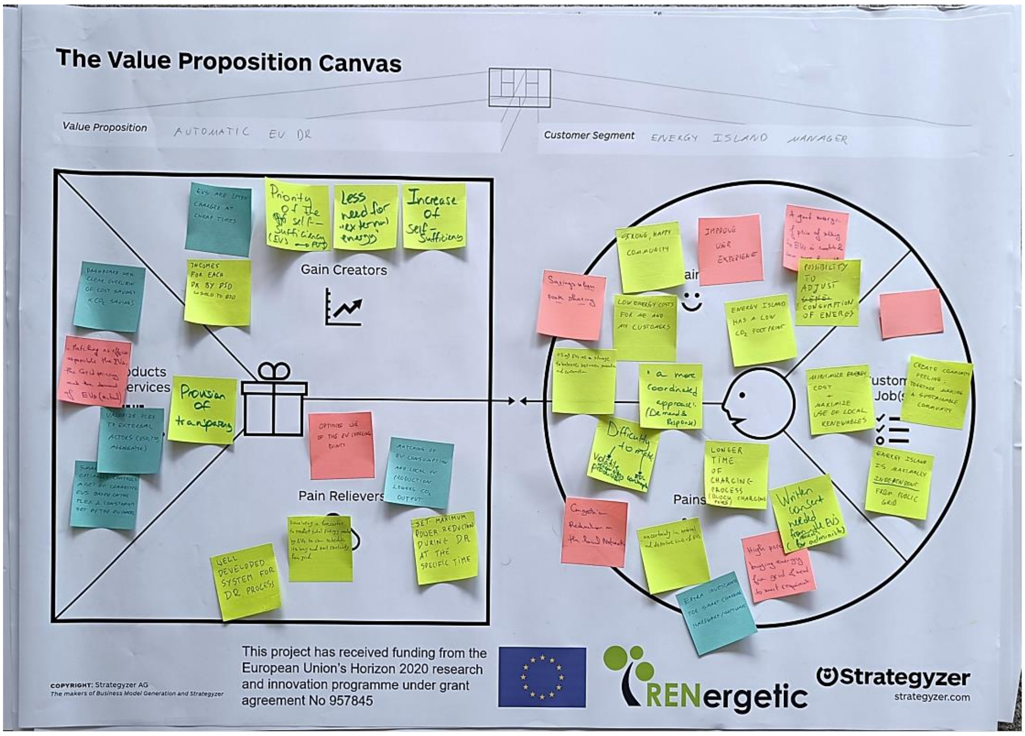


Figure IV-2 Instance of the Value Proposition Canvas Developed at the Passau Workshop

The overall results of the value proposition canvas workshop in Passau are included in the appendix IX. Some first take-aways are listed hereunder.

- The first epic selected is **automatic demand response for electric vehicles**, for which there are three different customer segment perspectives. These customer segments are the distribution system operator (DSO), the energy island operator, and the EV owners.
    - Additional gains related to this epic link to the fact what is allows to build a strong community that is working towards a common goal (not a financial goal)
    - Point of attention is to make a clear distinction between the relevant value propositions for the different customers, e.g., DSOs might never be interested in using the flexibility

- The second epic focuses on **automated heat demand response**. In this epic, three distinct perspectives are considered: the energy island operator, the residents, and the waste heat supplier.
    - For this epic, is it very important to have a good communication to the user. The solution proposed in this epic should not be perceived as a black box
    - End users (residents) should be made part of the energy transition

- The third epic is about **manual EV demand response** and again three different customer segments are identified: the energy manager, the community manager, and the residents.
    - The discussion tackled upon a lot of pains for different users in this epic, that need further discussion. It is important that the EV DR solutions makes recommendations that to not lead to tragedy of the commons.
    - We should communicate what we do and how do it, e.g. occupancy is to be taken into account. Avoid black box.

- The final epic involves **semi-automated heat demand response**. In this epic, three different customer segments are also identified. These are the heat consumer, the heat producer (Veolia) and the end users (residents and staff).
    - It seems difficult to difficult to find a win/gain for end users/ residents in this epic.

In summary, the value proposition workshop allowed to make a good first assessment of the potential of the different epics from the perspective of different stakeholders involved. It was further deepened in a business model canvas workshop, as described in the next subsection.

IV.3. Business Model Canvas workshop

Business Model Canvas (BMC)

The business model canvas can be defined as a management tool that allows a unified presentation language to be used to meet multiple business requirements. It helps to visually represent the business model of a company or project by describing its key elements, evaluating, and modifying business models (Osterwalder, Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers., 2010). The BMC framework captures nice key elements which portray various aspects of a certain project or business. The nine constituting elements of the BMC framework are shown in Figure IV-3.

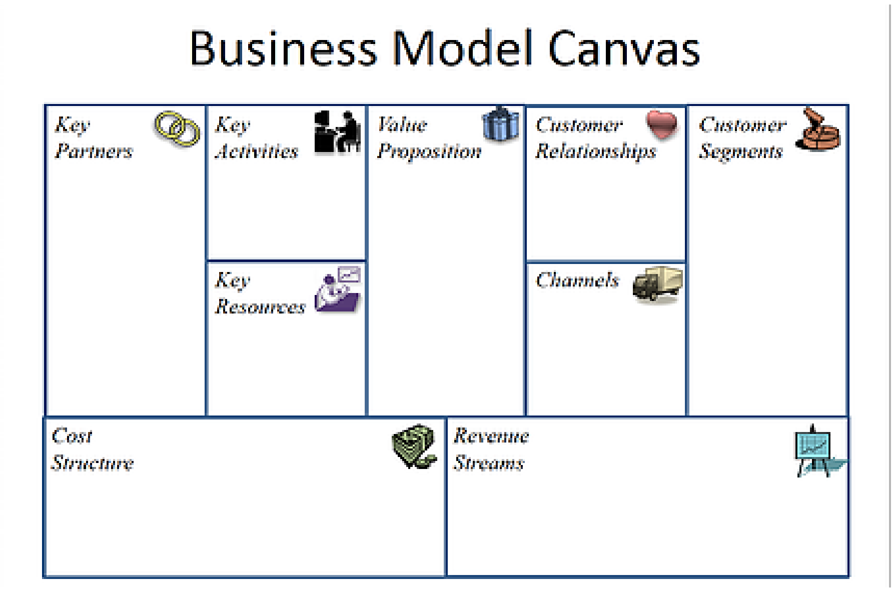


Figure IV-3 Business Model Canvas as Described by OsterwalderDallas, 2023)

In reliance on the classification of (Osterwalder, Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers., 2010) and (Goncearuc et al., 2022), the nine elements can be rearranged into four major categories reflecting the different viewpoints within a business construct.

1- Customer perspective assembling the upper right-hand side (Customer relationships, channels, and Customer Segments)

2- Business perspective regrouping the upper left-hand side of the canvas (Key Activities, Key Partners, and Key Resources)

3- Financial perspective assembling the cost structure and revenue streams.

4- Value proposition figuring in the centre of the BMC where the different elements revolve around this core element.

After the classification of the key items into four different groups, filling the individual components require a certain order that is highlighted in (Cowan, 2012) and (Goncearuc et al., 2022).

The order in which a Business Model Canvas (BMC) building blocks are filled is not necessarily fixed and can vary depending on individual preferences and circumstances. However, we typically start by Customer Segments, followed by Value Proposition. Next we fill Channels, Customer Relationships and Revenue sources/streams. At the left hand side of the canvas, we tackle Key resources, Key Activities, Key Partnerships and Cost structure resp.

A clarifying description of the nine key elements in the Osterwalder BMC is presented in Table IV-2.

Table IV-2 Descriptive Table of the 9 Key Elements of the BMC

Key Element in BMC	Description
Customer Segments	The term "Customer Segments" refers to the groups of people or entities/enterprises with requirements that the company can cater to. It is the initial stage in filling out the BMC, and all the company's products or services must be designed to meet the needs of at least one identified Customer Segment. This aspect of the BMC is critical both from the perspective of the customer and the company's overall business model.
Value Propositions	Referring to Osterwalder, Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers., 2010), the value proposition building block describes the set of products and services that create value for a specific target audience. This is the core element of the BMC where the company, the business, or a certain project is striving to deliver through a unique elements' mix. The values can be categorized as quantitative or qualitative (based on the targeted metrics). A combination of both is also common for businesses ambitioning to provide a good quality under budgetary constraints. This element connects the different perspectives of the BMC (namely business, customer, and financial aspects).
Channels	This element of the customer perspective constitutes the interface connecting a certain customer segment with the business value proposition. Thus, they are serving as bridges between the customer segment and the value proposition core element where every channel needs to have a link with a targeted customer segment. Among the main tasks that channels tackle are the promotion of a brand, the value proposed by the business (dissemination), enabling the customers to assess the products/services, allowing the distribution, guaranteeing the delivery, etc.
Customer Relationships	It represents the type of dealing with the customers by the business or the company offering the product or the service including the interaction envisioned in several circumstances. This is a further step that builds upon the channels after ensuring that the customers are reached (based on the defined order). Several approaches can lay under this building block regarding the level of relationship that a company wants to establish with its clientele. This can range from fully automated services to bespoke customer-centric services and products.
Revenue Streams	They represent the created income by the business or the company from the several customer segments. It embodies answering a crucial question dealing with the value proposed by the company for which a customer is willing to pay. These streams are the result of remuneration by the customer segment for the proposed value created by the business.

Key Activities	It is the specific set of tasks and processes that a company must perform to deliver its value proposition to its customers and, ultimately, generate revenue. These activities can be aggregated or complementarily linked to contributing to a least one of the value propositions defined beforehand based on the customer segments' requirements. As such, the key activities element is the fundamental generator of the multiple offerings to the customer. These activities differ immensely based on the business model type.
Key Resources	This building block in the BMC describes the various assets available for a business or a company to accomplish its key activities. Thus, the viability of the resources can be assessed when matching these numerous assets with the activities performed to map them accordingly to decide about their usefulness and their contribution to creating value.
Key Partnerships	This component regroups the companies, organizations, and external parties which interact with the business or the company to enable it to create value. This is reflected in the key activities and processes conducted based on the key resources. The value of the collaboration with key partners is worthwhile only when there is a direct/indirect implication on at least one of the key activities. Collaboration can be pivotal in certain conditions to optimize the business models, alleviating the risk, or resources supply.
Cost Structure	This element represents the many expenses that a company, business, or project incurs when it plans to perform key activities and, therefore, deliver the proposed value to customer segments. There are costs associated with these operations, the key costs of which are listed on the BMC. Each key cost must be related to the key activities. This is a subset of the BMC financial perspective.

Note that the elements from the value proposition canvas form the central axis for the business model canvas. The business model canvas adds more context and focusses on what is needed to develop the identified value propositions as well as the way to get to the customers and it adds a view on results costs and benefits.

BMC Workshop carried by RENergetic consortium

The RENergetic Value Proposition Workshop was held in Madrid during the PMB meeting on Tuesday, 2/28/2023, and lasted approximately two and a half hours. The images in Figure IV-4 illustrate the actual implementation of the BMC workshop during the Madrid PMB.

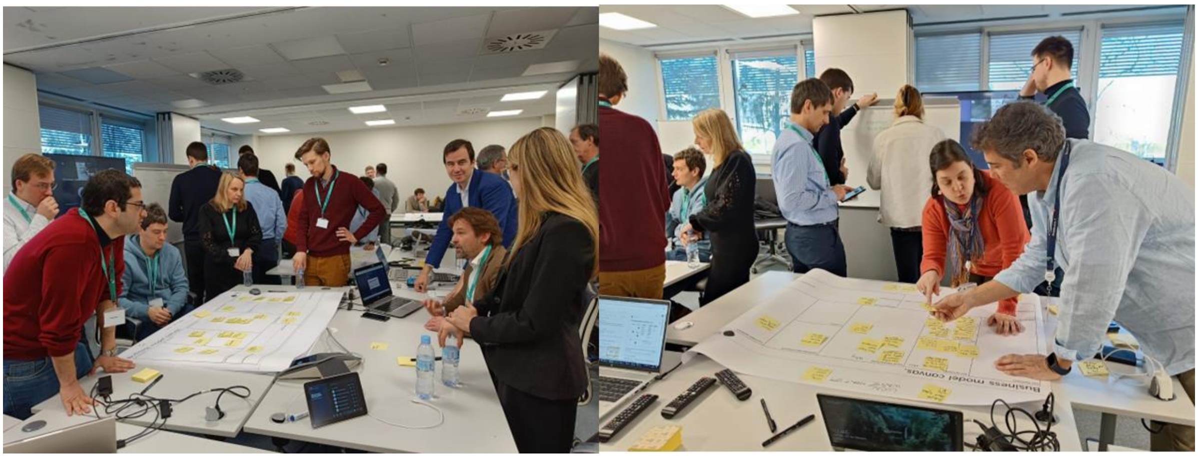


Figure IV-4 Madrid BMC Workshop Actual Implementation by the different Teams

Similarly, to the earlier VPC workshop, also the BMC workshop was structured around RENergetic epics as they form the project's best view on potential RENergetic value propositions at the time. In the BMC workshop, we built further on the epics for which value propositions had been described in the VPC workshop and added additional epics that gained importance in the project since then. The set of selected epics for the BMC workshop was the following:

1- Local waste heat optimization
2- Heat supply optimization
3- Heat demand response
4- Electricity demand response
5- Electricity supply optimization
6- Electric vehicles demand response
7- Cross Sectoral services

Compared to the epics selected in the value proposition canvas workshop, an update can be noticed since an introduction of new ones can be observed especially related to the electricity domain (electricity supply optimization and demand response actions to be exerted to serve certain objectives). Also, another epic was added concerning local heat waste optimization. The epics of manual and automated EV DR are merged into a more generic one called Electric vehicles demand response.

As far as it concerns the workshop organization, again we started by a short introduction concerning the concept of the business model canvas (Strategyzer, BMC [online], 2011). The PMB participants were distributed in team over the different epics, one or two responsibles were appointed per team. Each team took one position in the room and was equipped with large papers containing empty BMC canvasses, pens, and coloured post-it notes. The subsequent phase took the most time and concerned brainstorming and filling out the various canvases. The teams worked on each section of the canvas. This allowed brainstorming and collaboration between the different team members. Once the order-based filling technique was completed, the teams had the opportunity to inspect, refine, and finalize the canvases. In this phase, the areas or building blocks lacking a clear view are reiterated and agreed upon collaboratively to make sure that the final version of the BMC matches the team's perspective. A sufficient time was allocated per round for each of the epics and an example outcome of such a round is revealed in Figure IV-5.

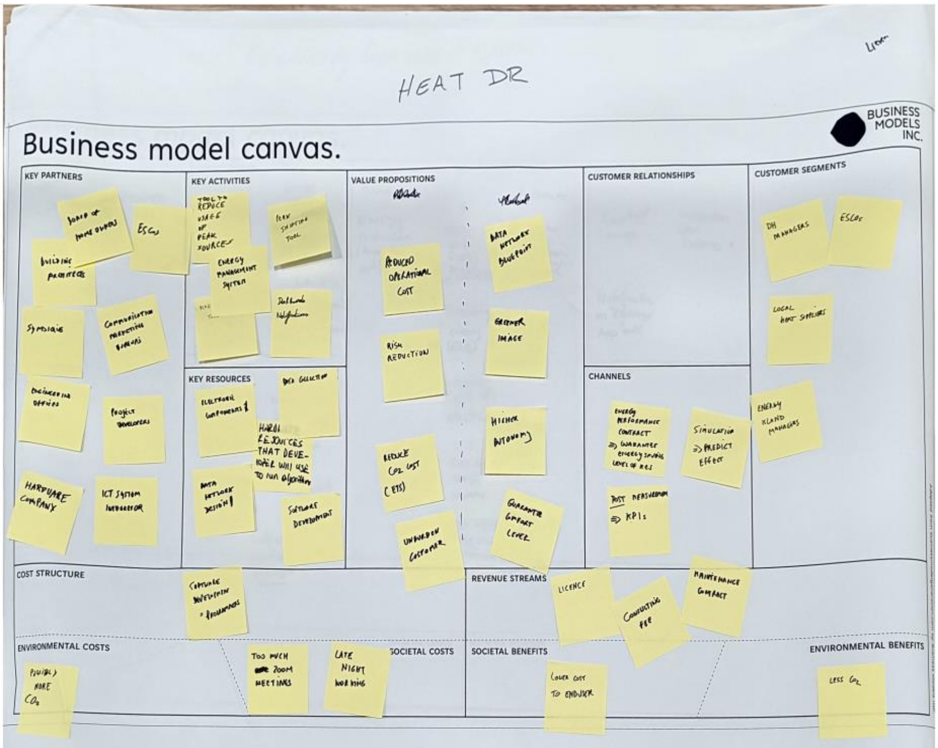


Figure IV-5 Example of the Business Model Canvas Developed at the Madrid Workshop

The outcomes of the workshop are compiled in several tables that include all the epics that were discussed and brainstormed. These tables can be found in the appendix IX.

Clearly, some additional insights have been gathered in this workshop. We got some first view of relevant cost and revenue elements, ideas have been exchanged on the way to target the different customer segments and the relationship to maintain with them. However, when it comes to fine-tuning the key activities and key resources required to actually develop the RENergetic solutions, the epics turned out not have to required level of detail. The major take-aways from the BMC workshop in this regard include the following.

- **Heat Supply optimization and Local Waste Heat Optmization.** There are two options for the source of the supply, which have an impact on the value proposition:
    - (1) Supply is a given, not to be impacted, e.g., Cristeyns as an input for New Docks (the focus of the resulting value proposition is on the internal optimization, while excess heat can still be treated)
    - (2) Supply can be controlled, e.g., heat generated by the datacenter in Poznan can be tempered (the focus of the value proposition is on the optimization of the energy to be sold externally, so that the external link is key here)
- **Heat DR**. The objective is to obtain economic, environmental and governance gains by shifting loads of demand. Within this epic two different value propositions are hidden, depending on the actual customers (segment) being targeted. The resulting tool will therefore show different functionalities according to the chosen customer segment, either to the heat/energy manager (in a B2B offer, e.g., to Veiolia) or to the end customer (e.g., residents). Several revenues streams seem possible here, based on licensing or other models.
    - Key activities: We offer to energy managers the ability to anticipate peaks of consumption by means of forecasting data based on historical patterns, a suggestion on the load that best complies with the objectives, optimizing the use of renewable sources.
- **Electricity DR**. Within this epic, again a differentiation needs to be made between two types of value propositions
    - (1) aimed at *internal optimization*
    - (2) aimed at the interaction with the external grid (e.g., based on the dynamic tariffs)

    - Key resources: anomaly detection + raising social awareness
- **Electricity Supply Optimization:** The value proposition is to make better use of the available energy sources within the energy island, minimizing costs of production of energy as well as maximizing the use of renewable sources, all from the supply point of view, meaning, the consumer will not be asked to adjust its behaviour but rather the supply will be made available depending on the cost of producing the energy using first renewable sources.
    - Key resources: The forecasted data will allow the system to store the energy when it is not going to be used immediately and prepare for a more appropriate moment. The battery plays an important role. It seems relevant to partition the battery in a "quality part" and an "economic part"
    - Key activities: The optimizer will shift the loads, however, through dashboards energy managers may amend the planning based on previous experience.
- **EV demand response**. The main value proposition covered in this epic is to reduce operational costs for charging station operators or charging point operators (CPO).
    - Key Activities are to Influence the charging process (in a 'manual' or 'automated' way), so that EV charging is shifted to periods when energy costs are low, more local renewable energy is consumed, available flexibility during the charging process is valorised on energy markets (e.g., through flex aggregators), ...
    - Customer segments are CPOs, Energy Island Managers, ESCOs
    - Revenues streams can be based on commission on cost saving of the customer
    - The uniqueness of the RENergetic solution relates to manual EV DR service tested with real users and automated EV DR service using advanced AI techniques (reinforcement learning).
- **Cross-Sectoral Services**. The broad value proposition covered by this epic relates to supporting decision-maker processes (due to better information). It also includes technical self-regulation (AI autonomously regulates the energy asset; e.g., Reinforcement Learning algorithm controlling autonomously the Charging Station) and helps to inform and report to relevant stakeholders
    - The uniqueness of the RENergetic solution in this regard relates to the combined forecasting & anomaly detection services and to the fact that the energy community members are aware of energy island benefits (societal benefit)
    - Key Activities include accurate forecasting of asset and user behaviour, automatic anomaly & fault detection for assets, simulation of what-if scenarios (business intelligence), visualization of information on dashboards and use forecasting services as input for direct system optimization
    - Customer segments include Energy (Island) Managers, Asset Owners, Energy Community Members
    - Revenues can be based on subscription fee, license

As a result of the above observation from the BMC workshop, we concluded that the epics did not have the required level of detail to be used as RENergetic value propositions that can serve as a basis for a market analysis. Therefore, we decided to engage in the definition of what we call the **RENergetic functional building blocks**, as described in the following subsection. These building blocks reflect the different value generating elements covered in the different RENergetic epics.

IV.4. Overview of generic RENergetic technical and social building blocks

The RENergetic Solution is a set of digital micro-services and a social toolbox to increase sustainability and self-sufficiency of a geographical confined non-industrial area.[4]

In this context, digital micro-services can be defined as services, realized through functional building blocks, in order to facilitate specific goals within an energy island (ex.: optimized heat and electricity supply, demand response programmes, increasing social awareness within the energy island). The final goal of the project is among others to build self-sustainable energy islands and develop solutions which can be replicated in other places too.[5]

As previously defined in the D 3.1, *the RENergetic system is designed according to the service-oriented architecture – each service performing specific functionality and communicated with other modules of the system*. Additionally, *its goal is to provide visualizations of the data coming from energy island systems and corresponding forecasts for the different types of the users, such us visitors, residents, and managers.*[6]

The overall goal is to develop technical solutions that are compatible with other existing solutions on the market and bring an additional value to the existing market actors. The technical solutions can then support energy communities and ESCOs to implement a specific business model (ex. PV production and optimized EV charging and/or heating system).

As previously mentioned in Section IV.3. , the different types of building blocks resulted from the discussions during the Business Model Canvas PMB Workshop in Madrid.[7] These technical and social building blocks are current tangible exploitable results from the software development, based on the different epics and micro-services. Their description in the coming sections must be however distinguished from the ICT functionalities, described in the Deliverable 3.1, as it focuses on a general tool explanation and the intended implementation within the project. Further technical software details will not be elaborated in this Deliverable. In the following sections IV.4.1. , IV.4.2. , IV.4.3. IV.4.4. the **technical and social building blocks** are listed. First, the **technical building blocks** with a corresponding description of needed data and a brief implementation plan with the current and target TRL levels give an overview of the technical feasibility of each of the blocks. Note that the evolution beyond the target TRL levels of each of the solutions (at the end of the project) will be dealt more in depth during the next Deliverable 7.7 *Go2MarketStrategy*). The detailed explanation regarding the TRL level can be found in Appendix IX.5. Regarding the data requirements in each of the building blocks it needs to be noted that different types of data (consumer, energy supply, weather, etc.) is a necessary pre-requisite for all technical and partially social blocks (Figure IV-6 Overview of the technical and social building blocks):

Note that the last two social building blocks at the end of the Subsection IV.4.4. are no RENergetic solfware implementations (so that also no TRL levels are mentioned), they constitute of communication methods and social toolbox.

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[4] This definition is an outcome of the internal RENergetic team workshop on the SGAM Model – 31st of March and 1st of April 2023

[5] D 8.1., p.7

[6] D 3.1, p. 2

[7] The RENergetic PMB referred to, took place between 27th of February and 1st of March in Madrid, Spain at INETUM

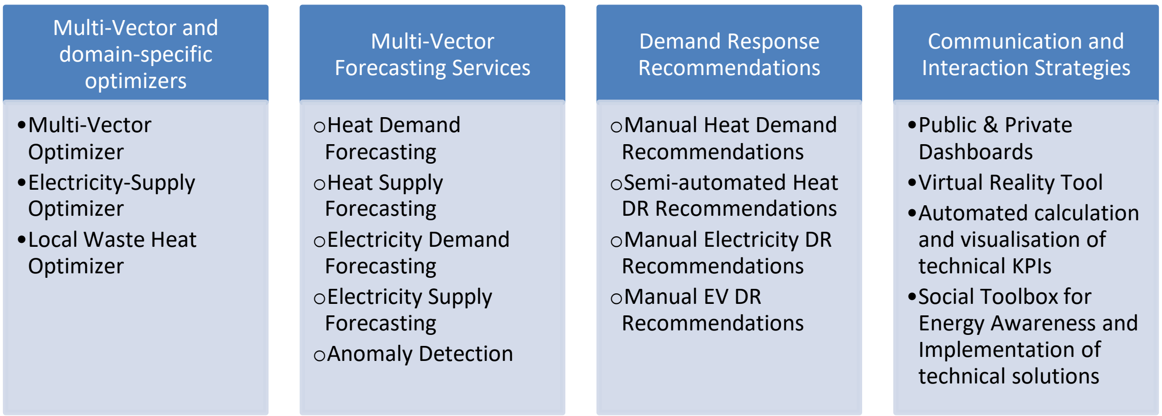

Figure IV-6 Overview of the technical and social building blocks

IV.4.1. (Global) Multi-Vector and domain specific optimizers

Multi-Vector Optimizer (MuVeCo): it helps to find the optimal energy profile for each component in each domain (fixed/flexible consumption/generation, interconnectors, storage) for the next time intervals. Additionally, MuVeCo considers physical limitations, such as electricity consumption limits for heat pumps, but also financial signals e.g., flexible grid pricing schemes or revenue opportunities from potential local energy markets to increase profitability of the system.

- Data Requirements: The MuVeCo requires specific data such as the parameters of the devices in the energy island and information about their connections; forecasted data about consumption and generation, thus historic data too. Results are shown in GUI (Graphical User Interface) and can be accessed through API (Application Programming Interfaces).
- Implementation Plan: MuVeCo is going to be integrated to the RENergetic system. Output of the optimizers is shown as Grafana dashboards and accessible through API.
- Current TRL Level: 4 (technology is tested with real data by initial developers).
- Target TRL Level: 6 (to be tested in Ghent, potentially also in OSR – Ospedale San Raffaele).

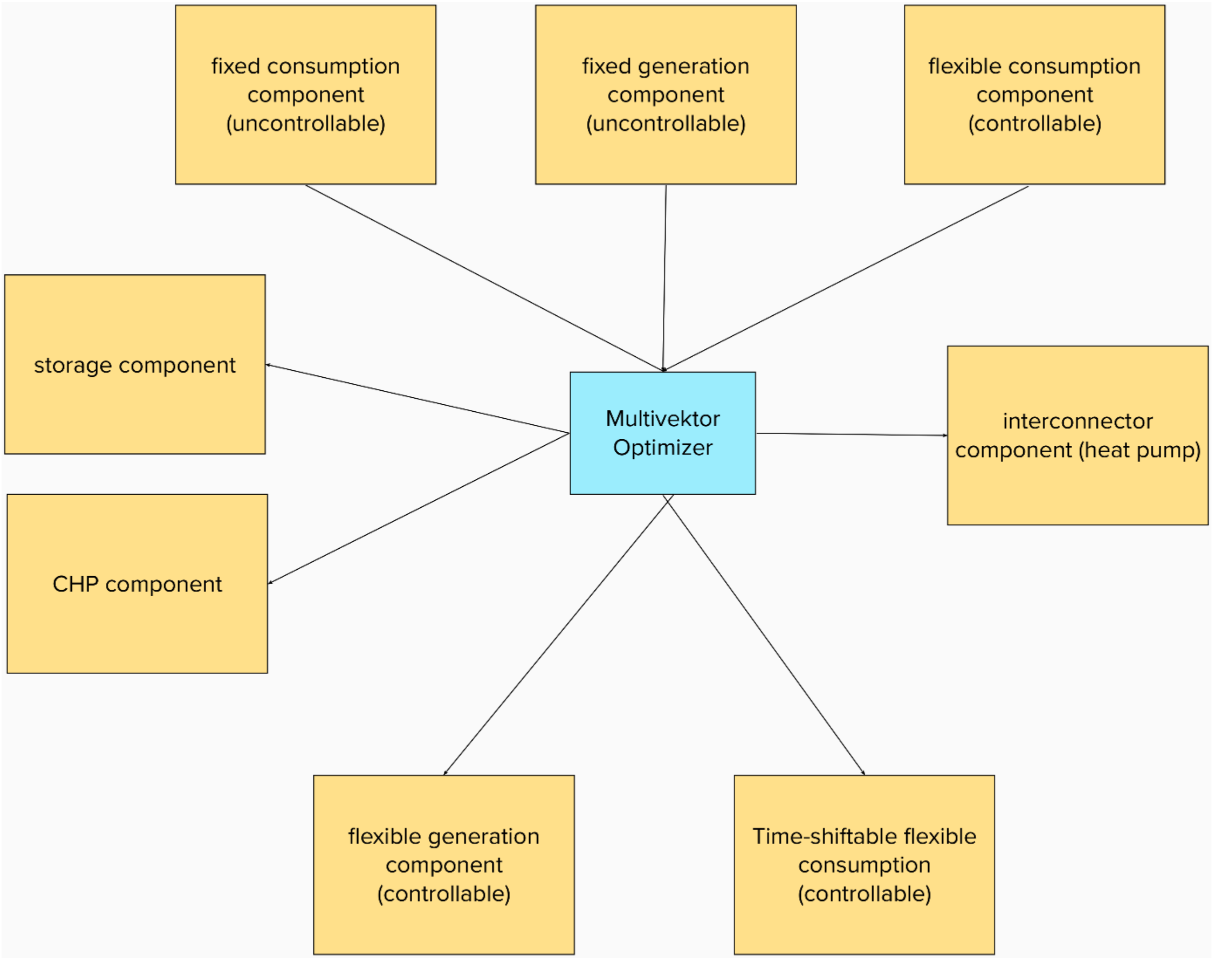

Figure IV-7 Components for the MuVeCo (outcome of an internal RENergetic team workshop, 31st of March, 1st of April)

- ***Electricity Supply Optimizer***: it distributes the scheduled energy flexibility received from the MuVeCo to electrical resources considering domain constraints and opportunities. Potential constraints here are voltage limits in energy island electricity grids, storage- use of flexibility for ancillary services (FCR – Frequency Containment Reserve, aFRR – automatic Frequency Restoration Reserve, mFRR – manual Frequency Restoration Reserve) or similar.
  - Data Requirements: Historical and current data from the electricity supply are needed alongside structural data about the power system, if voltage limits are to be considered.
  - Implementation Plan: Currently only implemented in the virtual pilot and potentially to be integrated within the RENergetic system.
  - Current TRL Level: 4 (tested by RENergetic development team).
  - TRL Level: 5 (to be tested in the virtual pilot).

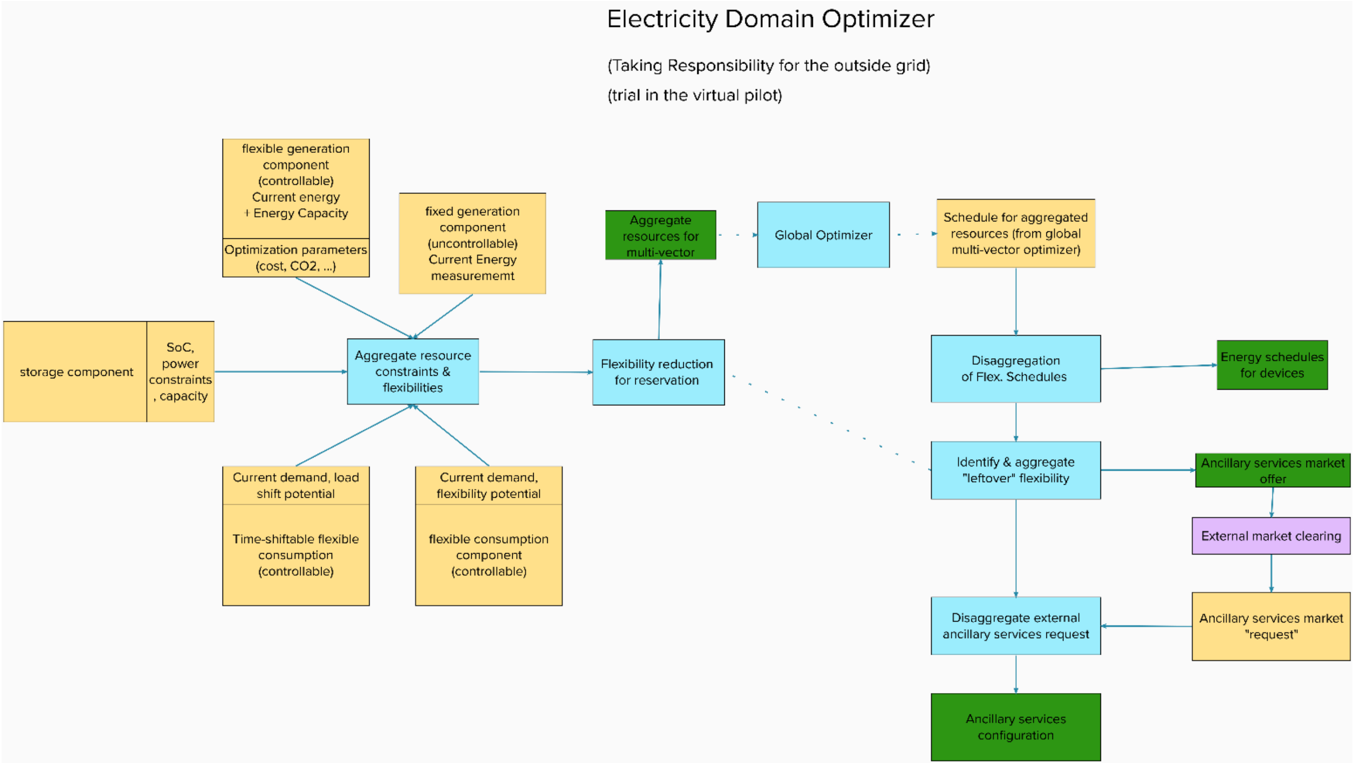

Figure IV-8 Structure of the Electricity Domain Optimizer (outcome of an internal RENergetic team workshop, 31st of March, 1st of April)

- ***Local Waste Heat Optimizer***: This functional block contains tools for planning of a heating infrastructure to ensure an optimal usage of local waste heat in a simulation. It is a collection of tools and models to design, optimize and evaluate local waste heat re-use in energy island.
  - Data Requirements: Historical and current data from the waste heat production are required here.
  - Implementation Plan: Currently it is at a conceptual stage only (Poznan – Warta Campus).
  - Current TRL Level: 4 (Proof of Concept has been developed).
  - Target TRL Level: 6 (to be tested in Poznan).

IV.4.2. Multi-Vector Forecasting Solutions

All forecasting blocks are based on the same architecture which can be adjusted to a different scenario and data follows a similar time series structure (only specific data parameters for the pilots and their definitions are changing). The time series with different time resolutions are transformed to the time series with hour resolution. This forecasting method can be applied to any pilot (the code remains the same, the input function differs).

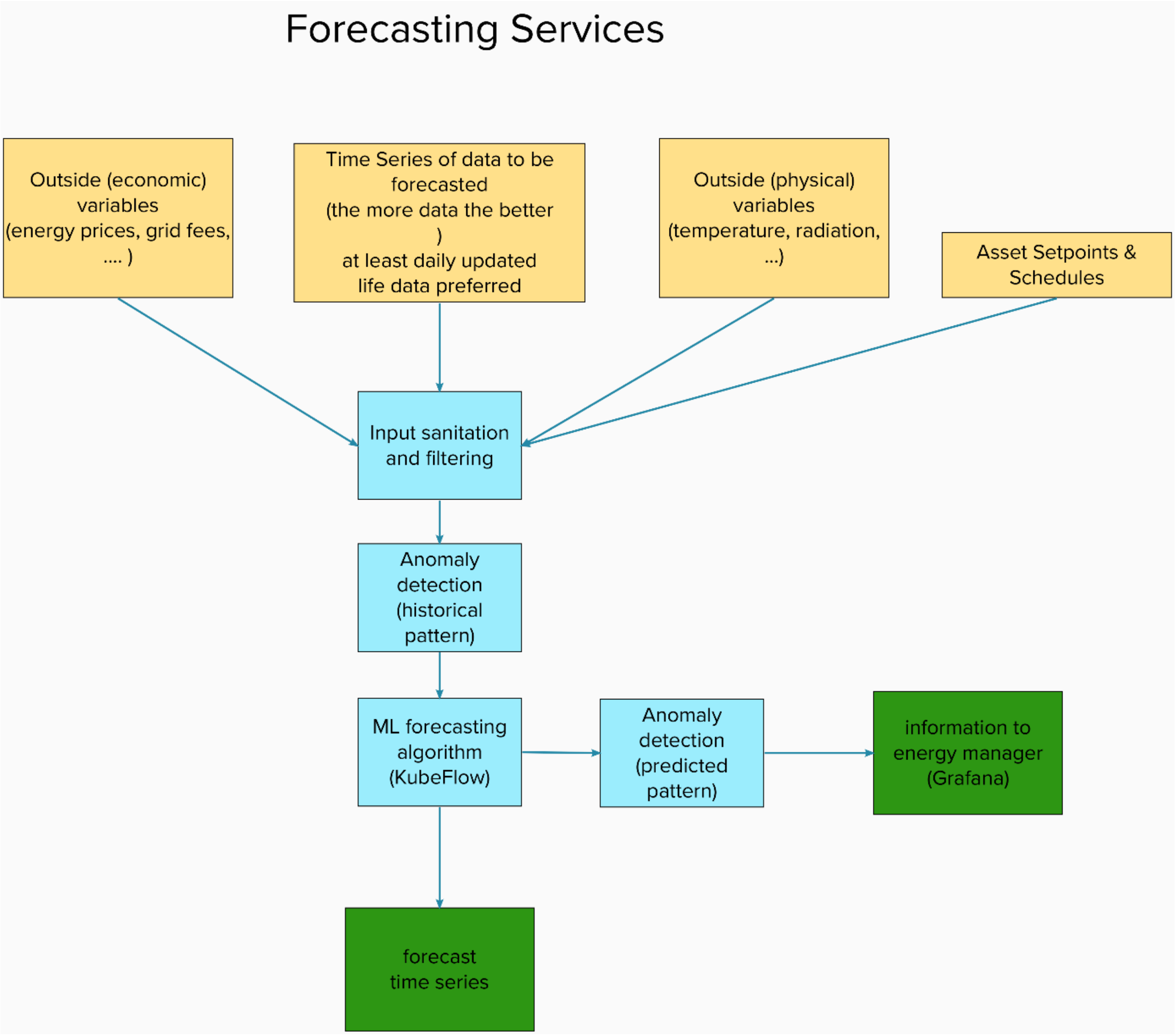

Figure IV-9 Structure of the Forecasting Services (outcome of an internal RENergetic team workshop, 31st of March, 1st of April)

The forecasting solutions connected to the MuVeCo are the following:

- **Forecasting Solutions**, including heat demand and supply forecasting, electricity Demand and supply forecasting (incl. EV charging stations occupancy forecasting)
  - Data Requirements: Historical Data about heat consumption, available waste heat, electricity demand and supply and EV occupancy is needed here.
  - Implementation Plan: To be implemented in the system, results are shown in GUI. Model parameters should be set in code.
  - Current TRL Level: 5 (implemented in FOG team).
  - Level Target: 7 (to be tested in all pilots).
- **Anomaly Detection**: it is applied to the forecasted generation and consumption in specific domain (heat and electricity). It detects anomalies within an energy island's data and sends automatic notifications to an energy manager.
  - Data Requirements: Historical Data about the electricity and heat demand and supply is needed here.
  - Implementation Plan: To be seen as a part of the forecasting solutions.
  - Current TRL Level: 5 (currently being tested by development team).
  - Target TRL level: 7(to be tested in all pilots).

IV.4.3. Demand-Response Solutions

- **Manual Heat Demand Response Recommendations:** it consists of recommendations for ESCOs, households and individual users within the RENergetic system on "how to shift" or reduce their heat demand.
  - Data requirements: Historic and current data about heat supply, and the "renewability" of the heat sources is required. Here, both definition and calculation of heat renewability are important here.
  - Implementation Plan: Tested within Pilots. A simple version is implemented already in the GUI and APIs. Rule-based version can be equally implemented (currently being decided) but is not tested yet.
  - Current TRL-Level: 5.
  - Target TRL level: 6 (potential testing planned in Ghent or in Poznan).

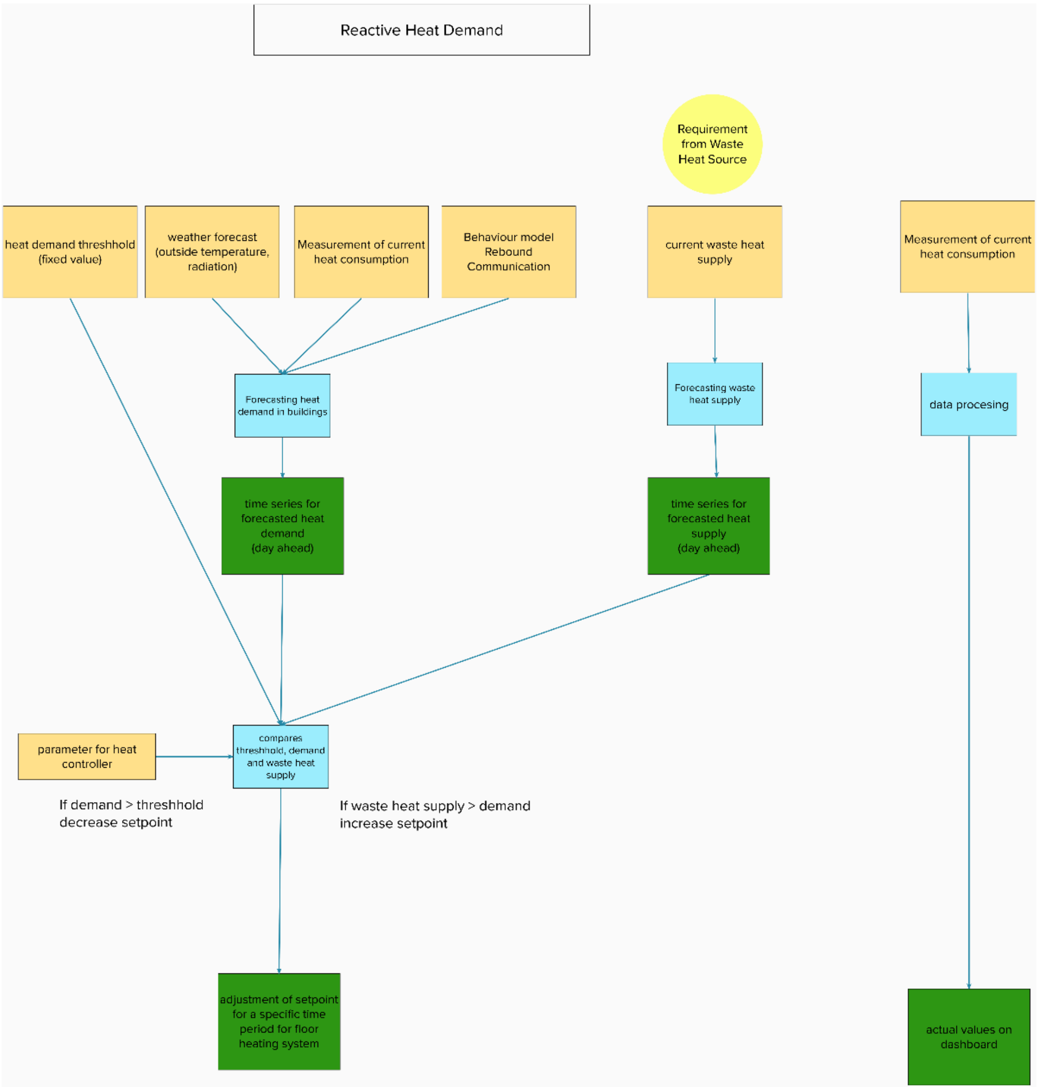

Figure IV-10 Ruled-based Heat Demand Model (outcome of an internal RENergetic team workshop, 31st of March, 1st of April)

- **Semi-automated Heat Demand Response Recommendations:** this block includes recommendations for technical managers on how to adjust buildings' setpoints so that the requested heat threshold is not exceeded.
  - Data requirements: Historical data is used. Predictions of heat demand and temperatures, weather data are considered.

- Implementation Plan: A machine learning platform Kubeflow is being used for the implementation. This functionality is planned to be tested in one of the pilots (Poznan).
- Current TRL Level: 4 (Proof of Concept has been developped).
- Target TRL Level: 6 (to be tested in Poznan pilot).

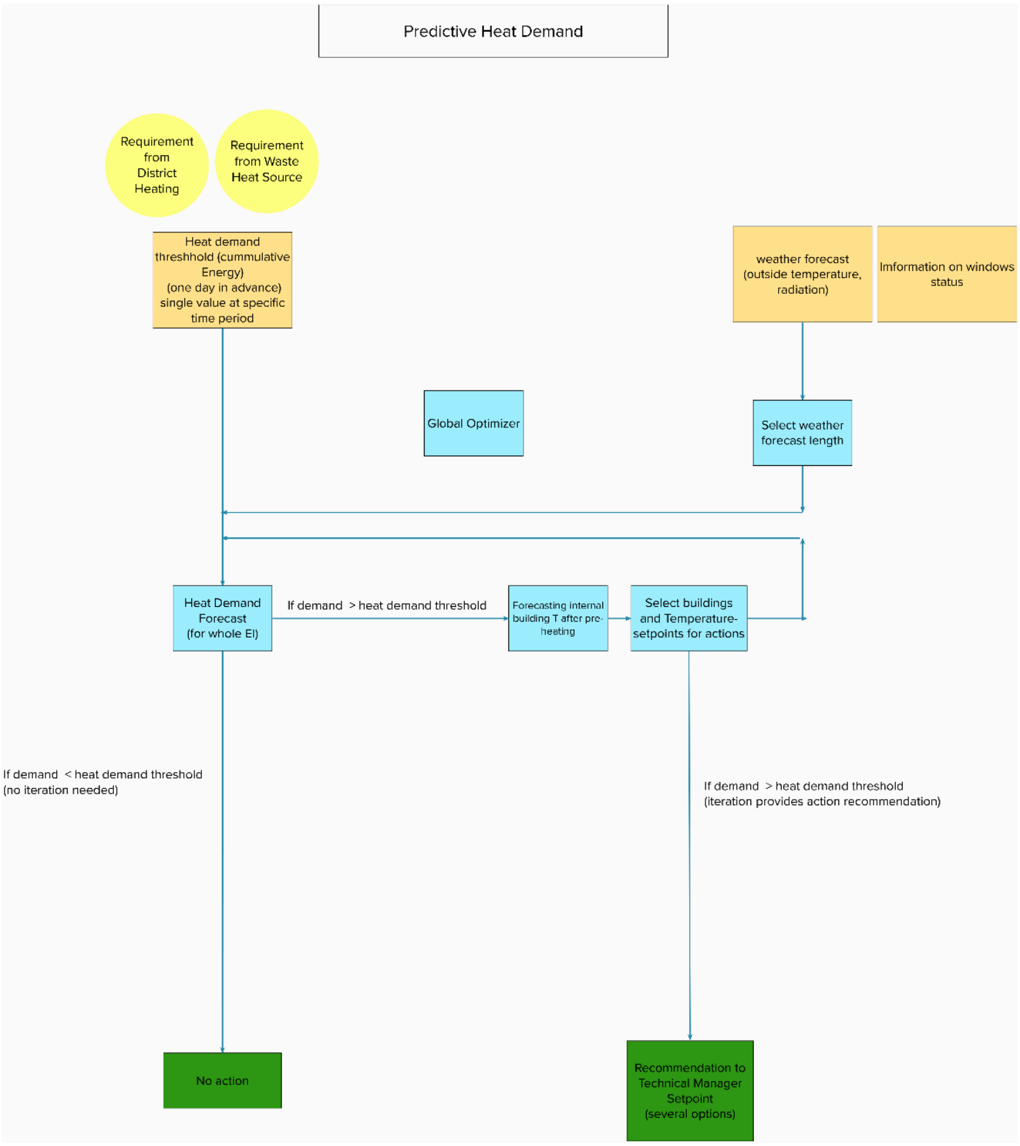

Figure IV-11 Predictive Heat Demand Model

(outcome of an internal RENergetic team workshop, 31st of March, 1st of April)

- **Manual EV DR recommendations:** this technical block displays more favourable periods for charging EV. The idea of the technical block manual EV DR is to show several static times specified by energy managers to users and to encourage users to charge their Evs at these favourable time slots.
  - Data requirements: Required data for energy managers for defining these good periods is: EV historical data and day-ahead prices and weather forecasts (for PV production).
  - Implementation Plan: A simplified version is going to be implemented in the system – notifications can be then visible on the GUI of a website, as well as accessed through API. A rule-based version can be also potentially implemented, but will depend on the additional replicability value.

   - Current TRL-Level: 5 (in development team).
   - Target TRL Level: 7 (to be tested in Ghent and Ospedale San Raffaele).
- **Automated EV DR with a Reinforcement learning:** this block includes automatic control of charging stations according to the domain specific objectives and is in line with global multi-vector optimization. AI allows for a control and scheduling of optimized charging sessions.
   - Data requirements: Required data for energy managers for this block is: historical data about EV charging sessions and users involved.
   - Implementation Plan: Implementation on the real hardware will probably not be feasible within a pilot. The integration into the current RENergetic system is currently being assessed. The AI and reinforcement learning tools are being tested within the Gent pilot.
   - Current TRL-Level: 4 (not in the RENergetic development team, only in local in Ghent development team).
   - Target TR level: 6 (to be tested in Ghent pilot).

The figure IV-12 illustrates how the RENergetic Demand response solutions in different sectors (heat, electricity, EV) are built and which input is needed to generate recommendations. It shows which different components are required for Demand-Response solutions. For the purposes of this deliverable and functional blocks description, the details of the legal, behavioural and specific business requirements will not be dealt with.

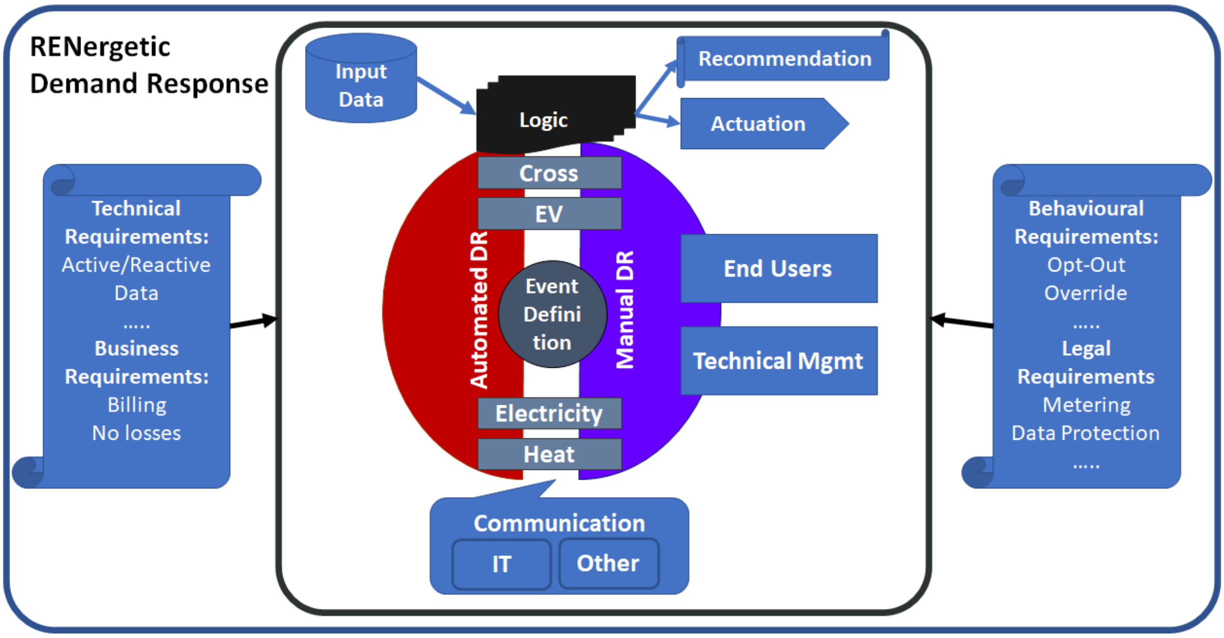

Figure IV-12 ***RENergetic Demand Response Solutions***

IV.4.4. Communication and interaction Strategies

- ***Public Interactive Dashboards***: Dashboard display generation and consumption by individual users (generalized). For generation it is three categories – renewables, fossil fuel and external grid. For consumption – categories of the consumers defined by the pilot (office, shared spaces, data center, for example). The dashboards are being combined within other technical functional building blocks.

  - Implementation Plan: Implemented in the system – GUI is shown, data used for the display is accessible through API. Some parameters can be configured through the GUI.
  - Data required: Data about current generation and consumption from different sources and consumers is needed. Additionally, data about "renewability" of the energy sources and consumer categories (with data about their consumption).
  - Current TRL Level: 6 (tested by RENergetic development team and other users for demo-purposes).
  - Target TRL level: 7-8 (to be tested by all pilots).
- ***Private Interactive Dashboards***: Private dashboard is planned to be displayed for the user who owns or occupies specific part (e.g. flat or office) of the energy island. The current consumption of heat and electricity is shown. The dashboards can be also configured for the energy manager – in that case energy manager is just a user that owns all energy island.
  - Implementation Plan: to be implemented in the system – GUI and API. Some parameters can be configured through GUI.
  - Data required: Current and historic data about energy (heat and/or electricity) consumption of the specific user is needed.
  - Current TRL Level: 5 (Proof of Concept has been defined).
  - Target TRL Level: 6-7 (planned to be tested in Ghent).

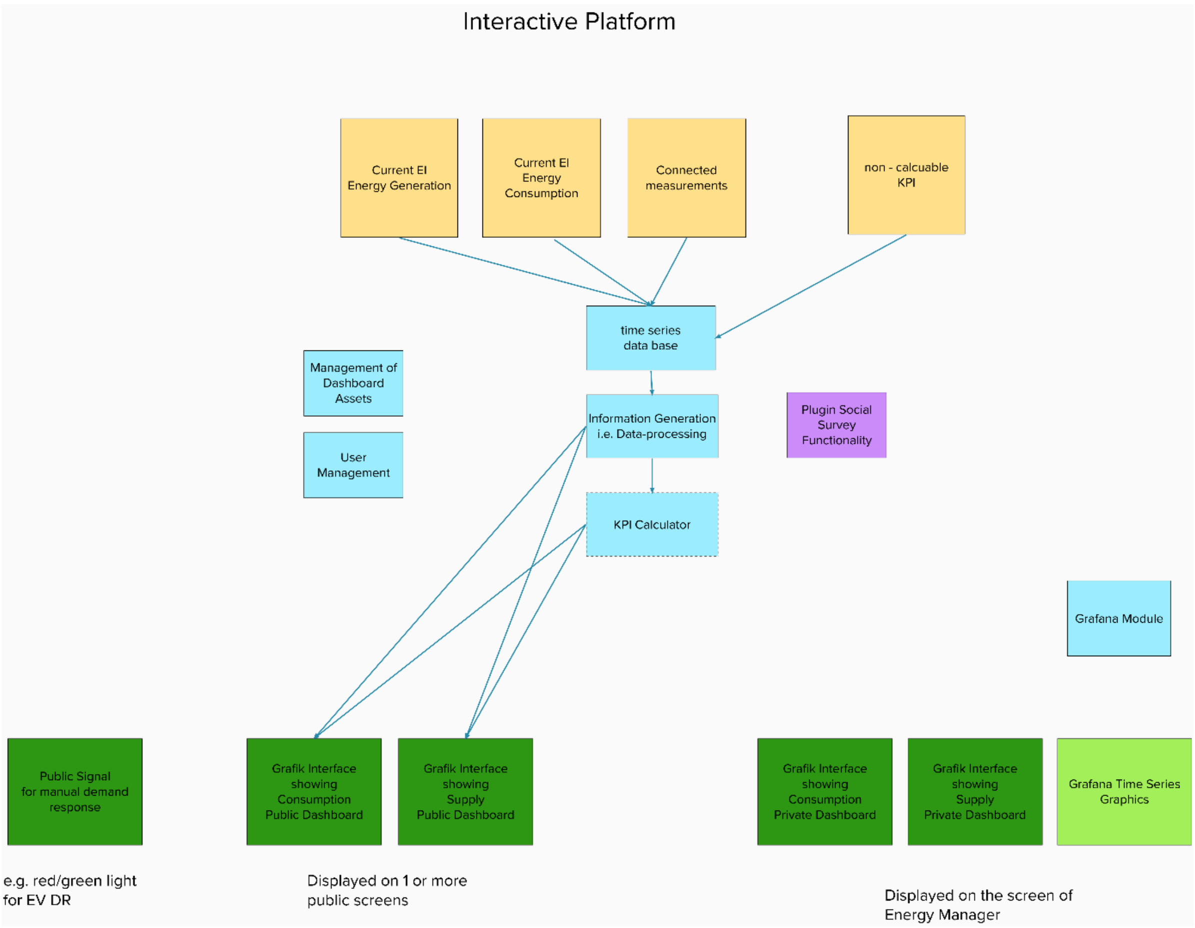

Figure IV-13 Structure of the Interactive Platform

(outcome of an internal RENergetic team workshop, 31st of March, 1st of April)

- ***Automated calculation and visualisation of technical KPIs:*** An automated calculation and related visualisation will be foreseen based for the technical KPIs identified in D7.2 – Description of evaluation metrics & KPIs. This concerns calculating for formulae listed in D7.2 starting from so-called "abstract meters" that hold the required data on energy parameters. The translation of the data from the actual physical meters at a specific pilot site into these abstract meters is under the responsibility of the pilots and therefore out of scope of the current solution. To be visualized and implemented within the GUI and API.
  - <u>Implementation Plan</u>: Implementation started, description is finalized. Currently being tested based on the data for the Ghent pilot site.
  - <u>Data required</u>: Current and historic data about energy (heat and/or electricity) consumption of the specific pilot site or energy vector therein.
  - <u>Current TRL level</u>: 5 (implemented by WP7 calculations, concept has been formulated and discussed and is now planned to be implemented by RENergetic dev team).
  - <u>Target TRl Level</u>: 7 (to be tested in Poznan, Ghent).
- ***Energy Island Digital Twin Creator (EIDTC):*** Main stakeholders of future energy islands, lack the tools that could help them visualize and simulate how their community could benefit from becoming a Legal Energy Community (LEC) or Energy Island (EI). Based on Intraverse, a Virtual Reality commercial solution developed by INETUM, the EIDTC system fills this gap. Conceived as a communication and decision tool, it helps decision makers (main stakeholders) to generate a high-level digital twin of their communities. Furthermore, it aims to provide a better understanding of what Energy Islands are.

  This tool is a commercial tool, developed by Inetum, demonstrating a Metaverse – it can be used to get a clear view on what a LEC can look like (for the perspective of the community members) already in a early planning phase
  - <u>Implementation plan</u>: The implementation plan is divided in 3 phases: analysis, development, test in pilot sites. The tool is currently on phase 1. The partners involved are CEIP, Poznan pilot, Gent pilot and Inetum
  - <u>Current TRL Level</u>: 9 (but not adopted to the case of LECs)
  - <u>Target TRL Level</u>: 7 (to be tested in Poznan, Gent).
- ***Social Toolbox for Energy Awareness and Implementation of technical solutions:*** *The social toolbox* is not in itself a separate technical block, but a set of methods, learnings and guidelines from concepts and trials developed in the project. It therefore will enable replicability and give further guidance to other energy communities and urban energy islands pursuing self-sufficiency. The parts related to a specific technical block described before will mainly build on results from trials with users that enable learnings on acceptance and best practices in implementation. This toolbox will thus also be an important part of the RENergetic replication package, to be delivered with D8.3 at the end of the project.
  - <u>Implementation Plan</u>: Currently being developed, planned to be implemented within the RENergetic System.
  - <u>Data required</u>: Data from social experiments, for examle Heat DR Trials in Gent; Electricity reduction trial in Poznan; Survey data from within Pilots and representative panels.

High Replication Level: based on the social experiments conducted in the pilots.Especially the used methods, experimental design and analysis strategy for social experiments, questionnaires and analysis code for surveys are replicable through the toolbox. The different technical and social building blocks are in themselves modular and can be implemented in any different pilot, depending on their replicability. How they can be placed within the market and compared with the existing solutions, is elaborated in the following section V and section VI. The final evaluation of the presented technical and social building blocks is planned for the upcoming D 7.7.

V. Preliminary Competitive Analysis

V.1. Exploratory market research based on stakeholder interviews

For performing the exploratory market research, we followed a rigorous methodology that involved conducting interviews with various stakeholders from different European countries. The purpose of these interviews was to gather insights on the state of current energy communities, including the challenges and opportunities associated with them, as well as to understand the challenges for local energy communities which are under development.

According to the European Energy community repository (Energy Communities Repository, 2023) and EE-Delta Research (Delta-EE, 2023), the leading countries in the development and application of LECs are Germany, Poland, Italy, Ireland, Spain & the Scandinavian countries. This also follows from the initial market analysis as reported in section III.2. The identified countries were used to guide our selection of interviewees. Based on some pragmatic consideration like the available time as well as the contacts that were available from RENergetic consortium members, 10 interviews were carried out. The interviewees are active in Poland, Germany, Belgium and Austria. All interviewees have an in-depth knowledge on ICT solutions for LECs.

During the interviews, a series of open-ended questions were asked to elicit detailed and nuanced responses from our participants. An overview of the relevant questions can be found in annex IX.3. Care was taken to ensure that the questions were relevant to the specific context of each country, and the approach was tailored accordingly. These interviews provided a first-hand view of the existing solutions on the market, which allowed a further in-depth analysis. This will be discussed in the next subsection.

V.2. Existing Solutions on the market

Based on the interviews, we are able to identify 33 relevant ICT solutions for LECs, originating from ICT solutions providers active in Europe. A first overview is given below. The solutions were categorised in 3 larger groups according to the energy vector they target: heat, electricity and both energy vectors.

- **Heat:**

  This group of solutions and solution providers focuses on the thermal energy solutions. The solutions identified can be found inTable V-1. Note that the state of the solutions is quite mature. Except those which are still in the research phase, the others all currently exist on the market.

Table V-1 Overview of existing solutions related to heat energy vector, as it resulted from the stakeholder interviews in the exploratory market research

Company/Solution name	Solution specification
MEO-Energy/Activeheat	Provides hardware and software to save CO2 and costs through automatic optimization

Rabmer Greentech GmbH/Wastewater Energy	Provides solutions for waste heat optimization. Focuses purely on the engineering aspect
KARNO/KARNO Energy	Provides solutions during the design, construction, funding, maintenance and regulation phases
Gradyent/Gradyent.AI	Provides the following solutions: temperature control, pressure control, production scheduling, user control & design and simulation
ENERPIPE/Natural Energy Solutions	Provides district heating network solutions such as heating network control, heating house technology, local heat buffer storage
Schneider Electric/Termis	Offers a district energy network simulation platform for improving system design and operation
Danfoss/Danfoss Leanheat	Offers a variety of end-consumer appliances with smart technology
VITEC Energy/Netsim	Provider of forecasting and grid simulation software for energy utilities, energy traders, TSO's
ShifftProject/*Product in research	A project that stimulates the adoption of low-carbon heating in existing residential buildings
Kyotherm	provides third-party finance for renewable heat production projects

- **Electricity:**

  This group comprises ICT solutions that facilitate the production, distribution, and storage of electricity, including renewable electricity sources such as solar and wind power, as shown in Table V-2.

Table V-2 Overview of existing solutions related to electricity energy vector, as it resulted from the stakeholder interviews in the exploratory market research

Company/Solution name	Solution specification
ASKI Energy/Aski Software	Visualization and optimization software for individual use
MEO-Energy/Propilot	Provides hardware and software for visualization, system-analysis and optimization
Energy.kompass/Energie Kompass GMBH	Specializes in innovative energy and environmental consulting, planning and project management and unit management
Austrian Institute of Technology/ *Product in research	Optimization for anomaly detection
WeSmart/WeSmartSimulator	Offer a platform for energy communities as well as optimization and visualization tools
E.ON Group/ Main E.ON	Provides a mobile application to the end-consumer that allows to monitor their consumption and manage their contracts
I-DE/Iberdrola	Offers a application on which the final user can remotely monitor their smart meters
E-REDES/E-REDES	The user can check their consumption, demanded power and technical data of the supply at home and consult power outages
Engie-App/Engie	An application which shows the electricity consumption every 24 hours

Repsol Vivit/Repsol	Is an application for the Repsol electricity consumers which allows for monitoring and comparisons.
Siemens/Bifrost	Provides a energy community network simulator
Octopus Energy/ Octopus Watch	Provides its final customers with a mobile application to monitor their consumption and to the administration regarding payments
Alpiq/Demand Response Manager	Provides energy trading solutions
E-Distribucion/E-Distribution	Provides an application that gives all the data regarding the delivery of electricity
RTE/Ecowatt	is a service that tracks electricity usage in France and provides alerts when the supply comes under stress
RTE/ECO²Mix	Is a end-user tool that helps consumers better understand and more effectively consumer electricity
EDGAR/EDGARSoftware	Is a software provider for complex energy solutions
Red Electrica de España/ REDOS	An application that can be consulted by either the end consumer or the operator. letting the user monitor and manage their electric system
IPTO/IP	Provides real-time open data on the electricity transmission system
Imple4droid/Adhorra en luz	Shows the price per kilowatt per hour of the Spanish market which allows the user to anticipate and plan the use of appliances
Public University of Navarra/Miluz	visualizes the time of the day with the lowest and highest energy price

Schneider Electric/ Wiser Energy	Is a smart home system that monitors the energy consumption and alerts in the event of energy-related anomalies
Centrica/Multi-F Solar	Plans and operates photovoltaic panels
Smappee/Smappee Infinity	Is a smart energy management solution for any energy need that allows monitoring and smart control
Engie+ Netamo/MA Conso+	Provides visualization and monitoring of energy consumption in real time for individual households
Calliope/Calliope v0.6.10	An optimization tool which can take into consideration several sectors and local components, determining the exact energy flow
Oemof/Oemof Tabular	An open energy modelling framework (flexible, cross-sectoral, modular, open, transparent and community driven)

- **Both energy vectors:**

  This group includes ICT solutions that focus on heat energy as well as electrical energy.

Table V-3 Overview of existing solutions related to both heat and electricity energy vector, as it resulted from the stakeholder interviews in the exploratory market research

Company /Solution name	**Solution specification**
Arteria Technologies/Arteria platform	Provides digitalization for old network grid plans, BI tools, End-User dashboards and optimization to save costs
E.ON Group/E.ON	A mobile applications which allows monitoring and provides advanced functionalities to manage contracts

Aurum Europe/EnergyFlip	Gives the user an up-to-date insight on how much gas and electricity their home uses
OpenMotics/ Openmotics Platform	Provides software and hardware to monitor and optimize energy and heat consumption
NProEnergy	A district energy planning tool, including demand simulation, district heating and system design

For each solution, the corresponding provider (company) with URL can be found in annex IX.4.

After listing all solutions encountered in our preliminary market analysis based on stakeholder interviews (and listed above inTable V-1, Table V-2 and Table V-3 **Error! Reference source not found.**), we tried to cluster the solutions in order to sketch some light in the typical categories of solutions, linked to the tool's objective on the one hand side and linked to the customer segments on the other hand side.

Classification of solutions according to their objective for energy or LECs

Setting up a LEC is a complex endeavour, where tools with different objectives can be helpful. A first classification of the identified solutions therefore starts from this perspective. The objectives identified are (1) building and documentation, (2) operation and maintenance and (3) energy efficiency (incl. optimization and digital twin). Table V-4 shows how the solutions are distributed over these objectives.

Table V-4 Energy Vector Solutions classified according to the objectives they target

Energy Vector	*Building and Documentation*	*Operation and Maintenance*	*Energy Efficiency*
Electricity	IQGeo/IQGeoPlatform	IQGeo/IQGeoPlatform	
	KeyDH/KeyDH GIS	KeyDH/ KeyDH GIS	
	Bentley/PLAXIS		
		E.ON/Main E.ON	
	ArcGIS/ArcGISOnline		
		Engie+ Netatmo/MA Conso+	
	ENELX	ENELX	
		Schneider Electric/Termis	Schneider Electric/Termis
	WeSmart/WeSmartSimulator	WeSmart/WeSmartSimulator	WeSmart/WeSmartSimulator
Heat	VITEC Energy/Netsim		
		MEO-Energy/Activeheat	MEO-Energy/Activeheat
			Rabmer Greentech GmbH
	ENERPIPE/Natural Energy Solutions		ENERPIPE/Natural Energy Solutions
		Danfoss/Danfoss Leanheat	Schneider Electrics/Termis
	KARNO/KARNO Energy	KARNO/KARNO Energy	KARNO/KARNO Energy

Both			Arteria Technologies/Arteria platform
		E.ON Group/E.ON	
		Gradyent/Gradyent.ai	Gradyent/Gradyent.ai
		Aurum Europe/EnergyFlip	
		OpenMotics/OpenMotics platform	

After mapping out all solutions encountered in this preliminary analysis above, the RENergetic solutions seemmostly complementary to the solutions that target the objectives “building and documentation” and “operation and maintenance”’ and potentially in competition with some solutions that target “energy efficiency (optimization, digital twin)”

Classification of solutions according to customer segments

Table V-5 shows a list of companies and organizations that are involved in various aspects of electricity efficiency, electricity supply, and heat management. Electricity efficiency measures aim to reduce electricity consumption while maintaining or improving the same level of service. Electricity supply companies are responsible for providing reliable and clean energy to meet the growing demand for electricity. Heat management is also a vital area for reducing carbon emissions, as the building sector is a key contributor to the greenhouse gas emissions – with a total of 35 % of the energy-related EU emissions in 2020 (EEA, 2022). Thus, the heating sector in the residential and commercial buildings is a signinificant area to tackle the reduction of carbon emissions.

The companies listed in the B2B and B2C categories are involved in providing energy-efficient products and solutions to residential, commercial, and industrial customers. They help consumers reduce their energy consumption and bills through smart technologies and innovative solutions. The companies listed in the B2G category are involved in providing services to governments and public utilities for managing their energy systems efficiently.

Table V-5 Energy Vector Solutions classified according to customer segments they target

	Electricity (supply and efficiency	*Heat*
B2C	MEO-Energy/Propilot Energy.kompass/Energie Kompass GMBH Siemens/Bifrost E.ON Group/E.ON Octopus Energy/Octopus Watch E-Distributciòn/E-Distribution I-DE/Iberdrola E-REDES/E-REDES Repsol Vivit/Repsol Imple4droid./Adhorra en luz Public University of Navarra/Miluz Aurum Europe/EnergyFlip SMAPPEE/SMAPPEE Engie+ Netatmo/MA Conso+ RTE (Réseau de Transport d’Électricité)/EcoWatt Red Eléctrica de España/REDOS	MEO-Energy/Activeheat Rabmer Greentech GmbH KARNO/KARNO ENERGY Danfoss - Leanheat OpenMotics/OpenMotics platform ENERPIPE/Natural Energy Solutions

	Independent Power Transmission Operator (IPTO)/IPTO Analytics	
B2B	AskiEnergy/Aski Software Schneider Electric/Wiser Energy Management Alpiq/Demand Response Manager	Arteria Technologies - Arteria Platform Gradyent - Temperature control Schneider Electric - Termis VITEC Energy - Netsim Kyotherm OpenMotics ENERPIPE EDGAR
B2G	Alpiq/Demand Response Manager	Arteria Technologies - Arteria Platform Kyotherm

The opportunities and threats for solutions in the electricity versus heat domain and how to position RENergetic solution therein is to be further explored, The upcoming deliverable D7.6 (Final European analysis and communication of obstacles to innovation around Energy Islands) will shed some light here, as e.g. the legal boundaries imposed on trading heat versus trading electriy will become clear.

Also the positioning towards end customers (B2C solutions) as opposed to professional users (B2B/B2G solutions) is to be explored further in later deliverables (like D7.7 - Go2Market results: Business, financial and sustainability plans)based on the specific potential of the identified RENergetic building blocks.

V.3. Positioning of RENergetic solutions within the market

In order to have a view on the position of the RENergetic solutions within the market, it is important to have an assessment of the opportunity attractiveness of these solutions. This will be executed more in detail in the next deliverables. We now have evaluated the addressed customers, the stakeholders and where feasible also the competitors. for the different RENergetic technical and social building blocks, as introduced in section IV.4.

The **Table V-6** is based on a combination of desk research (about competitive or complementary solutions), interviews held on existing solutions (see section V.2.) and interactions with our partners.

Table V-6 Overview RENergetic solutions (incl. customers, Stakeholders, competitors)

Solution/Building block	Addressed Customers	Stakeholders	Competitors[8]
(Global) Multi-Vector and domain specific Optimizers:			

[8] This evaluation is based upon the interviews we had and the input and evaluation of our partners.

Multi-vector optimizer (MuVeCo)	Small and medium sized companies parcs. Energy communities	Energy Island Managers, Energy Consumer: SME Owners,…, Service Providers	We have found complementary solutions that are situated in the activity of Energy savings – Energy Efficiency from the following companies: ASKI, MEO-Energy and Energiekompass. A potential competitor could be the Caliope solution. Based on our current research done so far, there are few competitors. More research will be done in the next deliverable.
Electricity supply optimization	B2B, B2C, B2G	Service Providers, Energy Island Managers, Energy Consumers	We have found competitive solutions and some complementary solutions that are situated in the activity of Energy savings – Energy Efficiency and electricity supply (see Table V-2 and Table V-3**Error! Reference source not found.**) [9]
Local waste heat optimizer	Big residential buildings or business parcs. Energy communities, residential districts,….	Energy Consumers, Energy Island Managers, Service Providers	We have found complementary solutions during our current research from the following companies: Rabmer Greentech GmbH and Kyotherm. Also note that Poznan will use the existing TRNSYS software to build the functionality on.
Multi-Vector Forecasting Solutions:			
Forecasting solutions	As other services: probably the bigger premises and any organization that is required to do budgeting, financial forecasts,….	Energy Island Managers, Service Providers, Energy Consumers (owners of big premises)	Based on our current research done so far we have not found any competitive solutions. More research will be done in the next deliverable.
Anomaly detection	Target customer with a certain minimum size e.g., hospitals….	Energy Island Manager, Service Providers	We have found one solution that is still in the Research stage (not on the market): E3@school (using AI) from the Austrian Institute of Technology that could be a competitive solution.

[9] Competitive solutions : E.ON, Octopus Watch, E-distribution, I-DE, E-REDES, Engie Energie, Repsol Vivit, EnergyFlip, SMAPPEE ; Complementary solutions : ECOWATT, ECO²MIX, REDOS, IPTO Analytics, Adhorra en luz, Miluz, Ma Conso +

			Further research will be done in the next deliverable.
Demand-Response solutions:			
Manual Heat Demand Response Recommendations	Energy islands that have the same level of maturity as Nieuwe Dokken in Ghent.	Energy Island Managers, Energy Consumers, Energy Producers, Service Providers	A possible competitor that was identified is the Arteria platform from Arteria Technologies. Further research will be done in the next deliverable to find similar solutions and to identify whether or not they are manual or semi-automated solutions.
Semi-automated Heat Demand response Recommendations			
Manual EV Demand Response Manual	B2C	Energy Island Managers, Service Provider, Energy Consumers (Residents, EV owner), Grid Operator (DSO & TSO's)	All providers of smart charging solutions are a potential competitor. Probably one of the most competition compared to other solutions.
Automated EV Demand Response with Reinforcement learning	B2B, B2C : Potential benefit for a charge point operator => they can market this. Get priority charging or flexibility charging.		There are already solutions on the market, but the majority do not make a distinction with customers that do care or that do not care when an EV is charged
Communication and interaction Strategies			
Public Interactive Dashboards	B2B, B2C	Energy Island Managers, Energy Consumers, Service Providers	A lot of dashboards already exist. So a lot of competition exists. Therefor Dashboards will not be marketed separately but are part of other solutions.
Private Interactive Dashboards:			
Automated calculation and visualisation of technical KPIs:			
Virtual Reality tool	Any energy island if they want to start.	Energy Island Managers, Energy consumers	No specific investigations has been executed yet on competitors in reference to this solution.
Social Toolbox for Energy Awareness and Implementation of technical solutions:	Any energy island if they want to start. Does not exist yet.	Energy Island managers, Energy consumers, Sustainable Energy Evangelist	According to our current research no such solution was found.

Based on our current research we can conclude that for the identified RENergetic solutions not many competitive solutions exist. Except for the EV demand response solutions and the electricity supply optimization where more competitive solutions were found. Nevertheless for the EV demand response we can make a difference by differentiating between customers that do care when their EV is charged and that do not care when their EV is charged.

VI. Further research will be done on this in the next deliverables. Relevant Business and Organizational models and Identified Next Steps

Within the current deliverable we focused on the identification of RENergetic value propositions, which will form the basis of the business models we want to put forward. Actual identification of relevant business models will happen in later Deliverables of this WP. In this section, however, we link functional blocks (RENergetic value propositions), as identified in section IV.4. to potential organizational and business models for LECs or energy islands.

VI.1. Business and Organizational Models for Energy Communities

For the purposes of this deliverable, an overview of the different business models is provided with the subsequent mapping of RENergetic solutions, as the RENergetic tools can facilitate different activities, in different organizational forms.

In the scientific literature, different business and organizational models are identified. Reis et al. (2021) defines seven business model archetypes, but hybrid models are a possibility. Those are: 1) energy cooperatives, 2) community prosumerism, 3) local energy markets, 4) community collective generation, 5) third-party sponsored communities, 6) community flexible generation, 7) e-mobility cooperatives. These business and organizational models can support energy communities in realizing their activities (such as energy generation, sale, sharing, storage and aggregation of electricity).

1. Energy cooperatives

   These type of energy communities are the most common in Europe. According to REScoop.eu there are about 1.500 renewable energy cooperatives who are member of the European federation of citizen energy cooperatives. But the number may be inaccurate, as there are more than 2.400 renewable energy cooperatives across Europe. Energy cooperatives are an example of citizen-led initiatives where the end-users join to raise the funding for owning energy generation systems. The governance of energy cooperatives is usually in the hands of the stakeholders, being part of the revenues reinvested in the community (e.g., improvement of infrastructures) and the rest distributed among the shareholders according to the cooperative statutes.

2. Community prosumerism

   Energy communities dedicated to prosumerism are typically communities of place created by prosumers, playing the role of decision-makers, investors, and customers, who join to benefit from financial conditions. Community members can buy and sell all their electricity within the community boundaries, exempting them from paying tariff components related with medium and high voltage distribution and transmission networks. Potential revenues obtained by selling excess energy can be distributed by prosumers to reimburse their investment or reinvested in the community, to improve social infrastructures and expand installed generation or storage capacities.

3. Local Energy Markets

   This particular model is being based on the local trading and exchange of prosumers and decentral energy actors (such as P2P exchange), leading to an overall reduction of external energy imports and savings between the retail and market tariffs. Individual trading conditions can be negotiated here among the prosumers and the external partners such as the DSO. The created revenue is being distributed among the market participants. Local proximity among the participants is an important requirement.

4. Community collective generation

   Collective self-consumption BM are based on shared generation and storage systems, which are installed on the rooftop of multi-tenancy buildings or in the vicinity of consumption sites, being the power output shared among several customers. The investment is typically shared by the dwelling owners and sophisticated ICT – based infrastructure is required.

5. Third-party sponsored communities (TPSC)

   The potential of energy communities has gotten a lot of parties interested, entities are willing to broaden their portfolio's with new customers and services. When these entities finance such projects, they usually maintain the assets ownership, being responsible for the project governance and investment decisions. Users benefit from renewable and typically cheaper energy while being engaged in local energy related programs.

6. Community flexible aggregation

   Community aggregators may be created to operate at a local level and the flexibility collected is grouped by a larger aggregator. Alternatively, community aggregators can also operate directly at the power system level, provided they are able to meet the required conditions.

7. E-Mobility cooperatives

   E-mobility cooperatives are created by engaging shareholders to provide community public transportation, car-sharing or car-pooling services. The companies can also exploit their assets as a resource: batteries can be used as storage resources, exploiting vehicle-to-grid and grid-to-vehicle modes to reduce energy bills by procuring energy during off-peak periods and providing flexibility services, which can be pooled by aggregators to deliver services to the grid.

In our terminology, the above models would be called organizational models. They can be set in relationship to business models that are driven by activities carried out by the community or energy island. These activities in their turn link to the RENergetic epics. In what follows the following 5 activities or "activity-driven business models" are considered.

- Own Heat Production (Integration Local Waste Heat or other RES)
- Collective PV-Prosumer Generation and Storage within a Community
- Smart EV-Charging (ex.: during most favourable times of high RES generation).

- External Grid Demand-Response Business Models: Offering Aggregated energy from DER and Flexibility Services to the DSO[10]
- Internal Demand-Response within an energy community/energy island to optimise Self-Sufficiency (with or without a storage)

These activities and linked business models create value for actual energy communities. RENergetic tools (based on the functional building blocks) can facilitate these activities and therefor increase the value being created. This mapping is illustrated in **Table VI-1**. Note that this analysis will be further explored also in D7.7 - Go2Market results.

Table VI-1 Mapping of Envisioned activity within a Multi-Vector Energy Island/Community

Envisioned Activity within a Multi-Vector Energy-Island/Community	Created Value for the Community/ Energy-Island	Business and Organisational Model	Facilitating RENergetic Tool
Own Heat Production (Integration Local Waste Heat or other Renewable Heat Sources)	Reducing heating costs and heat consumption through a shared heat grid infrastructure	- Energy Cooperative[11] - TPSC	Domain-specific optimizer (Local Waste Heat optimization) and Anomaly Detection;
			Heat Forecasting Services
			Heat Demand Response Recommendations (Manual and Automatic)
Collective PV-Prosumer Generation and Storage within a Community	Reduced electricity bill and/or cost-reflective tariffs[12] through energy-sharing;	- Community prosumerism - Local Energy Markets	Electricity Supply Forecasting Services and Anomaly Detection;

10 This model is currently not being tested in any of the pilots, nor analyzed in depth within this deliverable but will be addressed in the upcoming deliverable 7.6

11 Depending on the legal form, the resulting gains from the revenues are reinvested in the energy communities. The rules differ in each MS – a further analysis of the benefits of each organizational form will not be done in this deliverable.

12 The cost-reflective network charges are foreseen in the Renewable Energy Recast Directive (Art. 22 S. 4 (d)) – a REC implementation in accordance with the REC requirements are needed to realize the benefits under the Directive.

	Self-consumption and Sector-Coupling Optimisation within the Community for the Heat pumps and EV's charging	- Energy Cooperative - Community Flexible Aggregation - Community Collective Generation of active customers [13] - TSPC	Global Multi Vector Optimizer (especially within local energy markets)
Smart EV-Charging (ex.: during most favourable times of high RES generation)	Reduced electricity bill and cost-reflective tariffs	No specific legal form required (except if cost-reflective tariffs to be claimed by the EC): - E-Mobility cooperative - Energy Cooperative - TSPC	EV Demand Response Recommendations (Automated and Manual) Global Multi Vector Optimizer Interactive dashboards
External Grid Demand-Response Business Models: Offering Aggregated energy from DER[14] and Flexibility Services to the DSO[15]	Additional Revenue through Flexibility and Energy Trading of aggregated flexibility; Reduced electricity bills and tariffs through cost-reflective network charges;	- Community Prosumerism - Energy Cooperative - Community Flexible Aggregation - Community Collective Energy-Generation (depending on the MS definition of active customers) - TSPC	Electricity Domain Optimizer and Anomaly Detection; Global Multi-Vector Optimizer; Interactive and Grafana dashboards and communication guidebooks for community engagement

[13] Not all MS have fully implemented the Electricity Directive, defining active customers (Art. 2 (8), 15 of the Electricity Recast Directive)

[14] DER = decentral energy resource (a DER can be a storage, a PV or an EV charging station).

[15] This model is currently not being tested in any of the pilots, nor analyzed in depth within this deliverable but will be addressed in the upcoming deliverable 7.6

Internal Demand-Response within an energy community/energy island to optimise Self-Sufficiency (with or without a storage)	Reduced electricity bills and tariffs through cost-reflective network-charges; Creating additional flexibility to be traded on the external markets	No specific organizational form required (except if cost-reflective tariffs to be claimed by the EC). Can be realized through: - Community Prosumerism - Energy Cooperative - Community Flexible Aggregation - Community Collective Energy-Generation (depending on the MS definition of active customers) - TSPC	Forecasting Services Interactive dashboards and communication guidebooks for community engagement Electricity Supply Optimizer and Anomaly Detection Electricity Demand Response Recommendations

VI.2. Targeted stakeholders

Considering the stakeholders interests when linking those to the RENergetic tools (see Section IV) is equally important for the RENergetic market analysis. Note that the following interest analysis is independent of the chosen business and organization model (Section VI.1.).

The following stakeholders within the RENergetic pilots can be considered as the most relevant ones for a successful tool implementation and their adaptation, since their interests shape the necessary tools functions and the choice or a particular business model (identified during the Value Proposition workshops and Business Model Canvas workshops):

Table VI-2 Targeted stakeholders

Stakeholder	**Interest**	**Facilitating RENergetic Tool**
Electricity Grid operators (operating with energy islands)	- Cost-efficient grid management - Provision of CO2 neutral energy to the consumers	- Electricity and EV DR Recommendations - Electricity Supply Optimizer - MuVeCo

	- Obtaining additional flexibility from aggregated DERs	- Forecasting Solutions
Heat Grid Operator (potentially in cooperation with a Local Waste Supplier or a Data Center)	- Selling Co2 neutral Heat generated from Local Waste or Data Center	- Heat DR Recommendations - Heat Supply Optimizer - Anomaly Detection - Forecasting Solutions
ESCOs and Energy Island Managers[16]	- Energy Cost Minimization and maximal use of local RES - Creating a Community feeling - Optimization of Energy-generation and consumption - Maximizing the independency of the Energy island from the public grid - Provision of Energy-comfort to the residents - Waste Reduction	- Electricity and EV DR Recommendations (with AI Reinforcement Learning Methods) - Electricity Supply Optimizer - Anomaly Detection - MuVeCo - Forecasting Solutions - Interactive Dashboards - Communication Guidebooks
Energy Consumers (Residents, EV owners)	- Reliable energy provision - Reducing energy bills - Time-convenient, reliable and fast car-charging - Prefer renewable energy for car-charging - Waste reduction	- All manual DR recommendations (EV, Heat, electricity) - Interactive Dashboards

16 Also called Energy Island Operator, Energy Manager and community manager in the Value proposition canvases

	- Sustainable energy consumption - Comfortable living environment	

VI.3. Envisioned next steps

The current deliverable has set out some strong foundations but did not get to actual proposed business models for energy communities based on RENergetic solutions. This will be explored further in the remainder of the project.

- We will execute an opportunity attractiveness evaluation on the RENergetic solutions. To be able to do this we will evaluate the opportunity attractiveness of each of the market opportunities we see for our RENergetic solutions. This can be done using the model below:

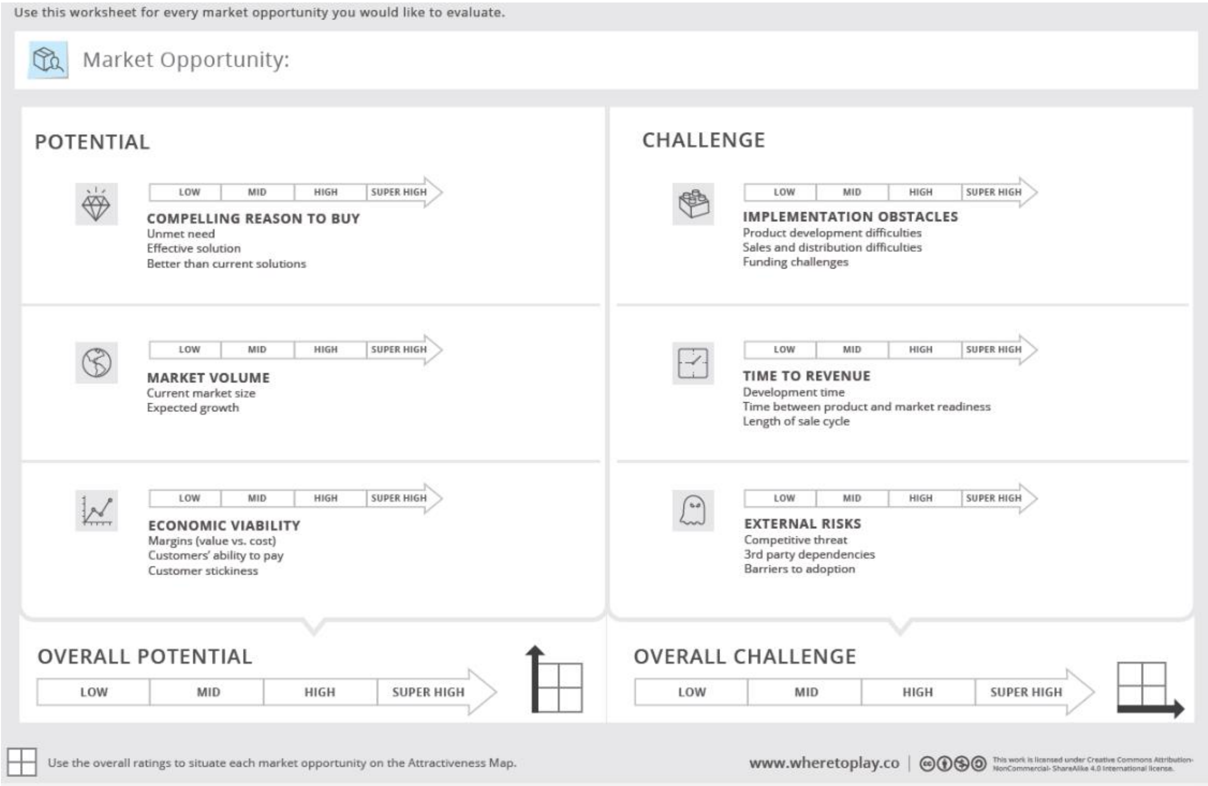

Figure VI-1Template for Opportunity attractiveness evaluation for each market opportunity.

Based upon the answers that will be gathered during this study, we will be able to plot the results on an Opportunity attractiveness Chart.

This will reflect potential updates in the TRL levels of the RENergetic solutions as well as a continued monitoring of the changing market of competing and complementary solutions. This will learn how to position our RENergetic solutions within this market and allow to build the so-called 'Value Map' (as mentioned in the DoA) that must then meet the customer/market needs to become successful. This will be reported in detail in D7.7 - Go2Market results.

Here below you can find a preliminary version, based on our internal team evaluation, on how the current RENergetic solutions could be positioned within the the opportunity attractiveness. For the upcoming Tasks, a deeper analysis of the opportunity attractiveness will take place.

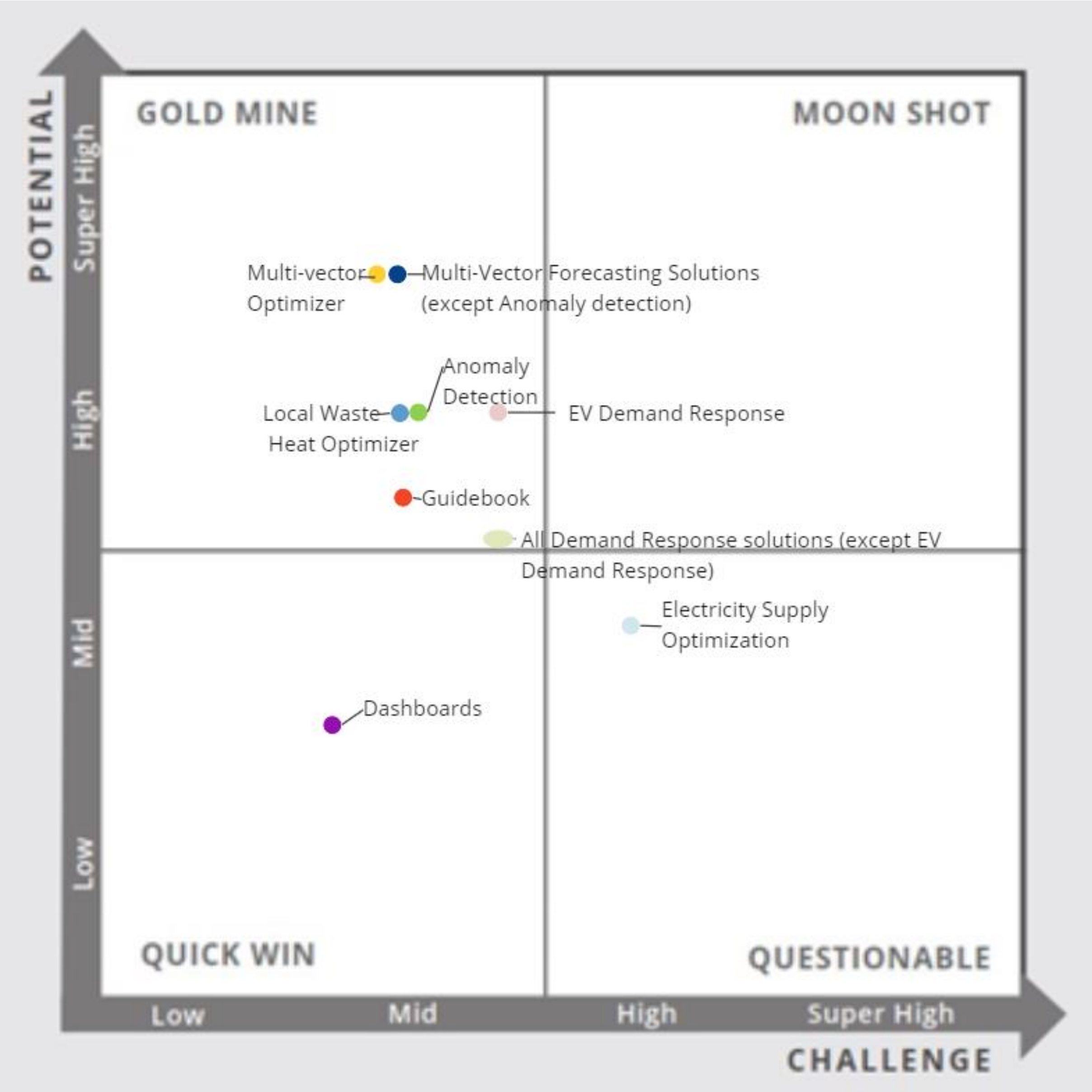

Figure VI-2 Subjective Preliminary Opportunity attractiveness evaluation for some of the RENergetic Solutions

We will also refine and define more concrete Business Models for Energy Communities for the RENergetic solutions in D7.7 - Go2Market results. Although the current deliverable is focusing on the market for solutions that help to improve internal activities within the energy communities, our exploration also showed a potential for activities of the local energy communities towards the external grid, e.g. External Grid Demand-Response Business Models, offering aggregated energy from DER and Flexibility Services to the DSO. This model is currently not being tested in any of the pilots, nor analysed in depth within this deliverable but will be addressed in the upcoming deliverables. The potential will be described in D7.6 - Final European analysis and communication of obstacles to innovation around Energy Islands and it will be quantitatively assessed for some specific scenarios in D7.6 - Final European analysis and communication of obstacles to innovation around Energy Islands.

VII. SUMMARY

This deliverable reports about the RENergetic initial market analysis and paves the way for identifying suitable value and business models for RENergetic solutions. Five interrelated contributions have been made in the current deliverable.

First, a stakeholder analysis is performed in section II, based on earlier work in D7.1. The key actors in the domain of local energy communities have been identified as energy consumer, (local) energy producer, energy island manager, grid operator (TSO and DSO), service provider and policy maker. Essential business roles within energy communities express the key activities that can be taken up by one or more stakeholders. Mapping of actors and roles allows to lay out the value network and organizational model behind the energy community. Also, by using a stakeholder map, we classify the identified stakeholders in core, directly and indirectly involved stakeholders.

Next, we analyze the context for the RENergetic value offer in section III. A short overview of the enabling and regulatory framework is sketched. We set the scope of the current market analysis (linked to the RENergetic solutions currently being demonstrated) to solutions internally to the energy communities (e.g. optimization, forecasting, ... for internal supply and demand). Although limited consolidated information is available for this market on a European level, we give some indications of the size of the market and the main countries to focus on.

The majority of the work reported in this Deliverable related to the proper articulation of the RENergetic value propositions. The trajectory followed in this regard is reported in section IV. As a clear view on the potential value propositions is essential for analyzing the market potential and proposing suitable business models, this was a major target in itself. After engaging the entire consortium in both a value proposition canvas workshop and a business model canvas workshop, we ended up with providing an overview of generic RENergetic functional building blocks that form the basis for the RENergetic value propositions and link to the epics used throughout the project. Four main categories of building blocks have been identified: global and domain specific optimizers, multi-vector forecasting solutions, demand-response solutions and communication and interaction strategies.

This classification of RENergetic building blocks served as the basis for the preliminary competitive analysis, as reported in section V. Using a structured interview approach, we ended up with a list of existing solutions on the market, either complementary or competing to the RENergetic solutions linked to electricity savings/efficiency, electricity supply and heat management. The encountered solutions could be classified according to the lifetime phases of the energy island they relate to, as well as according to the customer segment they target. Relating these existing solutions to the RENergetic solutions allowed to perform a first opportunity attractiveness evaluation of the RENergetic solutions, plotting them on orthogonal axes expressing the challenge versus the potential.

Finally, some business and organizational models have been identified based on a literature review. The organization models are put in relationship to business models that are driven by activities (linked to RENergetic epics) carried out by the community or energy island in section VI. RENergetic tools (based on the functional building blocks) can facilitate these activities that are essential to the business models and therefor increase the value being created, as illustrated based on an initial assessment here. This work will be continued towards D7.7 - Go2Market results.

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IX. Appendix

IX.1. Value Propositions Canvas compilation

VP Automated EV DR DSO

Value proposition Canvas	
Value proposition (epic): **Automatic EV DR**	Customer Segment (persona): **DSO**
Products & Services: • Define Frequency margin & power ceiling for energy demand • Dynamic peak shaving constraints can be set by an external party	Customer jobs: • Manage grid cost efficiently • Provide energy to consumers with good quality
Gain creators: • Savings when peak shaving by investment avoidance • Flexibility (you can connect more REN[17])	Gains: • Less network congestion • Support many Renewables in the grid • Postponing investment in the network infrastructure • More predictability • Possibility of power reduction
Pain relievers: • Considering voltage constraint for EV DR [18] • Less grid congestion • Better power quality	Pains: • New electronic loads + volatile production • Difficulty to coordinate systems with direct energy flows • Investment costs
Notes:	

VP Automated EV DR Energy Island Manager

Value proposition Canvas	
Value proposition (epic): **Automatic EV DR**	Customer Segment (persona): **Energy island manager**
Products & Services: • Provision of transparency • Valorise flex to external actors (DSO, TSO, aggregator) • Smart (charging) optionally controls a set of connected EVs based on the flex and constraints set by the EVs users. • Matching as efficient as possible the PVs, the grid pricing and the demand of EVs (actual) • Dashboard with clear overview of cost savings and co2 savings	Customer jobs: • Minimize energy cost and maximize use of local renewables • Create community feeling : together making a sustainable community • Energy island is maximally independent from public grid • Optimize use of energy
Gain creators:	• Gains: • Improve user experience.

[17] REN stands for renewability in an electricity system (PV-based or wind-based electricity)

[18] EV DR stands for Electric vehicles demand response

<table>
<tr><td>EVs are often charged at cheap times
Incomes for each DR by DSO ==> sold to DSO
Priority of self-sufficiency (EVs ==> PVs)
Less need for external energy
Increase of self sufficiency</td><td>Good margin if price of selling to EVs is constant and the energy provided comes from different sources (PV for free)
Possibility to adjust consumption of energy.
Energy island has a low co2 footprint.
Strong happy community
Savings when peak shaving
Low energy costs for me and my customers
A more coordinated approach (demand and response)
Using EVs as a storage to balance between generation and consumption</td></tr>
<tr><td>Pain relievers:
Optimization of the EV charging points
Matching of EV consumption and local PV production lower CO2 output
Set maximum power reduction during DR at the specific time.
Developing a forecaster to predict total energy demand by EVs to schedule its buy and sell electricity from grid.
Well-developed system for DR process</td><td>Pains:
Difficulty to match volatile renewable energy production and EV consumption
Longer time of charging process (block charging points)
Congestion on the local network
Uncertainty in arrival and departure of EVs
Extra investment for smart charging (hardware and software)
High energy prices when buying from grid and need to meet EVs requirements.
Written consent needed from each of EVs (for administrator)</td></tr>
<tr><td colspan="2">Notes:</td></tr>
</table>

VP Automated EV DR EV owner

<table>
<tr><td>Value proposition Canvas</td><td></td></tr>
<tr><td>Value proposition (epic):
Automatic EV DR</td><td>Customer Segment (persona):
EV owner</td></tr>
<tr><td>Products & Services:
Savings when peak shaving by investment avoidance
Flexibility (you can connect more REN)
Display of Flexibility<table><tr><td>20 € (1h)</td><td>20 € (3h)</td><td>20 € (5h)</td></tr><tr><td>40 € (2h)</td><td>40 € (6h)</td><td>40 € (10h)</td></tr></table>
Analysis of individual patterns → individual charging suggestion/recommendation
Smart algorithm automatically controls the charging stations in an optimal way</td><td>Customer jobs:
Charge on time
Want to have my car charged fast.
Use of renewables to charge
Lifetime of EV battery
My car is charged by the time I need it
Leave my car in a secured area for charging</td></tr>
<tr><td>Gain creators:</td><td>Gains:
Pay cheaper</td></tr>
</table>

• EV behaviour compliant with the overall goal of the energy island/community • Charging EVs when price is low and do nothing when price is high • Gamification: offer some fictive points for compliance with forecasting or recommendations • Fictive currency can be traded for local drinks in energy island bar • Provide information how you help co2 and energy consumption • Cars are charged with a higher share of renewable energy	• Feeling that I help • Reduce co2 emissions when using EVs and charging them with RES • With an EV I contribute more to sustainable society / community
Pain relievers: • Possibility to set parameters (minimum soc and charging time) • Option to set minimum soc (50%) that should be charged immediately. • Financial incentives (fee payment less)	Pains: • Afraid of time wasting • Lack of flexibility long time • Don't know if my car will be fully charged. • Avoid long waiting for charging. • When I want to leave earlier, I might have not enough energy to reach my destination
Notes:	

VP Automated Heat DR Energy Island

Value proposition Canvas	
Value proposition (epic): Automated Heat DR	Customer Segment (persona): **Energy island operator**
Products & Services: • Modelling district heating network • Forecasting waste heat consumption • Price prediction • Adequacy / monitoring • Optimization tool • Interface	Customer jobs: • Provide energy comfort. • Reduce waste. • Increase more local renewables
Gain creators: • Less complaints • Lower service cost • More happy customers	Gains: • Show that energy bills are decreased (affordability) • Transparency ==> creates trust with his customers • Better image ==> greener
Pain relievers: • Allow customers to overrule. • Price guarantee • Simplicity	Pains: • Risk that users think it is / becomes more expensive. • Increased complexity • Perceived discomfort – risk for complaints
Notes:	

VP Automated Heat DR Energy Island

Value proposition Canvas	

Value proposition (epic): **Automated Heat DR**	Customer Segment (persona): **Residents**
Products & Services: • Automatically increase heat consumption when there is waste heat • Higher share of locally provided energy • Forecasting availability of waste heat • Gamification • Forecasting (broadcasting heat demand data)	Customer jobs: • Reliability • Environmental awareness • Reducing energy bills • Avoid waste • Comfortable living environment • Energy security
Gain creators: • District is better more sustainable • Cheaper for energy • Transparent lower pricing	Gains: • Higher efficiency • optimization • Lower energy bills • System thinks for itself • No customer intervention is needed • Higher independency • Green attitude • Avoid human error
Pain relievers: • Ability to overrule • User friendly • Not/never cold • Beer • Transparency (how it works)	Pains: • Black box : don't know what happened • Higher perceived complexity • Technology anxiety • Comfort level dependent
Notes:	

VP Automated Heat DR Waste Heat Supplier

Value proposition Canvas	
Value proposition (epic): **Automated Heat DR**	Customer Segment (persona): **Waste Heat Supplier**
Products & Services: • Forecasting Waste Heat production • Optimize waste heat recovery. • Interface	Customer jobs: • Sell heat • Reduce co2
Gain creators: • Greener image • Higher avoided CO2 emissions • Increase sale of waste heat	Gains: • More income • Greener image • Tax discount environmental permit
Pain relievers: • Simplicity • Faster ROI • More flexible contracts	Pains: • Extra investment • More complexity • Contractual obligations
Notes:	

VP Manual EV DR Energy Manager

Value proposition Canvas	
Value proposition (epic): **Manual EV DR**	Customer Segment (persona): **Energy Manager**
Products & Services: • Information about other providers / areas / energy manager • Impact report concerning acceptance rate, impact on systems, savings • Inform about prices • Inform about renewables • Flexibility market platform	Customer jobs: • Peak shaving • Optimize balance group • Operate written regulation • Supply charging service to customers • Ensure customer satisfaction • Sell flexibility
Gain creators: • Understandable & accessible information of impact • Scheduling technology • Reliable forecasting mechanisms	Gains: • Profit • cost reduction • Happy customers • Optimal use of local renewable energy • Self-pricing of residents
Pain relievers: • Reinforcement model / reasonable estimate of responses	Pains: • Changes in regulation • Complaints • Uncertainty of responses • Mismatch to balancing • Forecasting errors • High costs
Notes:	

VP Manual EV DR Community Manager

Value proposition Canvas	
Value proposition (epic): **Manual EV DR**	Customer Segment (persona): **Community Manager**
Products & Services: • Community performance reports • Individual reports • Data collected for renewables used in charging	Customer jobs: • Maximum use of renewable energy • Collective efficacy beliefs • Create sense of belonging • Shared charging stations / zone • Collaborative community & strengthen engagement
Gain creators: • Public information availability	Gains: • Inclusive community • Stronger and more innovative community • Status attractiveness of community • Raised environmental awareness
Pain relievers: • Motivating user communication	Pains: • Complaints • People don’t participate –lack of participation
Notes:	

VP Manual EV DR Residents

Value proposition Canvas	

Value proposition (epic): Manual EV DR	Customer Segment (persona): **Residents**
Products & Services: • Individual feedback energy use • Inform about future renewables (visual, dashboard) • Customized DR information • Inform about future prices (visual, dashboard) • Community feedback on energy use • Personal information about charging availability (!)	Customer jobs: • Faster charger • Fulfil social norms, fit to their community • Get a cheap price • Ensure capacity charged in my EV battery for my daily routine • Feel good about using renewable energy • Guarantees for charging
Gain creators: • Financial incentive if people pay less • Forecasting of prices • Social/environmental incentive of knowledge • Forecasting of renewable energy	Gains: • Lower costs of energy • Self-efficacy benefits • More availability of charging spots • Use more renewables • Confidence in system • Transparency on charging • More feedback on charging
Pain relievers: • Customizable charging constraints & profiles • Accessible dashboard & user interface • Easy understandable information • Scheduling of charging	Pains: • Time constraints • Time investment in charging routine / Energy as a person • Information availability • Lack of understanding / suspicion • Affordability might be an issue • Waiting for my EV to charge • Violated charge expectations • Pay more because of green • I pay more than what I expected • My car is not fully charged when I pick it household: decision-making construct? Flexibility • Blocked charging spots • Finding a charging spot when I arrive home
Notes:	

VP semi-Automated Heat DR Heat Consumer

Value proposition Canvas	
Value proposition (epic): **Semi-automated heat DR**	Customer Segment (persona): **heat consumer**
Products & Services: • Forecasting dashboard next day • Service app for heat consumer • Dashboard for what-if analysis	Customer jobs: • Keep building in defined temperature range • Offer good service to students • Depress cost of heating and cooling
Gain creators: • Report engine for business manager • Clear interface with dashboard	Gains: • See all the information that I need • Satisfied tenants • Reduction of co2 emissions

	• Reduction of energy costs
Pain relievers: • Public information system • Increase indirect temperature • Scheduling recommendations (algorithm)	Pains: • Additional expenses for automation systems • Avoid spending time for calculation • Avoid complaints from students and professors
Notes:	

VP semi-Automated Heat DR Veolia (heat producer)

Value proposition Canvas	
Value proposition (epic): **Semi-automate heat DR**	Customer Segment (persona): **Veolia (Heat Producer)**
Products & Services: • Schedule for heat demand flexibility • Forecast report daily basis	Customer jobs: • Co2 reduction • Make profit • Provide heat
Gain creators: • Information for transparency • Calculation of co2 emissions	Gains: • Good publicity • Predictable heat consumption • Attract new customers • Good communication with heat consumer
Pain relievers: • Reduce heat consumer heat power • Optimize for co2 friendly boilers	Pains: • Launch new boilers • Shave heat demand peaks • Co2 taxes
Notes:	

VP semi-Automated Heat DR end-user (resident & staff)

Value proposition Canvas	
Value proposition (epic): **Semi-automated Heat DR**	Customer Segment (persona): **end-user (resident & staff)**
Products & Services: • Information dashboard • Annual report/ newsletter sources of energy	Customer jobs: • Study and work • Nice temperature in rooms
Gain creators: • Information on co2 footprint	Gains: • Less dependent on fossil fuel prices • Increase energy independency. • How far are we from EU energy goal • Live a sustainable life
Pain relievers: • Communication about temperature changes	Pains: • Unpredictable temperature changes • Be open for a difference in temperature comfort
Notes:	

IX.2. Business Model Canvases Compilation

Epic 1

Title: Cross-sectoral Services		Responsible (s): Matthias, Daniele		
Key Partners	Keys Activities	Value Propositions	Customer relationships	Customer Segments
- Data service provider - Cloud operator	- Direct system optimization - Improve business intelligence. - Forecasting algorithms - Dashboard design	- Improve decision making. - Informing/reporting to stakeholders	-Digital communication	- Energy managers - Energy island operator - Asset owner - Energy community members
	Key Resources		Channels	
	- Monitoring infrastructure - Graphic designers - ML engineers		Website	

Cost Structure		Revenue Streams	
- Server Operation Costs		- License - Subscription (Free)	
Environmental Cost	Societal Costs	Societal Benefits	Environmental Benefits
		Awareness	

Epic 2

Title: Electricity demand response		Responsible (s): Youssef, Melanie		
Key Partners	Keys Activities	Value Propositions	Customer relationships	Customer Segments
- Citizens - Residents - Energy provider	- Peak shaving (capacity tariff regime) - Focus groups with people (communication and training with citizens) - Awareness raising and educate people through the platform of RENergetic - Electricity curtailment (cutting electricity demand an optimal usage of the battery when necessary) - Recommendations to the users based on the renewability calculations	- Energy advisor (recommendations and notifications) - More green energy production - Flexibility offering (for the ESCO) - Lower electricity cost - Reducing energy poverty - Semi-automated energy management decision support - Interaction with dynamic tariffs depending on price regimes. -	Customer centric approach: - Contact page. - Cooperation with customers (co-creation) - Notifications or recommendations on App/website - Communities	- Citizens - Residents
	Key Resources		Channels	

	- Software developers (RENergetic development Team) - Renewability of the sources to balance the demand. - Electricity demand forecasting models - Connectivity with the electricity sources (automatic case)		Physical SMSs App Website	

Cost Structure		Revenue Streams	
- Server costs - Cloud costs		- License fee - Mutual benefit for business and customer if DR compliance	
Environmental Cost	Societal Costs	Societal Benefits	Environmental Benefits

Epic 3

Title: Electricity Supply Optimization			Responsible (s):	
Key Partners	Keys Activities	Value Propositions	Customer relationships	Customer Segments
- DSO - TSO - Battery supplier - Electricity supplier - Smart grid operator - Local energy cooperative	- Energy management system development - Optimize/manage electricity demand increase. - Create dashboard	- Reduce CO2 cost - Ensure optimal network design (blueprint) - Reduce operational cost - Guarantee greener image - Stabilization of energy parameters (quality of electricity) - Ensure energy autonomy. - Provide lower capacity tariff	Customer centric approach: - Dashboard	- Energy service company (ESCO) - District energy manager -
	Key Resources		Channels	
	- Electronic components - Data about sources used to optimize. - Network design - Human resources - Intellectual property		Electricity contract	

Cost Structure		Revenue Streams	
- Software development		- License fee - Consulting fee -	
Environmental Cost	Societal Costs	Societal Benefits	Environmental Benefits
	Coffee	Grid flexibility	Less CO2

Epic 4

Title: Electric vehicles demand response (EV DR)			Responsible (s): Matthias, Daniele	
Key Partners	Keys Activities	Value Propositions	Customer relationships	Customer Segments

- Cloud operator - TSO/DSO - Flexibility aggregators	- Charging station control algorithm - Forecasting services - RENergetic EV-DR implementation - Provide planning tool for CPO	- Sell flexibility to energy markets. - Increase self-consumption. - Reduced operating cost for the CPO. -		- Charging station operator - ESCO - Business Parks operating in charging points. - Energy island manager - Municipality operating charging points - Residential area or companies charging points
	Key Resources		Channels	
	- ML engineers - Software - Communication storage - Data storage			

Cost Structure		Revenue Streams	
		- Sell flex to energy markets. - Commission on cost saving of customer	
Environmental Cost	Societal Costs	Societal Benefits	Environmental Benefits

Epic 5

Title: Heat Supply			Responsible (s): Youssef, Melanie	
Key Partners	Keys Activities	Value Propositions	Customer relationships	Customer Segments
- Ghent (waste) heat producer, Poznan heat supplier (Veolia) - Poznan data center - Segrate co-generator - DSO (electricity supplier)	- Product that improves energy mix - Social activities to reduce heat demand -	- Less fuel sources needed - Complete independence (self-sufficiency) - Lower cost - Reduce heat poverty - Improve CO2 footprint		- Heat user (Segrate) - Heat user (residence university) - Heat user (individual user)
	Key Resources		Channels	
	- Heat supply and demand forecasting models - Developers - Simulation tool - Dashboard to share results about FC for energy manager - Anomaly detection for heat supply			

Cost Structure		Revenue Streams	
Environmental Cost	Societal Costs	Societal Benefits	Environmental Benefits

Epic 6

Title: Heat Demand Response			Responsible (s): Lieven	
Key Partners	Keys Activities	Value Propositions	Customer relationships	Customer Segments
- Project developers - ICT system integrator - Hardware company - Engineering offices - Communication and marketing bureaus - Board of homeowners	- Tool to reduce usage of peak sources - Energy management system - Peak shifting tool - Dashboard notifications	- Reduced operational cost - Reduce CO2 cost - Unburden customer - Data network blueprint - Greener image - Higher autonomy - Guarantee comfort level		- DH managers - ESCOs - Local Heat Suppliers - Energy Island Managers
	Key Resources		Channels	
	- Electronic components - Data collection - Hardware sources that developer will use to run algorithms - Software development - Data network design		- Energy performance contract è warrantee energy serving level of RES - Simulation è predict effect - Post measurement è KPIs	

Cost Structure		Revenue Streams	
Software development=programmers		License Consulting fee Maintenance contract	
Environmental Cost	Societal Costs	Societal Benefits	Environmental Benefits
Possibly more CO2	Too much zoom meetings Late night meeting	Lower cost to end-user	Less CO2

Epic 7

Title: Local Waste Heat Optimization			Responsible (s): Sonja, Mona	
Key Partners	Keys Activities	Value Propositions	Customer relationships	Customer Segments
-	- Optimize configuration and design of external heat. - Detailed configuration of water loop and heat pumps -	- Maximizing revenues by selling heat to the district operator - Money savings (not purchasing heat) - Maximize waste heat utilization. - Maximize autarky level - Maximize CO2 emissions reduction - Minimize fossil fuels use - Maximize RES utilization	- Legal agreement between DSO and partners	- ESCOs - Highly skilled facility managers -
	Key Resources		Channels	
	- “Trnsys” simulator - KPI calculator (amount wasted heat used), CO2 saved …			

	- Forecast heat wasted from the data center (supply) - Collecting heat consumption from campus buildings - Dashboard final gains & KPIs - Demand forecasting of heat consumption from energy island buildings			

Cost Structure	Revenue Streams
	- Heat provider buys excess heat. - Heat producer è heat consumer çè heat supplier

Environmental Cost	Societal Costs	Societal Benefits	Environmental Benefits

IX.3. Interview questions exploratory market research

A set of baseline questions were used to structure the interviews. These questions included topics such as the current market, company offerings, infrastructure optimization and planning, heat network infrastructures, digital technologies, demand response and forecasting methods, and active consumer behaviour. However, it's important to note that these baseline questions were followed up with additional, more in-depth questions to gain a comprehensive understanding of market and the goals of the interviewee (or the company he/she is presenting). By going beyond the basics, interviewers gathered a more accurate picture of the market.

- What kind of technologies does your company offer to customers?
- Do they apply to existing infrastructures (optimization) or to new infrastructures to be built (planning)?
- For what type of heat network infrastructures are your technologies applied, with what generation equipment and components?
- What are the specific characteristics of your digital technologies?
- Do these include heat demand response tools and forecasting methods?
- Do these also incorporate active consumer behaviour?

IX.4. ICT-Solution Company table

Solution Name	*Company Name*	*URL*
ASKI	ASKI	https://www.aski-energy.com/ueber-uns/
Propilot	MEO-Energy	https://www.meo-energy.com/
Energie.kompass	Energie.kompass	https://www.energie-kompass.at/

Siemens	Siemens	https://bifrost.siemens.com/home/
E.ON	E.ON Group	https://www.eon.de/de/meineon/start.html
Octopus WATCH	Octopus Energy	https://octopus.energy/smart/intelligent-octopus/
E-Distribution	E-Distributiciòn	https://www.edistribucion.com/
I-DE	Iberdrola	https://www.i-de.es/
E-REDES	E-REDES	https://www.e-redes.pt/en
Engie Nederland Retail nv.	Engie Energie	https://www.engie.nl/product-advies/app
Repsol Vivit	Repsol	https://www.repsol.es/particulares/digital/repsol-vivit/
Adhorra en luz	imple4droid.	https://www.ahorreluz.es/
Miluz	Public University of Navarra	https://www.unavarra.es/conocerlauniversidad/?languageId=1
Schneider Electric	Schneider Electric	https://www.se.com/ww/en/product-range/62107-wiser-energ
E3@School	Austrian Institute of Technology	https://www.ait.ac.at/en/
EnergyFlip	Aurum Europe	https://www.aurumeurope.com/en/energyflip/
SMAPPEE	SMAPPEE	https://www.smappee.com/
MA Conso+	Engie+ Netamo	https://particuliers.engie.fr/electricite/contrat-electricite/service-ma-conso-plus.html
Alpiq	Alpiq DRM	https://www.alpiq.it/en/energy-solutions/digital-energy-solutions/demand-response-management-system
ENELX	ENELX	https://www.enelx.com/it/it/istituzioni/citta-digitale/comunita-energetiche
ECOWATT	Réseau de Transport d’Électricité	https://www.rte-france.com/actualites/application-mobile-ecowatt
ECO2Mix	Réseau de Transport d’Électricité	https://www.rte-france.com/en/eco2mix
REDOS	Red Eléctrica de España	https://www.ree.es/en/activities/operation-of-the-electricity-system/redos-app-system-operator
IPTO Analytics	Independent Power	https://www.admie.gr/en/mobile-app

	Transmission Operator	
Kyotherm	Kyotherm	https://www.kyotherm.com/en/
Rabmer	Rabmer Greentech GMBH	https://www.greentech.at/firmen/rabmer-greentech-gmbh/
Arteria Platform	Arteria Technologies	https://www.arteria-tech.com/arteria-en.html
KARNO	KARNO	https://www.karno.energy/
Gradyent	Gradyent	https://www.gradyent.ai
Danfoss Leanheat	Danfoss	https://www.danfoss.com/en/
ShifftProject	Research	
VITEC Energy	VITEC	https://vitecenergy.pureservice.com
OpenMotics	OpenMotics DSO	https://www.openmotics.com/#producten
ENERPIPE	ENERPIPE	https://www.enerpipe.de/de/produkte
EDGAR	EDGAR	https://go-edgar.de/#show=all
nProEnergy	nPro	https://www.npro.energy
Calliope	Calliope v0.6.10	https://calliope.readthedocs.io/en/stable/
Oemof	Oemof Tabular	https://oemof.org

IX.5. TRL Level table

In order to assess the technology readiness of the RENergetic solutions, we have based ourselves on standardized Technology Readiness Levels as listed below. It needs to be mentioned that the technical and social building blocks from this Deliverable can only be partially compared and mapped to the initial planned assets list in the DoA of the project. In the course of the project new priorities were made and new epics were developed, due to the technical particularities of each pilot, data privacy and security issues during the data collection process and internal expertise changes among the different RENergetic partners. Therefore, the presented TRL levels are not to be seen in relation with the initially presented assets TRL table in the DoA – the RENergetic Team developped a refined TRl definition, in accordinace with the project setting.[19]

[19] RENergetic DoA, p. 28, *Table 1 – Assets available in the Consotrium, current TRL and target TRL*

This table provides an overview of the different TRL levels. The full table incl. Medical device and drus + examples of each can be found on: https://horizoneuropencpportal.eu/sites/default/files/2022-11/trl-assessment-tool.pdf

What is your solution?	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9
A Product that is manufactured	Analytical studies on separate elements of the technology. Laboratory based trials that show the feasibility of the predictions.	Basic technological components integrated together to show that they work together. At this point durability is not yet important	Basic technological components integrated within realistic context under a fully controlled environment in or outside the lab	A functional version of the product working on a realistic environment able to draw conclusions on the technical and operational capabilities of the product.	A manufacturable version of the product working on an environment which addresses all the operational requirements for the product.	Product in its final form working in full mode under expected conditions and periods.	Product in its final form under full commercial deployment.
An industrial process	Laboratory experiments are designed to verify that the conceptual process works as expected.	Process components are validated indivually and could be integrated in an ad hoc manner at lab scale.	Integrated validation of the process to produce small outputs or short batches of the end product.	Development of a pilotscale testing plant or unit (1/100th of commercial scale) including engineering-scale equivalents of all the operations that will be required at scale.	Successful demonstration of the continuous operation of the pilot plant/unit during a relevant timeframe.	Demonstration plant is constructed (1/10th of commercial scale) and operated in continuous mode, including working outside normal parameters.	Commercial plant/unit set up and running for full range of operating conditions.
A software	Initial script & functions to solve the desired problem.	Alpha version of the software tested internally (both functionalities and process) by the development team	Alpha version of the software functionalities tested by outsiders of the development team.	Beta version of the software functionalities tested by selected enduser under a control mode.	Beta version of the software functionalities widely open to endusers.	Stable version of the software available for the market.	Stable software available for the market. Stable version of the software available for the market in full business plan condition

The solutions being implemented within the RENergetic project are situated at TRL levels 4 to 7. In order to assess the TRL levels for all building blocks separately, the following specific interpretation was given to the TRL levels.

TRL level	Description within RENergetic context
TRL 4	tested by initial development team
TRL 5	tested by RENergetic development team (meaning it is tested by outsiders of the initial small development team working on the individual solution)
TRL 6	tested in a single pilot (with a defined and instructed group of real users using a working prototype)
TRL 7	tested in multiple[20] pilots (with a relevant number of real users using a working prototype)
TRL 8	tested in multiple pilots (with a relevant number of real users using a working solution)

[20] Testing in multiple pilots increases the overall replicability of a particular solution since all the pilots are different with respect to their technical components, applicable epics and user groups.