Review and definition of innovative business models under consideration of the governance framework

D4.2

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 957843 (MAESHA). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

Deliverable D4.2

REVIEW AND DEFINITION OF INNOVATIVE BUSINESS MODELS UNDER CONSIDERATION OF THE GOVERNANCE FRAMEWORK

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DELIVERABLE 4.2 – VERSION 5
WORK PACKAGE N° 4

Nature of the deliverable		
R	Document, report (excluding the periodic and final reports)	x
DEC	Demonstrator, pilot, prototype, plan designs	
DEM	Websites, patents filing, press & media actions, videos, etc.	
O	Software, technical diagram, etc.	

Dissemination level		
PU	Public	x
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

Quality procedure

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More information on the project can be found at https://www.maesha.eu

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Executive Summary

The MAESHA project aims to enable the right conditions to facilitate the decarbonisation of Mayotte island as a demonstrator. With this objective in mind, the project will:

1. Develop an open, central Flexibility Management and Trading Platform (FMTP)
2. Deploy the sensing network, as well as the pilot technologies to be tested
3. Develop the needed long-term business and market data-driven analyses

A variety of stakeholders, such as prosumers, distribution system operators (DSOs), energy retailers, and aggregators, benefit from this objective. This field's business opportunities will be investigated, and the ensuing business models will be created and verified.

The aim of this deliverable is to define innovative business models tailored to Mayotte's energy market's specific use case. Starting from the market design and the initial business cases, the interactions between the market actors are analysed. These business models aim to have more sustainable energy production on the island from the environmental and financial points of view. The idea is then to promote the use of local renewable energy when it is produced and to limit the usage of storage and backup diesel generation. Special attention has also been given to the flexibility needs of the island for congestion management and balancing. The business models have been tailored to Mayotte but also designed to be flexible enough to be implemented on the follower islands with few changes. Finally, a Lean Business Model Canvas (BMC) analysis has been carried out.

A lean business modelling approach has been followed for the development of this work. First, using the MAESHA architecture[1] and the flexibility market design created in T4.1, the stakeholder interactions and potential commercial use cases[2] have been assessed. Through a brainstorming session and literature analysis, these business opportunities were further developed in the second step, mapping prospective business models for MAESHA. Then, the most promising ones were chosen after being compared to the regulatory framework. A thorough explanation of various business concepts will be given in this document. A lean business model canvas study will be carried out as the final iteration of this assignment, taking into account the input from the MAESHA consortium partners.

The first group of business models (BMs) focuses on the role of the aggregator, distinguishing different models according to how they interact with the other actors.

A second group of BMs is related to the local energy communities (LECs), proposing various roles for this this entity, spacing from a small aggregator to an energy and flexibility service provider. Note, that legislation on energy communities is in a very initial state and currently peer-to-peer schemes for energy communities are not feasible in most European member states (including Mayotte (FR)). Thus, these schemes are out of scope.

The last group of BMs comprise the business models of energy service companies (ESCo) where it is proposed as an operator of the different assets to provide energy services.

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List of Abbreviations

aFRR	automatic Frequency Restoration
BACS	Building Automation and Control System
BM	Business Model
BMC	Business Model Canvas
BR	Balance Responsibility
BRP	Balance Responsible Party
BSP	Balance Supplier Party
CSP	Capacity Service Provider
CMSP	Constraint Management Service Provider
DA	Day Ahead
DER	Distributed Energy Resource
DR	Demand Response
DSO	Distribution System Operator
ESCo	Energy Service Company
FCR	Frequency Containment Reserve
FLESCo	Flexibility Service Company
FMTP	Flexibility Management and Trading Platform
FRP	Flexibility Requesting Party
FVC	Flexibility Value Chain
ID	Intraday
LEC	Local Energy Community
LS-ESS	Large Scale Energy Storage System
mFRR	manual Frequency Restoration
P2P	Peer-to-Peer
PPA	Power Purchase Agreement
SUP	Supplier
ToU	Time of Use
TSO	Transmission System Operator
USEF	Universal Smart Energy Framework

1. Introduction

The MAESHA project aims to enable the right conditions to facilitate the decarbonisation of Mayotte island as a demonstrator. With this objective in mind, the project will:

1. Develop an open, central Flexibility Management and Trading Platform (FMTP)
2. Deploy the sensory network, as well as the pilot technologies to be tested
3. Develop the needed long-term business and market data-driven analyses

Based on these tools, MAESHA expects to increase renewable energy sources penetration to more than 70%, reach at least 90% of Mayotte's population, and act as a lighthouse for other European islands.

1.1. Scope and Objective of the Deliverable

The aim of this deliverable is to define innovative business models (BMs) tailored to Mayotte's energy market's specific use case. Starting from the market design and the initial business cases, the interactions between the market actors are analysed. These business models aim to have more sustainable energy production on the island from the environmental and financial points of view. The idea is then to promote the use of local renewable energy when it is produced and to limit the usage of storage and backup diesel generation. Special attention has also been given to the flexibility needs of the island for congestion management and balancing. The business models have been tailored to Mayotte but also designed to be flexible enough to be implemented on the follower islands with few changes. Finally, a Lean Business Model Canvas (BMC) analysis has been carried out. In this context, also possible pricing strategies are described.

1.2. Structure of the Deliverable

This deliverable is structured as follows:

- Chapter 2: Explains the methodology used to elaborate the task
- Chapter 3: Defines the market participants and summarises the flexibility products to be delivered within MAESHA
- Chapter 4: Introduces the proposed market and defines a list of business models for the participants
- Chapter 5: Further analyses the BMs with a Lean Business Model Canvas strategy
- Chapter 6: Draws the conclusions about the work and results

1.3. Relation to Other Tasks and Deliverables

As shown in the task's relation diagram of Figure 1, the work of this task and this deliverable heavily builds on the work carried out in the initial MAESHA's tasks in WP1 and in close collaboration with other related market design tasks in WP4. The outcomes are relevant for the whole project and, above all, to establish a self-sustained energy flexibility market after MAESHA.

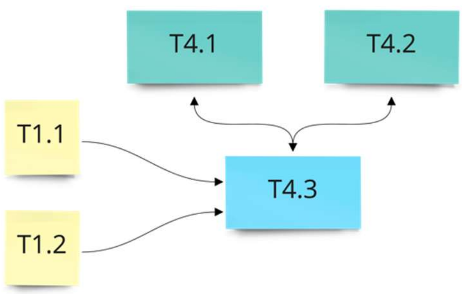

Figure 1: Tasks Relational Diagram

2. METHODOLOGY

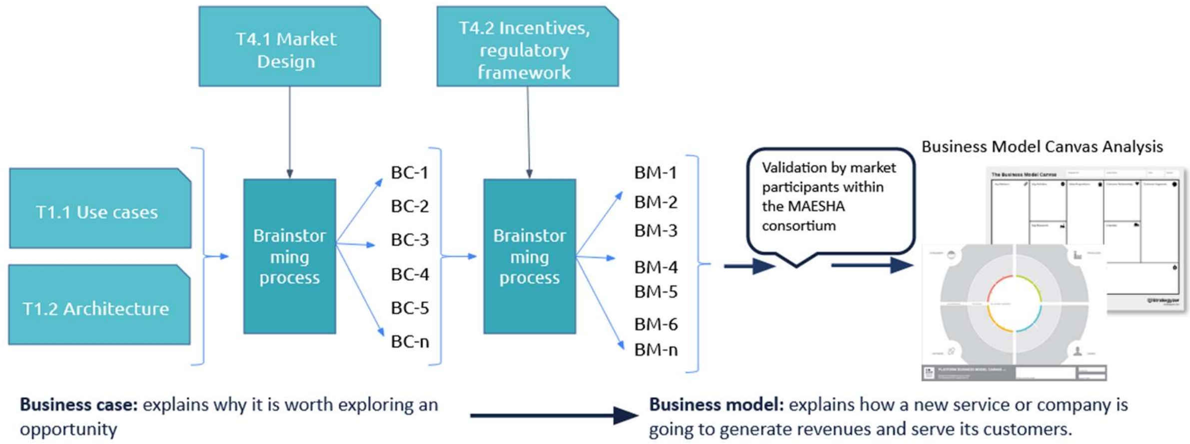

Figure 2: Methodology used to elaborate the BMs

First, using the MAESHA architecture[1] and the market design created in T4.1, the stakeholder interactions and potential commercial use cases[2] have been assessed.

Through a brainstorming session and literature analysis, these business opportunities were further developed in the second step, mapping prospective business models for MAESHA. Then, the most promising ones were chosen after being compared to the regulatory framework. A thorough explanation of various business concepts will be given in this document. A lean business model canvas study will be carried out as the final iteration of this assignment, taking into account the input from the MAESHA consortium partners. This methodology is shown in Figure 2.

For the analysis of the regulatory environment, a review of documents, including policy and regulatory documents, scientific and grey literature was conducted. In addition, the practical knowledge of local stakeholders and information from meetings with market actors and institutions were used. For the case of Mayotte, conducting such an assessment proves particularly challenging, as the applicability or implementation of policies and regulations may differ from that in mainland France.

3. MAESHA MARKET PARTICIPANTS

This section aims to evaluate the traditional European energy market models to foster a shared knowledge of the functions, relationships, and procedures they establish. In addition, this chapter provides a basis for developing a new energy market model that is distinctive to Mayotte and consistent with the MAESHA framework while also being sufficiently general to be easily reproducible on other islands.

A detailed assessment of the literature has been conducted, for this reason, looking at both stakeholder organisation rules and market notions covered in scholarly publications. The commonly used USEF [3] and ENTSO-E[4] models have received particular attention. Successful integration of the MAESHA concept into the established market structure can be accomplished by assessing these frequently utilised models.

The functions of market stakeholders and actors are described in detail in the following sections referring to their USEF definition[3]. Then, building on these standard bases, the markets and how the different parts can interact concerning the proposed flexibility products are examined and adapted to the specific case of MAESHA.

3.1. MARKET PARTICIPANTS DEFINITION

This introductory section would serve to give a common understanding of the market participants foreseen within MAESHA. The list does not consider the totality of the possible roles within the electrical grid but covers the main one, especially when considering the island's framework.

Active Customer: The role of the Active Customer is to consume, generate or store electricity within its premises. USEF does not distinguish between residential end-users, SMEs or industrial users; they are all referred to as Active Customers. Figure 3 shows the various components that can constitute an Active Customer within the framework of MAESHA.

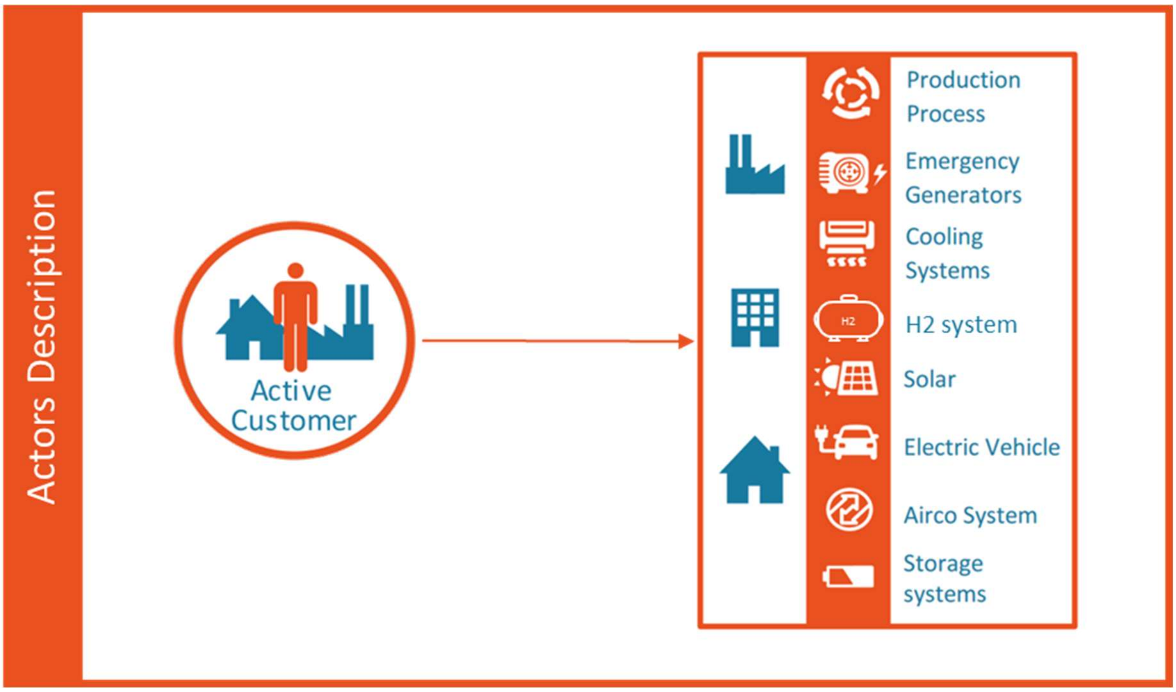

Figure 3: Detailed Description of the Active Customer within MAESHA

Active Customers are a source of demand-side flexibility (both varying their energy consumption and production). Therefore, bundling a suitable number of Active Customers allows the Aggregator to offer flexibility service on the market.

Additionally, a variety of flexibility services are available to Active Customers. These services enable energy optimisation behind the meter and can be offered by an Energy Service Company (ESCo) or an energy community. The most pertinent services are self-balancing, kWmax control, and Time-of-Use (ToU) optimisation (load shifting from high-price to low-price intervals).

Energy Service Company (ESCo): The ESCo provides Active Customers with auxiliary energy-related services such as remote maintenance for flexible assets, energy optimisation services, management and advisory services, and insight services. In the context of local communities, the ESCo can also provide peer-to-peer (P2P) energy trade among participants by running a shadow administration, which is separated from the administration of a supplier/BRP. Figure 4 summarises some roles that an ESCo can take within MAESHA.
The ESCo is not regarded as an active participant in the electricity market because it has no official obligations inside the electricity grid. i.e., it does not need to take balance responsibility.

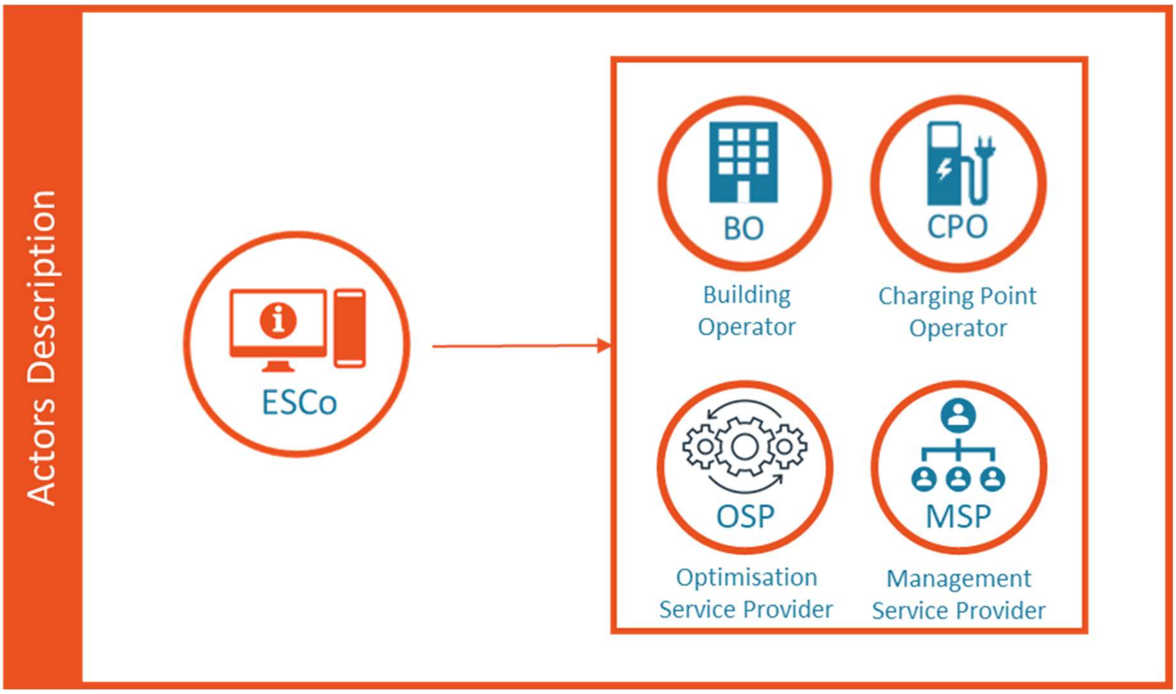

Figure 4: Services that the ESCo could offer within MAESHA

Aggregator: The Aggregator's job is to gather flexibility from Active Customers and their flexible assets and sell it to the Frequency Requesting Party (FRP), typically the Balancing Responsible Party (BRP), the Distribution System Operator (DSO), or the Transmission System Operator (TSO). The Aggregator and its Active Customers agree upon commercial terms and conditions for the acquisition and management of flexibility.
By selling it to the service/FRP that needs it the most urgently and, therefore, is willing to pay the highest price, the Aggregator seeks to maximise the value of the flexibility, providing the best remuneration for itself and its clients.
In order to guarantee the flexibility offered to the market, the Aggregator must eliminate the uncertainties of non-delivery from a single Active Customer. As a result, Active Customers are shielded from the dangers associated with trading in flexibility markets. The Aggregator is also in charge of the billing and payment procedures related to the provision of flexibility to the Active Customer.
Depending on the aggregator type used, the Aggregator may be required to operate as a Balance Responsible Party (BRP). More particularly, how these alter the balance of responsibility among the many actors depends on the contractual provisions in the aggregator model.

According to the EU Renewable Energy Directive, an aggregator may also act as a facilitator for P2P trading amongst prosumers.
Finally, an aggregator may be a stand-alone market participant, but this function may also be carried out by another free market participant, such as a conventional energy supplier.

Figure 5: Aggregator Role as defined by the USEF[3] Framework

Supplier: According to the USEF[3] framework, *the role of the supplier is to source, supply, and invoice energy to its customers. The supplier and its customers agree on commercial terms for the supply and procurement of energy*. The free choice of suppliers is a core premise of the European liberalised energy market, as expressed in Article 4 of the EU Directive on uniform rules for the internal electricity market. The structure of provided tariffs and other delivery criteria are unregulated and can be decided upon by the contractual parties. The supplier must be a member of a balance group with a BRP, with the latter responsible for balancing supply and demand for the energy that the supplier sources and sells. As a result, the BRP is also liable for any imbalances caused by discrepancies between the supplier's forecast and the actual load profiles of the prosumers.

Producer: The Producer's responsibility is to supply energy to the grid, significantly contributing to the safety of the energy supply. The Producer's primary goal is to run its assets as efficiently as possible.
Since renewable energy sources like wind and solar power have a relatively low operating cost and compete with existing power generation units, introducing distributed flexibility and changes to the merit order can drastically alter its operating conditions even though its responsibility remains the same.

Balance Responsible Party (BRP): The BRP is responsible for actively balancing supply and demand for its portfolio of actors (producers, suppliers, aggregators etc.). Each party connected to the grid oversees their own balancing position and must, therefore, control the precise quantity of energy introduced and consumed in the electrical system. To do so, each actor connected to the grid must be a part of a balance group, making an effort to minimise internal imbalances. The Imbalance Settlement Responsible must bear the costs of the remaining imbalances unless flexibility can be obtained on the wholesale market. The supplier usually assumes the prosumer's balancing duty through the contracted BRP.

Distribution System Operator (DSO): *The DSO is responsible for operating, maintaining and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity* [3].
According to the Council of European Energy Regulators (CEER), when it comes to innovative services in demand-side flexibility, DSOs must behave as impartial market facilitators and in the general

public's best interests. DSOs should be involved primarily by acquiring flexibility resources to carry out voltage regulation and congestion management. According to CEER, DSOs should typically utilise local flexibility resources at the distribution system level; however, doing so might need the employment of intermediaries like aggregators.
In terms of flexibility market, USEF defines the DSO interactions as follows:

1. check whether demand-side flexibility activation within its network can be safely executed without grid congestion and
2. purchase flexibility from the aggregators to accomplish its system operations tasks

Transmission System Operator (TSO): The TSO transports energy from centralised Producers to dispersed industrial Active Customers and DSOs over its high-voltage grid. The TSO safeguards the system's long-term and short-term ability to meet electricity transmission demands. The TSO is responsible for keeping the system balanced by deploying regulating capacity, reserve capacity, and incidental emergency capacity. The TSO can purchase flexibility via the BSP of the Aggregators active on its network.

Within MAESHA, the ***Local Energy Communities (LEC)*** have been introduced, and their role within the energy market will be detailed in the following dedicated section.

3.1.1. Local Energy Community (LEC)

The European Commission has recently suggested changes to the Renewable Energy Directive (RED II)[5], recognising the need to raise the bar on renewable energy in order to reach its climate goals. For their part, citizens are becoming more active within their own neighbourhoods, creating campaigns to promote the use of renewable energy sources and the use of energy-saving technologies. In addition, the Clean Energy for All Europeans legislation package[6] (CEP), which defined and implemented enabling conditions for energy communities, recently recognised such projects.
Local Energy Communities (LEC) are typically founded for environmental, economic and social purposes benefits rather than for financial profits. According to the definition provided by the European Union, a LEC is a legal entity that is based on voluntary and open participation and is, in fact, controlled by shareholders or members who are natural persons, local government entities, including municipalities, and SMEs. An analysis on the current regulation about LECs is carried out in section 4.2.2.
LECs may provide a variety of services, some of which are orientated toward the production, supply, storage, or aggregation of energy (usually from renewable sources), while others are focused on improving energy awareness and efficiency. These services have been elaborated and represented in Figure 6 [7] and briefly explained herein:

a) **Services to increase energy awareness**: Communities can initially provide energy-related services to their members with an emphasis on raising energy awareness by offering energy diagnosis, monitoring energy use, or promoting knowledge acquisition and exchange through specialised workshops and training programmes. Such services are often provided to (individual) Prosumers by the ESCo; therefore, it is considered that a community acts as an ESCo when it provides these services to its members.
b) **Joint purchase and maintenance of shared assets**: Most LECs are formed to jointly produce renewable energy, leading to the acquisition of shared assets or the common ownership of individual assets. Cooperatively acquiring energy assets as a community brings numerous advantages as easing the process of gathering information, buying DERs, and installing and maintaining them. Also, being part of a community puts the customer in a stronger negotiation position than an individual. Communities that prefer acquiring shared generation assets might provide DERs to members who ordinarily lack the technical or financial means

for an individual installation. These situations typically allow for consideration of larger-scale technologies, for example, a community-owned solar plant. It is crucial to notice that also profit-driven market party playing the role of an ESCo could likewise offer joint acquisition and upkeep of shared assets.

c) **Supply of shared energy**: When community-wide renewable energy generation is established, the community also naturally assumes the Producer role. Through a Power Purchase Agreement, communities can sell their energy to centralised, profit-driven Suppliers and BRPs (PPA). The community may, however, supply its own members with energy as a further step.

d) **Peer-to-Peer (P2P)**: The virtual exchange of energy amongst community members holds excellent potential for managing community generation and supply. The demand for this strategy, also known as peer-to-peer (P2P) supply, is indeed rising. P2P supply makes it evident where the energy being purchased came from, which can help consumers become less reliant on Suppliers; P2P supply has, therefore, the potential to eventually eliminate the need for a traditional Supplier for the members of a community. In order to manage the excess in energy production or consumption, the community would therefore need to enter into a bilateral agreement with a third market participant or participate in the wholesale market. Indeed, the Clean Energy for All Europeans package[1] supports the concept of LECs accessing electricity markets to achieve this. In this situation, the community would also need to assume balance responsibilities, which might be delegated to a third party or decided to be done by the community itself (by taking on the role of BRP). A growing number of efforts are looking into various strategies to help the community accept the responsibilities of both Supplier and BRP in the future, such as by utilising blockchain technology. These initiatives introduce a cryptocurrency into the community to encourage the physical (real-time) use of local production.

e) **Flexibility Services**: Communities can provide certain flexibility services (e.g., peak reduction) to the grid by coordinating and aggregating shared and community members' assets.

LECs are growing in popularity and becoming more professional as they look for ways to expand both their functions in the energy system and the kinds of activities they can provide to their members.

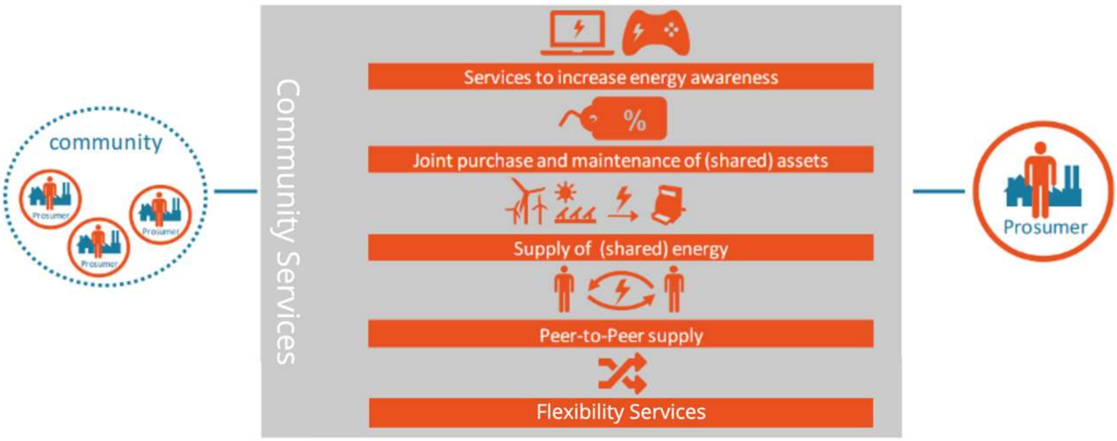

Figure 6: Services[7] that can be offered by a Local Energy Community

By controlling the community's load and generation profiles, they can provide a remarkable amount of flexibility to be traded on the market. As a result, demand-side flexibility-related activities might be seen as complementary to energy generation and boost the economic value of a LEC.

[1] https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en

All the services described above are considered for MAESHA's case, with a small exception for P2P supply. Indeed, the current economic framework implemented in Mayotte (French Framework) and unclear regulation makes it more convenient for the customers and community to sell excess energy to the grid, as it is highly remunerated thanks to financing statal incentives. Therefore, P2P will not be implemented. Instead, the communities can optimise their self-consumption (self-balancing).

Another element introduced within MAESHA is the **Flexibility Market Trading Platform (FMTP).** That is the actual trading platform within MAESAH and match the demanded flexibility services with the offers.

3.1.2. Summary

Flexibility is valuable for all the specified grid actors. The active customers can employ flexibility for in-home optimisation by, for example, maximising against variable energy costs and/or grid tariffs or boosting self-consumption of self-generated electricity with the support ESCo's services.
A Supplier/BRP can optimise its portfolio with the aid of flexibility while also reducing sourcing costs, increasing revenue from generation, and avoidance of imbalance charges. The DSO can employ flexibility, such as postponing or avoiding the cost of grid reinforcement, to actively manage the currently available capacity. TSOs can apply flexibility in multiple ways, from system operation services for balancing purposes to constraint management.
Figure 7 represents the interaction model elaborated by USEF, where it is specified the relation of the cited actors within the flexibility value-chain (both implicit and explicit).

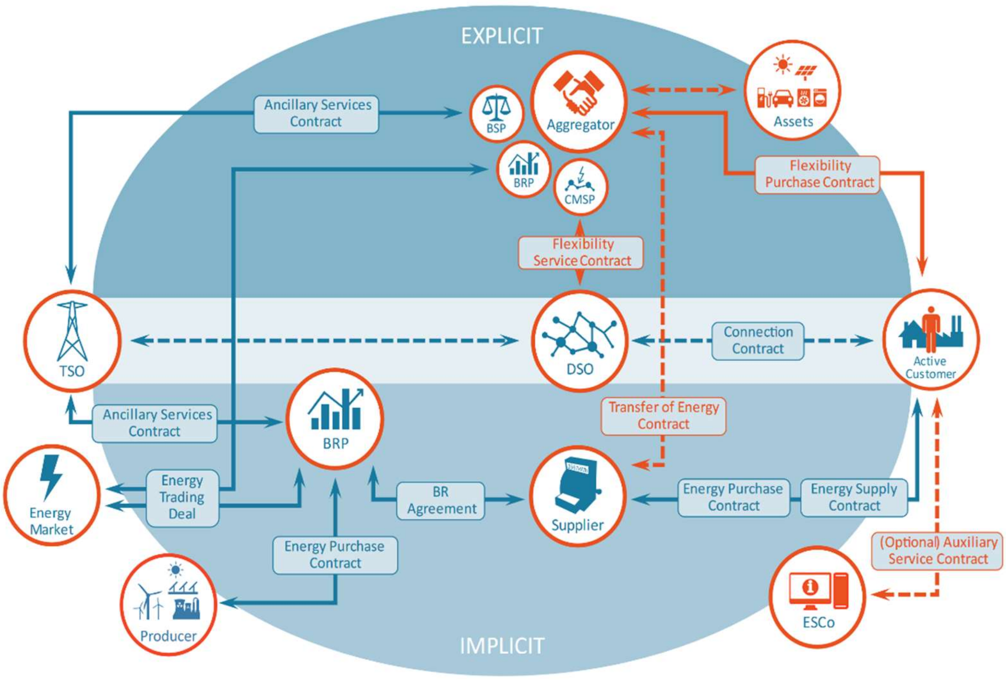

Figure 7: USEF[3] implicit/explicit flexibility interaction model

Within MAESHA, the consortium must cope with the specificity of the island's electricity value chain. Indeed, Electricité de Mayotte (EDM) is a vertically integrated utility, i.e., an energy Supplier, a Transmission System Operator (TSO), a Distribution System Operator (DSO) and a Balance Responsible Party (BRP) at the same time. It also produces 95% of the island's energy and will be the party operating the FMTP platform.

A new interaction model is presented in Figure 8 which takes into account the specificity of Mayotte and the new services and actors introduced within the project. This model has been kept flexible enough to be implemented also on the follower islands.

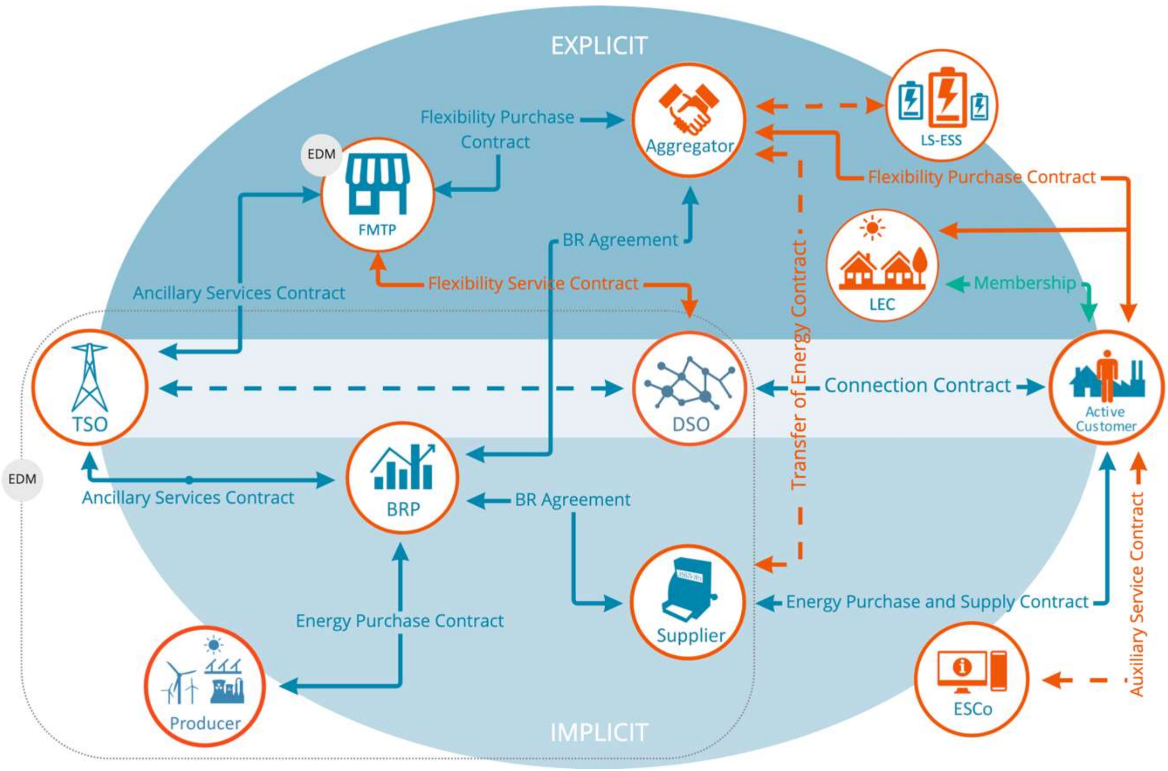

Figure 8: Proposed implicit/explicit flexibility interaction model within MAESHA

3.2. MAESHA Flexibility Products

3.2.1. Explicit distributed flexibility services

Figure 9 shows the list of the implicit and explicit demand flexibility (DF) services elaborated by USEF[3]. These services can be classified as follows:

- **Implicit**:
  - *The services for local (in-home, in-factory) optimisation are only financially viable if there is a financial incentive for each type of local optimisation.*
- **Explicit**:
  - *Constraint management services help the grid operators to optimise grid operation using physical constraints and impact on markets.*
  - *Adequacy services aim to increase the security of supply by organising sufficient long-term peak and non-peak generation capacity. Adequacy services can be provided to either the TSO or the BRP*
  - *Wholesale services help BRPs to decrease sourcing costs (purchase of electricity) – mainly on Day-Ahead (DA) and Intraday (ID) markets - but also costs for sourcing through balancing mechanisms. In the* Flexibility Value Chain (*FVC), the BRP is the FRP for wholesale services*
  - *Balancing services include all services specified by the TSO for frequency regulation.*

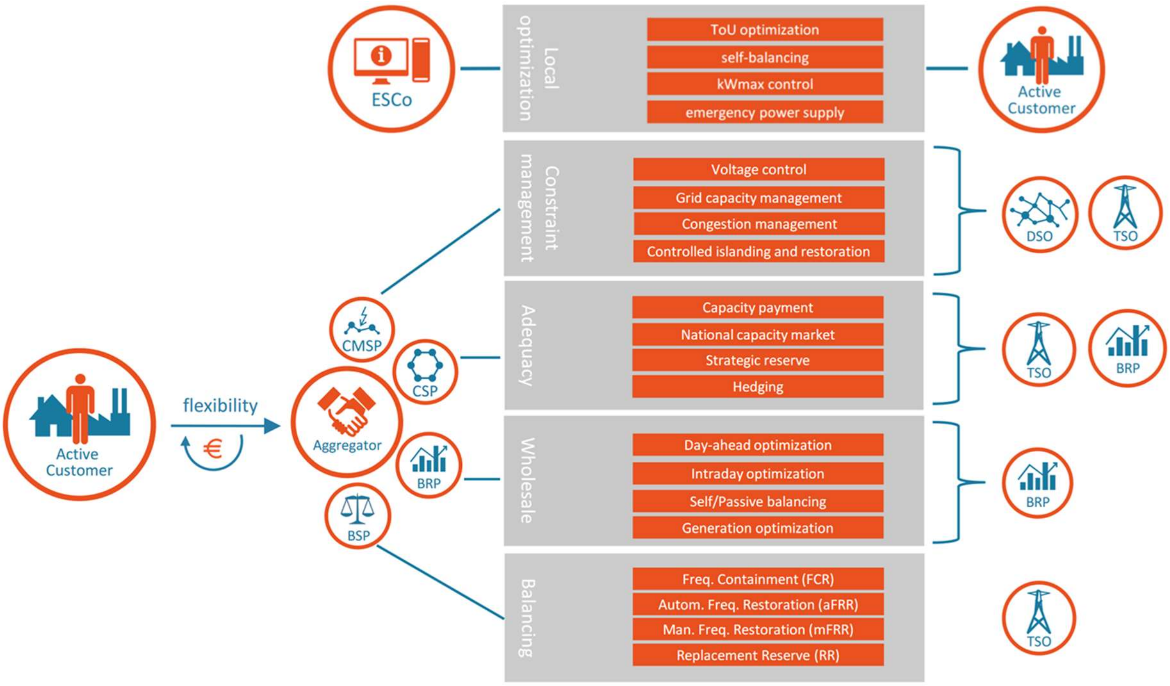

Figure 9: Implicit and Explicit flexibility services defined by USEF[3]

Within D1.1[2], these services have been analysed in relation to the energy system in Mayotte and its foreseen evolution. They resulted in the definition of the following three services to be provided to the island's grid:

- Balancing,
- Constraints Management,
- Local optimisation

The relevance of these services has been assessed by organising multiple workshops with local stakeholders (grid operator, local population, and relevant local authorities) to understand their specific needs. From this evaluation, **five services/use cases** have been selected and described using the IEC 62559-2 template. They are herein summarised for the sake of completeness[2]:

- **Frequency control**, which objective is to establish balancing services to maintain the equilibrium between consumption and generation while minimising the frequency deviations from nominal values (i.e., 50 Hz in Europe)
- **Voltage control**, whose objective is to propose voltage control services to keep voltages within specific safety bands and restore their values to normal range after grid disturbances.
- **Minimisation of the consumption peak**, whose objective is to minimise the consumption peak to avoid potential congestion, expensive start-up of peak generators or adequacy issues that may occur in the electricity system of the island.
- **Local Optimisation – Self Balancing**, whose objective is to implement collective self-consumption operations and to hybridise assets (EV charging stations and air-conditioning units) with photovoltaic panels to maximise the use of Renewable Energy Sources.
- **Energy Access**, whose objective is to respond to the lack of reliable access to electricity in Mayotte while at the same time offering services to the grid and fostering the involvement of marginalised communities.

Also, a mapping table has been elaborated to keep consistency between the service naming kept in the different MAESHA deliverables and the USEF[3] framework. The results are presented in Table 1.

Table 1: Mapping of MAESHA and USEF Services

MAESHA Services	USEF Services	Notes
Voltage Control	Voltage Control	
Minimization of Peak Consumption	Congestion management	The use case "Minimization of the consumption peak" has several sub use cases. During the pilot demonstration, it is meant to be used to provide economic and environmental optimization by avoiding the expensive start-up of polluting peak generators. That corresponds to day-ahead optimization in USEF framework. By the end of life of the existing generation capacity, this use case will also be supporting system adequacy. Finally, the use case can be extended to congestion management if location-based optimization is used.
Frequency Containment Reserve	Frequency Containment Reserve	
Automatic Frequency Restoration	Automatic Frequency Restoration	
Manual Frequency Restoration	Manual Frequency Restoration	
Fast Frequency Response	Frequency Containment Reserve	Fast Frequency Response can be aligned with FCR for disturbance (FCR-D), while FCR above is FCR for normal operation, known as FCR-N.

[2] Refer to MAESHA's Deliverable D1.1 for the complete description

Figure 10 puts in context the aforementioned services, connecting them with the specific providers and beneficiaries in the case of Mayotte. It includes both Implicit and Explicit flexibility services.

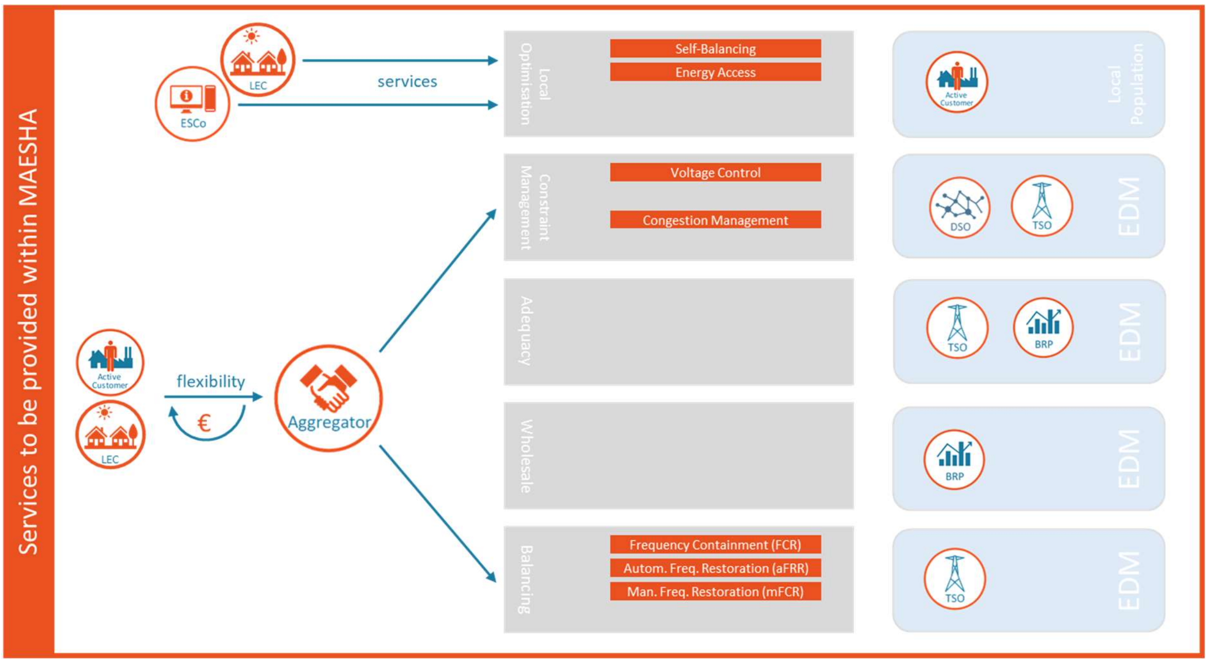

Figure 10: Flexibility services and market participants defined for MAESHA

It has to be pointed out that although all the services will be tested, the Voltage Control will not be contemplated as a service to be offered through the FMTP platform developed along the project, as not interesting from the current market point of view.

4. MAESHA Market Definition

The current energy market implementation in Mayotte is represented in Figure 11. This market structure is non-liberalised, so the central grid roles are concentrated in a single entity.

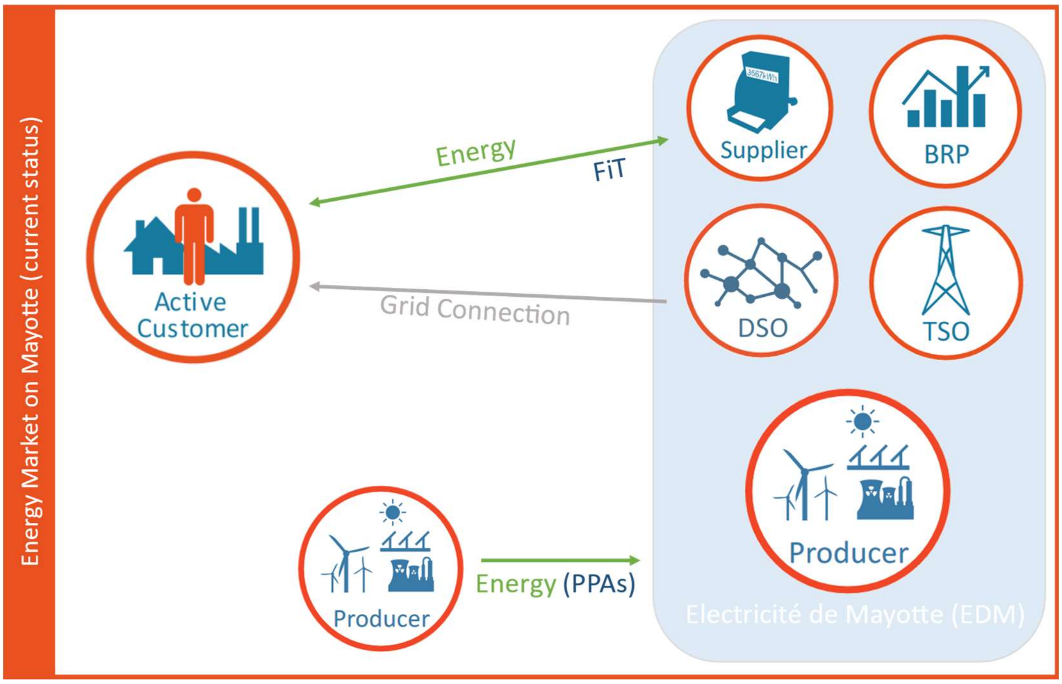

Figure 11: Current Status of the Energy Market on Mayotte

4.1. Proposed Market for MAESHA

Based on the various concepts and restrictions introduced above and the work made in deliverables D1.1, D1.2 and D4.1, a role model has been developed within the current deliverable to introduce a flexibility market within the context of MAESHA (Figure 12).

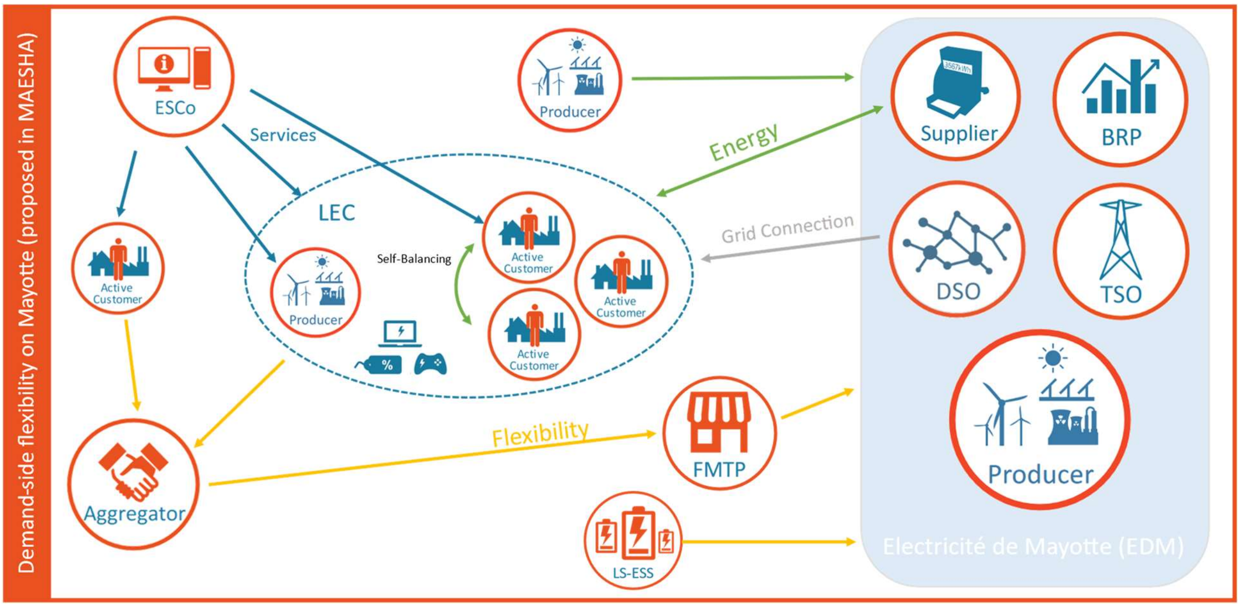

Figure 12: Proposed Market implementation within MAESHA

The objective is to make it flexible enough to be easily applicable to the particularity of the replication islands. The introduction of a flexibility market within MAESHA opens the doors to the appearance of new actors in the existing context, i.e., the ESCo, the Aggregator and the LEC.
The ESCo can offer different services to the Active Customers and LECs, for example, energy management services and insights, consulting, community, and assets management. In some cases, the ESCo can invest on its customers with mutual benefit on the long term.
As specified in section 3.1.1, the LEC can take over some ESCo roles if holding the necessary technical expertise. The community can also manage the member's flexibility and hold a stronger negotiation position with the Aggregator.
Finally, the Aggregator is the central node of this framework, as it is the connection link between the FRPs and the customers and will offer the flexibility through the FMTP developed within MAESHA.
As a clarification, this scheme would merely represent the possible roles in the most general way, and it is not tied to only one entity. For example, the operator of the LS-ESS or the community could trade their flexibility directly on the FMTP, but in this case they are acting also as Aggregators.

4.2. Business Models

Figure 10 clarifies how the various market actors interact to provide the services delineated in D1.1. In this model elaborated for MAESHA, the Aggregator plays a significant role in the explicit flexibility market. By comparing the current market status represented in Figure 11 and the one proposed in MAESHA (Figure 12), it is possible to notice that other market actors have been introduced in addition to the Aggregator. They are the ESCo and the Energy Community Operator, and both will complementarily collaborate to deliver the self-balancing and energy access services in MAESHA. In the following subsection, some possible business models are introduced and further analysed through a canvas analysis in Section 5.

Table 2 summarises the contribution of the proposed business models to MAESHA's specific objectives:

- SO1: Develop an innovative smart platform aggregating multiple flexibility services to provide flexibility for the stabilisation of the electricity grid on islands
- SO2: Reach up to 70 to 100% of RE penetration with close collaboration between Local Energy utilities, communities, modellers, and flexibility solutions providers
- SO3: Create synergies between electricity and other networks
- SO4: Activate and involve local communities for better ownership and acceptance of energy transition
- SO5: Demonstrate at full-scale level the global solution on the island of Mayotte
- SO6: Ensure the replicability of the solutions developed through the follower islands
- SO7: Create a publicly available toolkit and a user-manual for wide replicability to give perspective to the project beyond the follower islands

Table 2: Contribution of BMs to MAESHA objectives

BM	SO1	SO2	SO3	SO4	SO5	SO6	SO7
AGGR-1	X	X				X	
AGGR-2	X	X				X	
AGGR-3	X	X				X	
AGGR-4	X	X				X	
LEC-1		X		X		X	
LEC-2		X		X		X	
LEC-3		X		X		X	
LEC-4		X		X		X	
LEC-5		X		X		X	
ESCO-1		X				X	
ESCO-2		X				X	
ESCO-3		X				X	
ESCO-4		X				X	
ESCO-5		X				X	

4.2.1. Aggregator

The Aggregator has a central role in the presented market model. It creates flexibility services based on the aggregation of demand-side flexibility and delivers these products to FRPs, optimally trading them to maximise monetisation.

By applying this explicit DR model, the Aggregator links the local prosumers to flexibility markets. An aggregator could also potentially assume the role of facilitating peer-to-peer (P2P) trading among prosumers, providing the necessary P2P platform with a fee-based revenue scheme. However, this element cannot be considered as it is not feasible under the current regulatory framework. Instead, the Aggregator could offer similar expertise for matching the generation and demand of a local energy community (or, more generally, of a given area) for self-balancing purposes, although this role is better suited to an ESCo, as it has no direct flexibility market connection.

Generally, these two elements may compete as the aggregator's mission is to maximise the profit for itself and its customers. Accordingly, the Aggregator will either favour making bids on the flexibility markets for packaged flexibility or try to use peer-to-peer trading to self-balance the neighbourhood. The local community's self-balancing takes precedence only if this significantly lowers prosumers' grid costs. Only the remaining flexibility will be made available on the market in this scenario.

Aggregator Implementation Models[3]

The USEF has identified seven implementation models for the Aggregator (*in addition to the split supply model*) defined in relation to the Supplier and the BRPs (Figure 13: USEF[3] Aggregator Implementation Models).

[3] An Aggregator Implementation Model (AIM) is a market model for the Aggregator role, describing its relation to the Supplier and BRP of the Prosumer, and how balance responsibility, transfer of energy and information exchange are organized [3]

For the case of Mayotte, even if there are no impediments for the Dual BRP cases, currently, no other BRPs are present on the island. The same reason applies to the uncorrected model, which results in an imbalance for the BRP of the supplier, and balancing shall happen externally. So only the split supply, integrated and broker cases are considered for the short term.

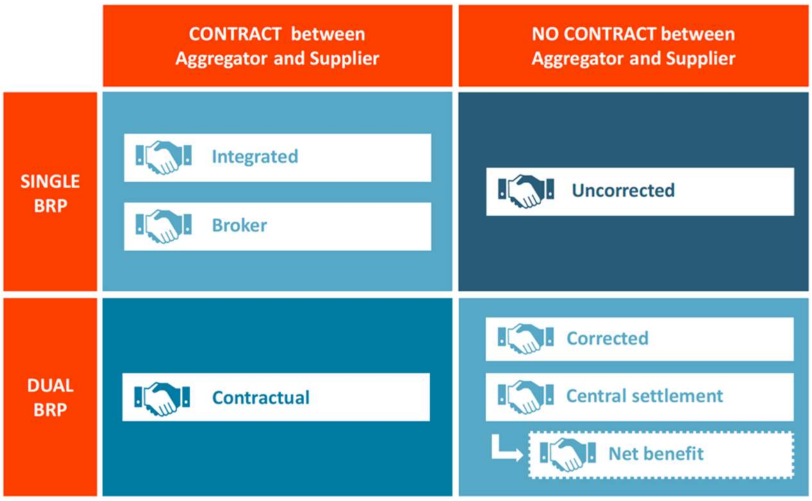

Figure 13: USEF[3] Aggregator Implementation Models

Split Supply: The *split supply model* is one of the simplest ways to deliver flexibility as it separates the flexible asset from the rest of the load.

This model (represented in Figure 14) divides the Active Customer load's supply into controllable and non-controllable loads, with one Supplier bearing supply and balance responsibility (BR) for the controllable load and another Supplier for the non-controllable load. The supplier of the controllable load has two options for utilising the controllable asset's flexibility: either they collaborate with an aggregator or take on the aggregator's function independently. This approach is often put into practice by adding more meters, either in parallel with the original meter or behind it (sub-metering).

A split supply option may be a valuable alternative model for Aggregators to offer their services. For example, an electric mobility service provider could use the electricity meter in the charging unit of the electric vehicle as a sub-meter and trade the flexibility of the charging process.

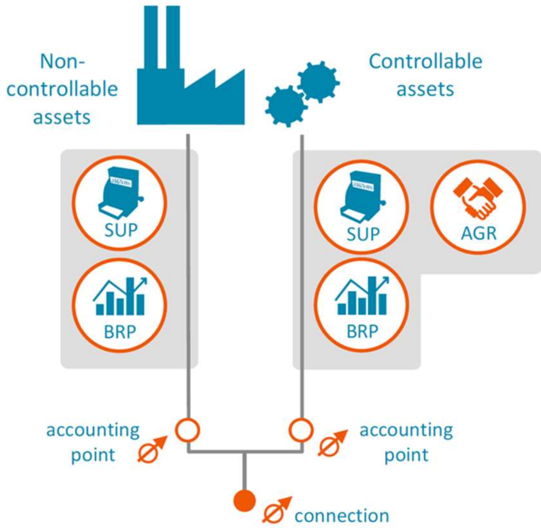

Figure 14: Split Supply Model (USEF[3])

Integrated: In the integrated approach, a single market party serves as both the supplier and the Aggregator. Both the open supply position and imbalance compensation are not required. A contract between the Supplier/Aggregator and the Prosumer details the sale of energy and the purchase of flexibility in exchange for a reward, the nature of which depends on the offer. Suppliers may handle aggregation on their own or via the assistance of a third party[3].

Broker: The Aggregator delegates the balance duty to the Supplier's BRP under the broker model. Bilateral settlements based on contractual agreements are utilised to compensate for the open supply position and the resulting imbalance. The Supplier's BRP should be informed of the activated flexibility in its portfolio at the Active Customer level[3].

Regarding the business models for the aggregator, different possibilities have been examined. The following tables (Table 3 and Table 4) summarise the business models and their compatibility with the implementation models.

Table 3: Aggregator BMs

Business Model	Explanation	Relevant for Mayotte
Combined Aggregator - Supplier	The supplier also offers aggregation services. Only one BRP at the connection point.	N
Independent Aggregator as a service provider	The aggregator is a service provider for one of the other actors in the market but does not sell flexibility to FRPs.	Y
Independent delegated Aggregator	The aggregator directly sells flexibility to FRPs.	Y
Active Customer/LEC as Aggregator	Large-scale active customers can adopt the role of aggregator for their own portfolio.	Y

Table 4: Compatibility of Aggregator's BMs and Implementation Models

	Split Supply	Integrated	Broker
Combined Aggregator-Supplier	X	X	
Independent Aggregator as a service	X	X	X
Independent delegated Aggregator	X		X
Active Customer/LEC as Aggregator	X		

The Business Models listed in Table 1 are analysed here using a classical BM template.

Table 5: Business Model – Combined Aggregator-Supplier

Element	Description
ID	AGGR-1
Service Provider	Energy Supplier
Customers	Aggregating flexibility from: Active Customers Selling flexibility to: FRPs in the flexibility Market (DSO, TSO)
Problem	Individual Active Customers do not have enough flexibility capacity to access the market.
Service	Supply and aggregation are offered as a package, one BRP per connection point
Value Proposition	Additional Revenues for the Supplier, lower prices or compensations for the Active Customers
Unique Selling Point	A joint point for energy and flexibility services
Resources	Market Access, Large pool of active customers, additional metering devices, IoT control devices for flexible assets, FMTP, Aggregation Platform
Revenue Model	Revenues from trading flexibility, Improved Clients' retention

Table 6: Business Model – Independent Aggregator as a Service

Element	Description
ID	AGGR-2
Service Provider	Specialised Aggregation Company, (FI)ESCo, Appliances Manufacturers
Customers	Aggregating flexibility from: Active Customers Selling aggregation service: Energy Supplier, BRPs, Other Aggregators
Problem	Some actors do not have the technical expertise to gather flexibility from individual and agglomerated customers
Service	Bundle flexibility for other market actors that will trade it on the market
Value Proposition	The Aggregator do not assume the risks of market participation
Unique Selling Point	The contractor will be able to quickly add flexibility services to its portfolio without taking the risk of developing a custom solution
Resources	Market Access, Large pool of active customers, additional metering devices, IoT control devices for flexible assets, FMTP, Aggregation Platform, Communication to the Balance Group
Revenue Model	Pay per use, fees on sold flexibility, subscription

Table 7: Business Model – Independent Delegated Aggregator

Element	Description
ID	AGGR-3
Service Provider	Specialised Aggregation Company
Customers	Aggregating flexibility from: Active Customers Selling flexibility to: FRPs in the flexibility Market (DSO, TSO)
Problem	Individual Active Customers do not have enough flexibility capacity to access the market.
Service	Bundle flexibility and sell it to the FRPs
Value Proposition	Revenue from a flexible asset without market risks/expertise
Unique Selling Point	Highly specialised service provider, seeking the maximum benefit for itself and its customers
Resources	Market Access, Large pool of active customers, additional metering devices, IoT control devices for flexible assets, FMTP, Aggregation Platform, Communication to the Balance Groups, Regulation must allow the business model, and finally, the settlement mechanism must support it.
Revenue Model	Revenues from trading flexibility

Table 8: Business Model – Active Prosumer as Aggregator

Element	Description
ID	AGGR-4
Service Provider	Large Active Prosumers (e.g. Industry, LS-ESS, Companies)
Customers	Aggregating flexibility from proprietary portfolio Selling flexibility to: FRPs in the flexibility Market (DSO, TSO), Aggregators
Problem	Large active customers could have enough flexibility to trade in the market and participating through intermediaries reduces the obtainable revenues
Service	Provide flexibility using large shiftable loads or energy storage devices and sell it to the FRPs
Value Proposition	Maximum revenue from a flexible asset
Unique Selling Point	The customer will receive the full value of its provided flexibility
Resources	Large and shiftable loads, LS-ESS, Market access
Revenue Model	Revenues from trading flexibility

Regulatory Fit and Economic Viability

All the Business Models specified above are relevant for the case of Mayotte.
The Business Model *Combined Aggregator-Supplier* can be applied by the MAESHA partner EDM and could be the initial case to be applied as no external actors are needed in this scheme. Indeed, EDM as the main island supplier could act as an aggregator and offer services to the DSO and TSO sections of the same company.
The partners CENTRICA and CYBER-GRID could potentially cover the roles of Independent Aggregators during the project, offering aggregation as a service specialised respectively for residential and industrial aggregation. Independent aggregation is principally allowed by French regulation.

Under the French regulatory system, the TSO is responsible for balancing supply and demand. To ensure equilibrium, TSOs make use of many different means, including primary, secondary and tertiary reserves, the access storage, and the interruption of supply. Prosumers and consumers contribute to the balancing of the grid by locally balancing and by financially compensating the BRP for the imbalances they cause in the system as part of the TURPE tariff component. Suppliers must contribute to system balancing by purchasing capacity guarantees.
All market players are principally allowed to provide frequency ancillary services, regardless of technology type or interconnection. Also, they are allowed to trade flexibility at free prices on a secondary market. For small producers, this secondary market is the only option to access flexibility, which has presented an important obstacle.

4.2.2. LEC

Along with the LEC, the figure of the Community Operator also needs to be introduced. According to the REDII[5] directives, the community shall be formally administered by an association of its members. However, the (technical) management can be subcontracted to a third party. This opens different scenarios and opportunities for various roles and services to be provided by and for the energy communities. If the community itself could provide the technical capabilities to perform as an operator, several additional revenues became available for its participants.
The community can provide energy consultancy to its members to optimise their consumption. Additionally, it can organise the joint purchase of energy assets (generation and storage) with a significant advantage in terms of acquisitive power. If the assets are shared, the community can act as the energy supplier and, not being profit-driven, can easily integrate programs for providing electricity access to energy-poor families. Indeed, it has been detected as the best possibility to carry out this task in a self-sustained way, also beyond the MAESHA project duration.
The community can also manage its flexibility and participate in the market through an aggregator. Market models where the community acts as the Aggregator (and also takes the role of BRP) exist, but those are generally better suited for larger communities (>100 members), which is difficult to obtain in small islands.

Table 9: Business Model – LEC as Independent Aggregator

Element	Description
ID	LEC-1
Service Provider	Local Energy Community
Customers	Aggregating flexibility from: Members, Community assets Selling flexibility to: Bigger Aggregator
Problem	Individual Active Customers do not have enough flexibility capacity to access the market and less negotiation power
Service	Bundle community's flexibility and sell it to a bigger aggregator
Value Proposition	Additional revenues for the community's members
Unique Selling Point	Selling flexibility as a community implies higher comfort and revenues than trading it individually
Resources	Aggregation Platform, Shared assets
Revenue Model	Revenues from trading flexibility

Table 10: Business Model – LEC as Energy Access Facilitator

Element	Description
ID	LEC-2
Service Provider	Local Energy Community
Customers	Citizens
Problem	Some customers cannot bear the burden of full cost ownership of solar kits
Service	The community can finance the purchase of the devices and ownership is transferred over time via a periodic payment plan
Value Proposition	New members are added to the community and more energy is generated locally
Unique Selling Point	A community with more members can self-balance more easily and customers can access to renewable energy
Resources	A consistent number of community members
Revenue Model	Fees on the loans, revenues from excess energy

Table 11: Business Model – LEC as an Energy Service Provider

Element	Description
ID	LEC-3
Service Provider	Local Energy Community
Customers	Citizens
Problem	Some citizens do not have (physical) access to the grid
Service	The community can provide renewable energy under the form of shared charging points
Value Proposition	Energy is made available at a fair price
Unique Selling Point	Provide a service for the citizens
Resources	A pay-per-use system
Revenue Model	Revenues from sold energy

Table 12: LEC as self-balancing entity

Element	Description
ID	LEC-4
Service Provider	LEC Operator
Customers	DSO
Problem	The RE generation can put further pressure on the grid operator if not balanced
Service	The community takes the responsibility for self-balancing, optimizing local grid usage
Value Proposition	Reduce grid expansion costs
Unique Selling Point	The community already owns the assets to perform this operation
Resources	Optimisation software, favourable regulatory framework, incentives for optimising grid usage
Revenue Model	Incentives

Table 13: Shared E-Mobility inter and intra communities

Element	Description
ID	LEC-5
Service Provider	LEC Operator
Customers	Community Members
Problem	No public transport available in Mayotte[4]
Service	Provide shared EVs and charging stations within different communities
Value Proposition	Provide a public service and add more assets to the communities to use for flexibility services
Unique Selling Point	No high acquisition costs for the users, long term revenues for the communities
Resources	EVs imports, shared vehicles management and optimisation software, charge optimisation software
Revenue Model	Pay-per-Use, revenues from flexibility services

In this case, different vehicles ownership models might be possible, e.g. the community self-owns EVs, or they are provided by a mobility provider (e.g. SAZILE, Mob'helios)

Regulatory Fit and Economic Viability

European and French law provide the legal and regulatory frameworks for LECs in Mayotte. However, local implementation is lagging, as some important rules have not been defined for the island. Building on European regulation (Directive (UE) 2019/944, June 5th 2019), the French law defines two types of energy communities: the *Communauté Energétique Renouvelable* (CER), defined in articles L291-1 and L291-2 of the energy code and the *Communauté Energétique Citoyenne* (CEC), outlined in articles L292-1, L292-2 and L292-3 of the energy code. Both legal concepts are still awaiting an implementing decree.

The main difference between the two energy communities is that CERs should have local and small-sized stakeholders and produce electricity exclusively from renewable sources, while CECs may also

[4] Ferries and taxis are the only means of public transport in Mayotte. See for example, https://www.mayotte.gouv.fr/Politiques-publiques/Culture-Tourisme-et-Patrimoine/Decouvrir-Mayotte/Vie-Pratique

include large companies, engage in aggregation activities and generate electricity from any source, not being limited to renewables. At the same time, CECs have higher responsibilities, including balancing responsibilities.

Both CECs and CERs are allowed to self-consume and to feed-in the surplus electricity to the grid. For generation capacities below 100 kWp, the DSO is obliged to purchase the feed-in. In mainland France, this threshold has been raised to 500 kWp under some conditions, but these regulations do not apply for the non-interconnected zones. To allow for collective self-consumption (Autoconsommation Collective, ACC), the energy community must enter a special ACC contract with the DSO. Collective self-consumption can take place in geographical proximity, with a maximum of 2 km distance between participants, and smart meters are needed for the measurement of the in- and outflows of each participating unit. Both CECs and CERs are granted non-discriminatory access to energy markets, either directly or by aggregation.

To be economically attractive, the total costs of self-consumption, i.e., generation costs, network usage fees and taxes, must be lower than the price for electricity from the grid. In Mayotte, this is not the case at the moment: the network fees (“TURPE”) are higher than the price of electricity from the grid, and Feed-in Tariffs (FiTs) are so high that injecting the produced electricity into the grid remains economically more attractive than self-consumption.

Regulatory barriers impede the implementation of self-consumption projects in Mayotte. At the moment, a regulatory framework for ACC contracts between energy communities and the DSO, Electricité de Mayotte (EDM) is lacking, especially regarding the fees for using the local network. Without such a framework, self-consumption activities by energy communities are not feasible.

LEC-1: LEC as Independent Aggregator

Aggregating flexibility and selling it to an aggregator presents a viable option for the market in Mayotte. For example, an energy community could take part in a demand response programme, thereby offering flexibility to the grid. However, the small sizes of residential users could complicate the development of an attractive revenue model. In principle, a CEC would be allowed to offer the aggregator services by itself.

LEC-2: LEC as Energy Access Facilitator

By buying assets and handing ownership of these assets to its members in time, the LEC basically acts as a financing entity for its members. This should not pose regulatory challenges and is in line with the common goal of LECs to deliver economic, social and environmental benefits for its members instead of pursing profit maximization for the organization itself. However, the change of ownership could present a difficulty regarding the contracts with ESCOs, DSOs and other external parties. In the worst case, these contracts would need renewal, and neutralize the benefit of shared negotiation power of an LEC. Organizing ownership within a cooperative or association can circumvent this problem. Members of the cooperative or association receive financial shares according to their investments, which can be sold to new members when individuals decide to leave the group.

LEC-3: LEC as a service provider

Providing energy access tackles an important issue of marginalized communities without access to electricity in Mayotte. In principle, energy communities are allowed to sell electricity. For ensuring alignment with the social purposes of LECs, the revenues from electricity sales should only cover the costs of supplying it, rather than aiming for profit maximization. If the infrastructure used for the provision of the service, e.g., connection lines and other technical equipment, is not owned by the LEC, the community needs to enter additional contracts specifying the terms of use.

LEC-4: LEC as self-balancing entity

In France, LECs under 3kW are exempted from the balancing responsibilities that larger projects must meet. CECs, on the other hand, are obliged to provide balancing services, either directly or indirectly. If the potential for self-balancing by small RECs presents an attractive service to other market actors, it could become the basis of a revenue model.

LEC-5: Shared e-mobility between the community

Both RECs and CECs are allowed to produce, consume, store and sell electricity. Combined with the provisions on self-consumption, this would allow LECs to provide charging points for electric vehicles (EVs) owned by community members. Extending the charging service to the public might be feasible as long as the legal purpose of the energy community, aiming at community benefit rather than profit maximization and economic activity, is guaranteed.

4.2.3. ESCo/FLESCo

As already specified in section 3.1, an ESCo can provide all kinds of auxiliary energy-related services to prosumers. The role of a Flexibility Service Company (FLESCo) is defined in the literature as a company that offers services behind the meter that are primarily focused on flexibility. Additionally, unlike an ESCo, a FLESCo does not always have to take a risk to achieve cost savings.
Within this document, the term ESCo will also include the FLESCo services in accordance with the more general definition from USEF.
In the proposed market model, the ESCo can provide energy optimisation and flexibility services to communities and individual prosumers, for example:

- Management of community's assets (generation and storage)
- Community Operation
- Community Flexibility Management (load shifting)
- Individual Prosumer Energy Optimisation and Flexibility Management (load shifting)

Also, the ESCO can act as grid scale storage systems operator and charging points operator.

Table 11: ESCo as LEC Operator

Element	Description
ID	ESCO-1
Service Provider	ESCo
Customers	LEC
Problem	The community need to manage its assets (maintenance, monitoring), technical support, administrative support
Service	The LEC operator actively takes care of the technical and administrative management of the community as well as assets optimisation.
Value Proposition	Reduced ROI, increased assets lifecycle, reduced unexpected maintenance
Unique Selling Point	Get the most of community assets
Resources	Optimisation software, ToU tariffs and/or Power Tariffs
Revenue Model	Fees

Table 12: ESCo as a charging point operator

Element	Description
ID	ESCO-2
Service Provider	ESCo
Customers	Municipality, Public transports companies, Private EV fleet owners
Problem	The charging points need to be managed (maintenance, monitoring) and the charging could be optimised.
Service	Management and optimisation of the charging points
Value Proposition	Reduced operational costs, possibly additional revenues from trading flexibility from EV batteries
Unique Selling Point	Most efficient use of the EV charging points
Resources	EV charging optimisation software, Flexibility Market, Fleet of EV, ToU tariffs and/or Power Tariffs
Revenue Model	Fees

Table 13: ESCo as a Building Operator

Element	Description
ID	ESCO-3
Service Provider	ESCo
Customers	Public and Private Buildings
Problem	Correctly managing a building can cut its energy consumption by several percentage points
Service	Management and optimisation of the building operation. Providing flexibility services (shifting loads to match ToU tariffs). Renewal advisory
Value Proposition	Reduced operational costs, possibly additional revenues from trading flexibility
Unique Selling Point	More efficient and sustainable buildings
Resources	BACS, Optimisation Software, ToU tariffs and/or Power Tariffs
Revenue Model	Fees

Table 14: ESCo as a grid scale Energy Storage System operator

Element	Description
ID	ESCO-4
Service Provider	ESCo
Customers	Aggregator, DSO
Problem	Large Scale Storage systems are needed for a correct functioning of the grid
Service	Install and operate large scale energy storage system to provide flexibility and stability services to the grid
Value Proposition	Pay per use energy and flexibility services
Unique Selling Point	Always available backup energy service
Resources	LS-ESS, Optimisation Algorithm, Flexibility Market
Revenue Model	Revenues from trading flexibility and stability services to the grid

Table 15: ESCo as a flexibility services operator for Active Customers/LECs

Element	Description
ID	ESCO-5
Service Provider	ESCo
Customers	Large Active Customer, LEC
Problem	Large Active Customers and LECs could trade their flexibility on the explicit flexibility market but do not have the expertise to do it
Service	Operate the loads of the customer according to the explicit flexibility requests
Value Proposition	Revenue from a flexible asset without expertise
Unique Selling Point	Highly specialised service provider
Resources	Flexibility Market, Flexibility Management Software
Revenue Model	Fees

Regulatory Fit and Economic Viability

ESCO-1: ESCo as LEC Operator

Delegating the management and optimization of community assets to an external service provider is in line with the French legal provisions for energy communities.

ESCO-2: ESCo as a charging point operator for public transportation

In French regulation, the provision of charging services is not considered electricity supply but rather defined as a service (Article 64 of Law on Orientation on Mobility (LOM)). A re-sale of electricity would be forbidden, but as charging point operators offer additional services, such as parking services, they are exempt from these provisions. The Energy Code defines an electrical charging point as a parking space for the charging or battery swap of one vehicle.

DSOs, however, are not allowed to participate in the e-charging market according to L.353-7 of the energy code. This restraint includes the ownership, development, management or operation of charging infrastructure. Exemptions may be granted by the regulatory authority, and DSOs are allowed to operate charging stations for their own use.

Public authorities can outsource the construction and operation of charging points to third parties. Within a public procurement contract, the public body pays the third party for its services, while remaining legally responsible. In a concession model, private companies are allowed to install and operate charging points at a profit, shifting the operating risks to the private sector. While the public actor might support these operations through subsidies or other measures, a risk-free operation by private actors is not foreseen.

For the case of Mayotte, (private) ESCos would principally be allowed to operate charging points. EDM, as the DSO, however, would not be allowed to participate in the market, unless an exemption was granted by the CRE. However, operating a charging station for its private use, i.e., for charging EDM's own EV fleet, would be allowed.

ESCO-3: ESCo as a Building Operator

Renovations and other investments for the energy efficiency of buildings typically require large investments. Attractive financing models and means of obtaining these funds thus become particularly important for the viability of such projects. Energy Performance Contracting (EPC), allows to finance such investments from the energy savings that can be obtained, splitting the risks and profits between the ESCo and the client. The City of Paris, for example, has used EPCs for financing the renovation of public buildings. Both public and private actors in Mayotte could copy this approach to facilitate energy-saving investments. Outsourcing the management of buildings, energy efficiency operations and similar activities, does not affect the status and eligibilities of the contracting entity. For example, social housing facilitators who offer their tenants the possibility of collective self-consumption, are still legally considered the managing party for this consumption even when the operational management is delegated to an external provider.

ESCO-4: ESCo as a grid-scale Energy Storage System operator

In Mayotte, two grid-scale batteries for energy storage are currently entering operation. The storages are managed and operated by private companies, who sell their services to EDM. After meeting the regulatory requirements for the installation of grid-scale storage set by the CRE, including the call for tenders, an operation of such energy storage systems thus presents a feasible business opportunity on the island.

ESCO-5: ESCo as a flexibility services operator for Active Customers/LECs

Any certified actor is allowed to offer flexibility in the French energy markets. The aggregation and offering of bundled flexibility by ESCos thus present a feasible option. The French regulatory provisions further allow for the aggregation of LEC services, and for the management of LEC activities by third parties. A bundling of flexibility services of LECs by an ESCo should thus be possible.

4.3. Conflicts and Challenges

From the M18 review meeting, some challenges emerged that could prevent the defined Business models from being implemented. The evolution of these issues will be tracked during the project.

- So far, the project has experienced difficulties recruiting staff and external contractors
- Independent producers have already existing long-term contracts
- Regulatory barriers (for example LECs within the French regulatory framework)
- Limited EVs in Mayotte, no importer for EVs
- PV acquisition and installation is too expensive for small communities (in relation to the average wage)
- Unclear structure for obtaining subsidies
- The limited availability of energy-related data has been an ongoing challenge
- The distinct regulatory provisions and exemptions for the non-interconnected zones, and their appliance in practice, present a challenge to external companies and other potential market actors

<u>Financing Opportunities</u>

Several support schemes are available in Mayotte, including subsidies and favourable financing. However, the support landscape appears scattered, with complicated bureaucratic processes and limited visibility of financing and support opportunities. For example, participating entities need to contract external consultants, usually from outside of Mayotte, to become eligible for subsidies for the installation of solar PV.

Important donor organisations include the French environmental and energy agency ADEME (Agence de l'environnement et de la maîtrise de l'énergie) and French development agency AFD (Agence Française de Développement). ADEME, among other activities, provides technical support and finances feasibility studies. AFD facilitates low-cost loans for green projects, with a strong focus on public actors. Publicly available subsidies include programmes by the French energy regulatory commission CRE (Commission de Régulation de l'énergie). As part of its funds for energy savings programmes, CRE supports the purchase of energy-efficient air conditioners (ACs) in Mayotte. EDM facilitates the programme.

5. BUSINESS MODEL CANVAS ANALYSIS

In this chapter, a first qualitative validation of the proposed BMs is performed. This is achieved in close collaboration with all the market participants (DSOs, aggregators, retailers) and technology developers within the MAESHA consortium.

For this analysis, a Lean Business Model Canvas[8] methodology is applied. It provides a framework that helps to structure business ideas and to evaluate their marketability while still being flexible for adaptations and the integration of new elements.

The Lean Canvas is a business model visualization tool that combines elements of the Business Model Canvas, on the one hand, and the Lean Start-up method, on the other. The *lean* version of the classical Business Model Canvas designed by Osterwalder[9] has been preferred as better suited for the uncertain environment of a start-up as many of the analysis blocks of the BMs simply do not yet exist in the start-up phase of a company. It is composed of the following elements:

1. **Problem**: List of the highest priority problems of the customer segments
2. **Customer Segments**: The problem and Customer Segments are interrelated and should be defined in detail.
3. **Unique Value Proposition**: A value proposition represents what the company is offering on the market and why the customers should prefer it
4. **Solution**: How the company is going to solve the customers' problems
5. **Channels**: Channels are the ways to reach the customers.
6. **Revenue Streams:** How the company is going to produce incomes
7. **Cost Structure**: List of all the operational costs for taking the business to market.
8. **Key Metrics:** Important metrics that can be used to monitor performance.
9. **Unfair Advantage**: Circumstances that put the company in a prominent position for the business. Unfair advantage can be insider information, getting expert endorsements, existing customers etc.

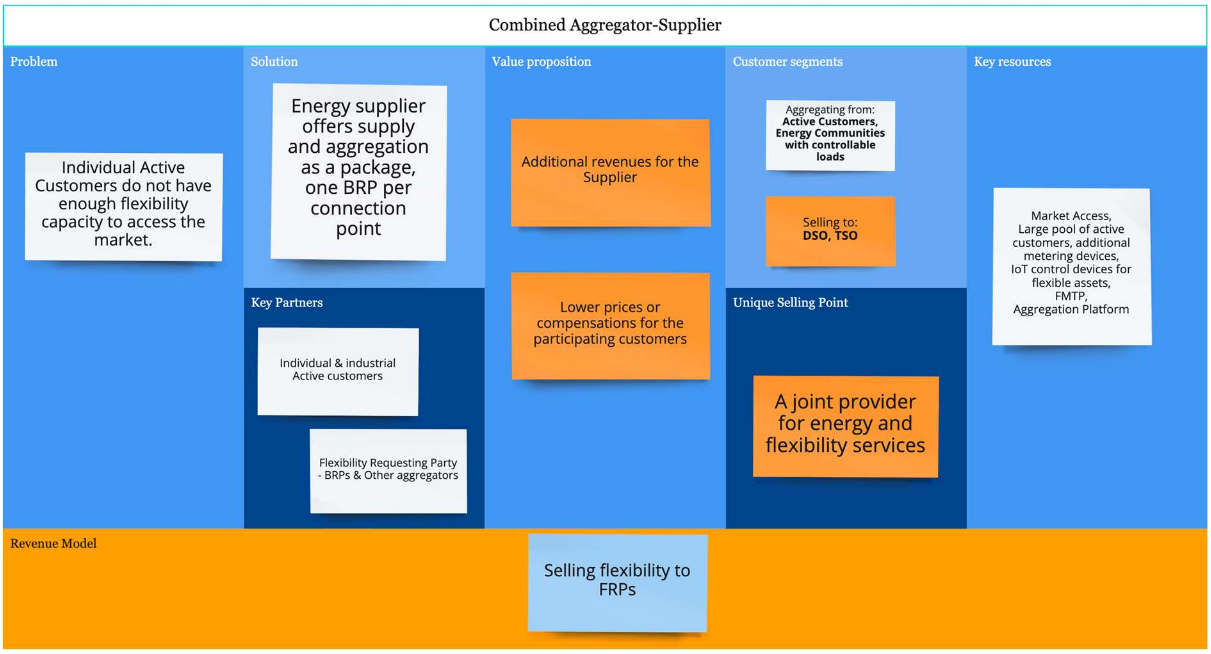

Figure 15: Combined Aggregator-Supplier BM

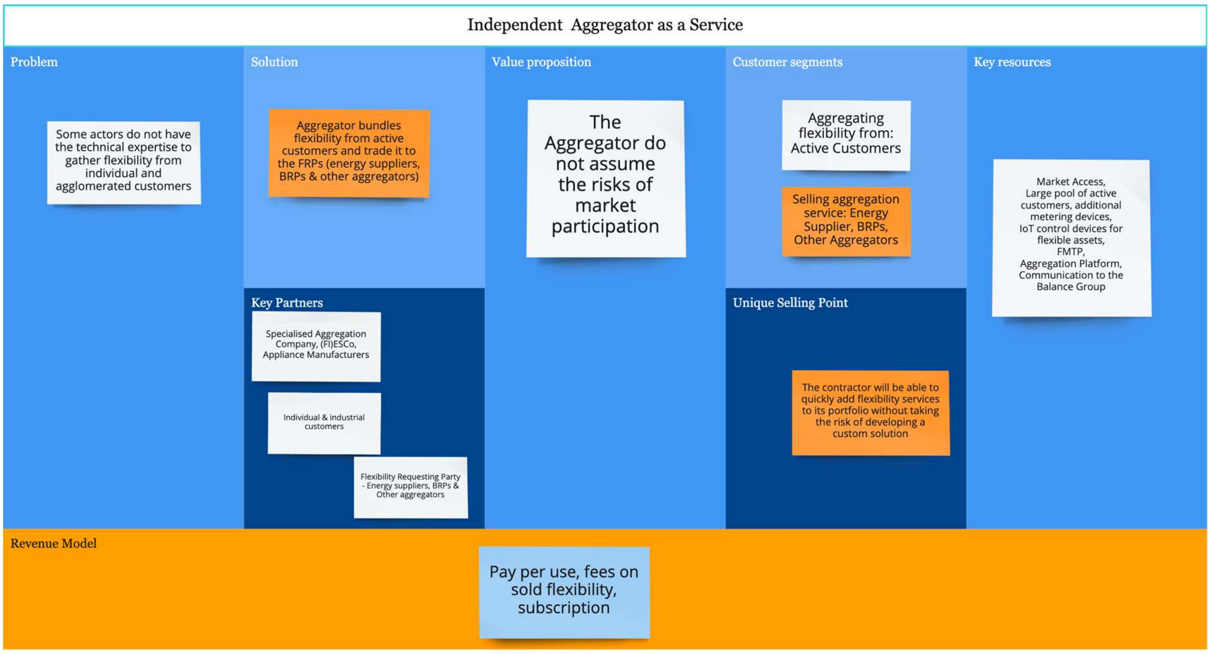

Figure 16: Independent Aggregator as a Service BM

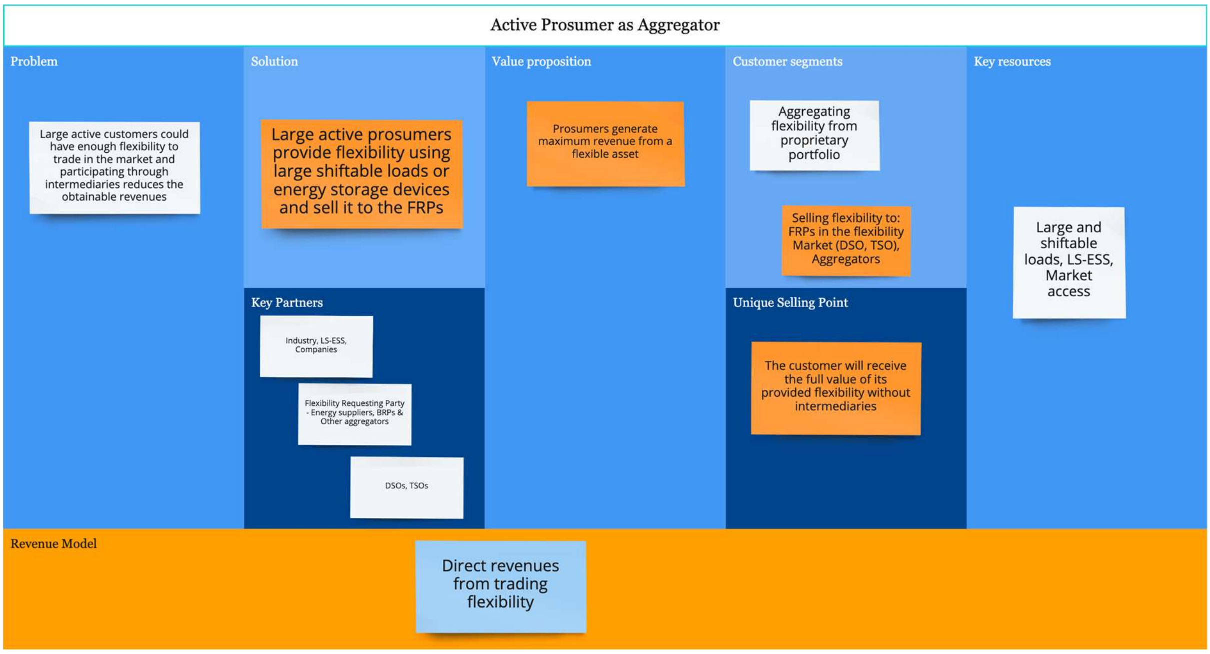

Figure 17: Active Prosumer as an Aggregator BM

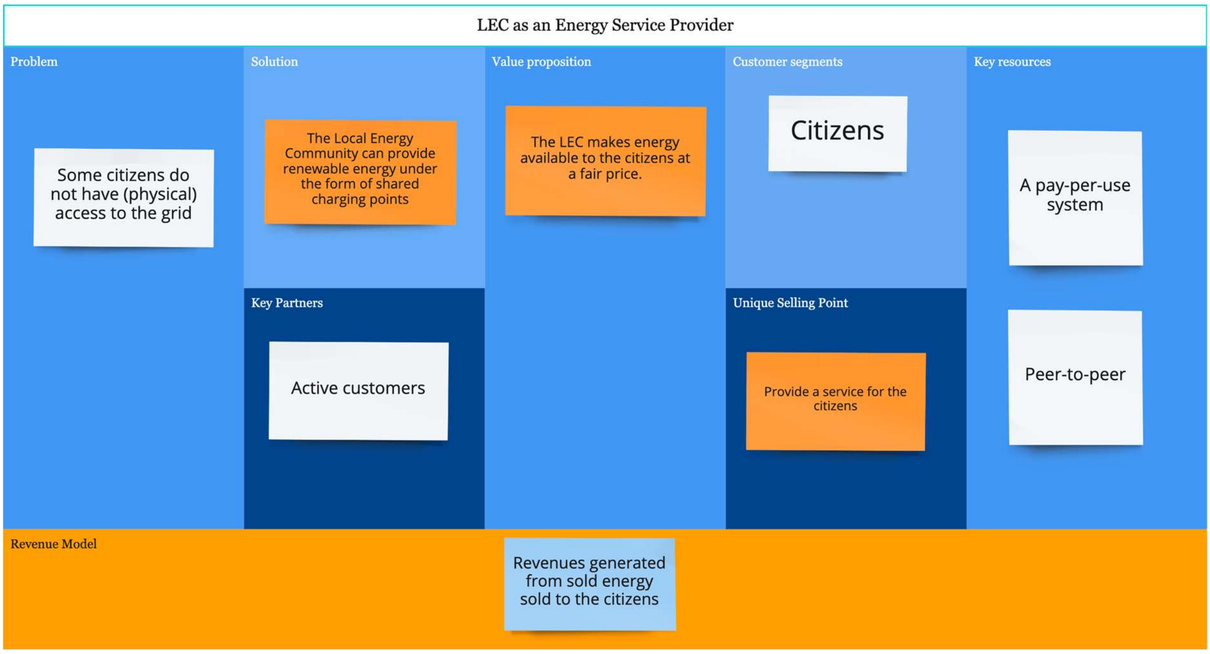

Figure 18: LEC as an Energy Service Provider BM

Figure 19: LEC as Self-balancing Entity BM

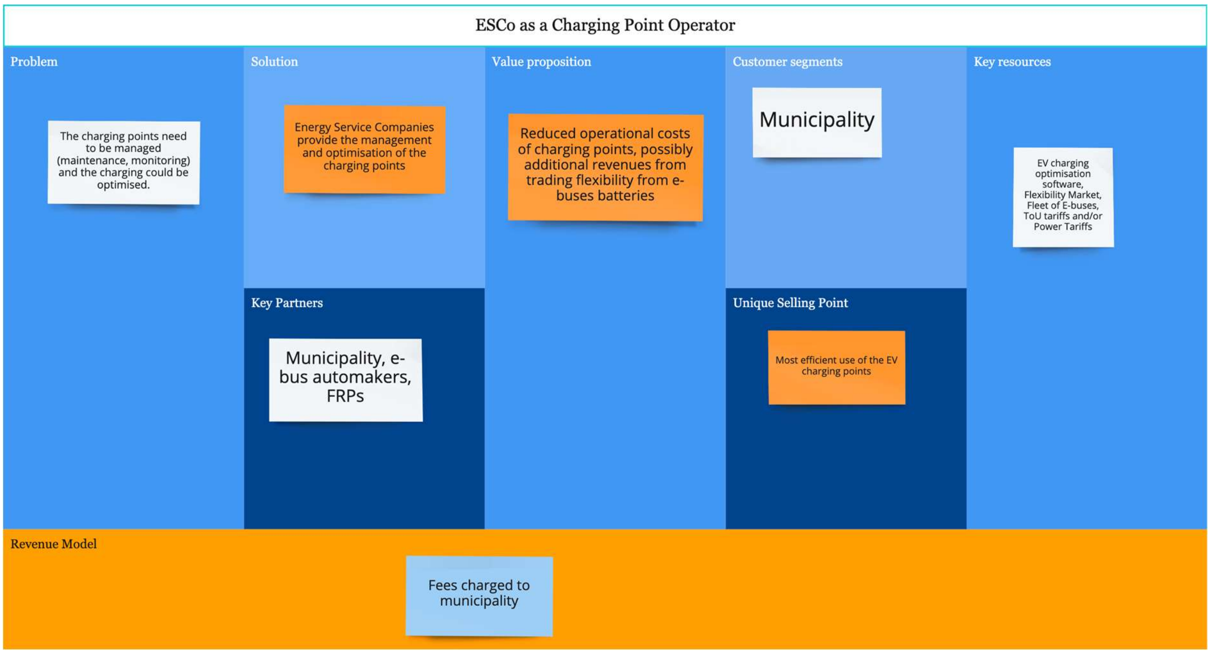

Figure 20: ESCo as a Charging Point Operator BM

Figure 21: ESCo as a Grid Scale ESS Operator BM

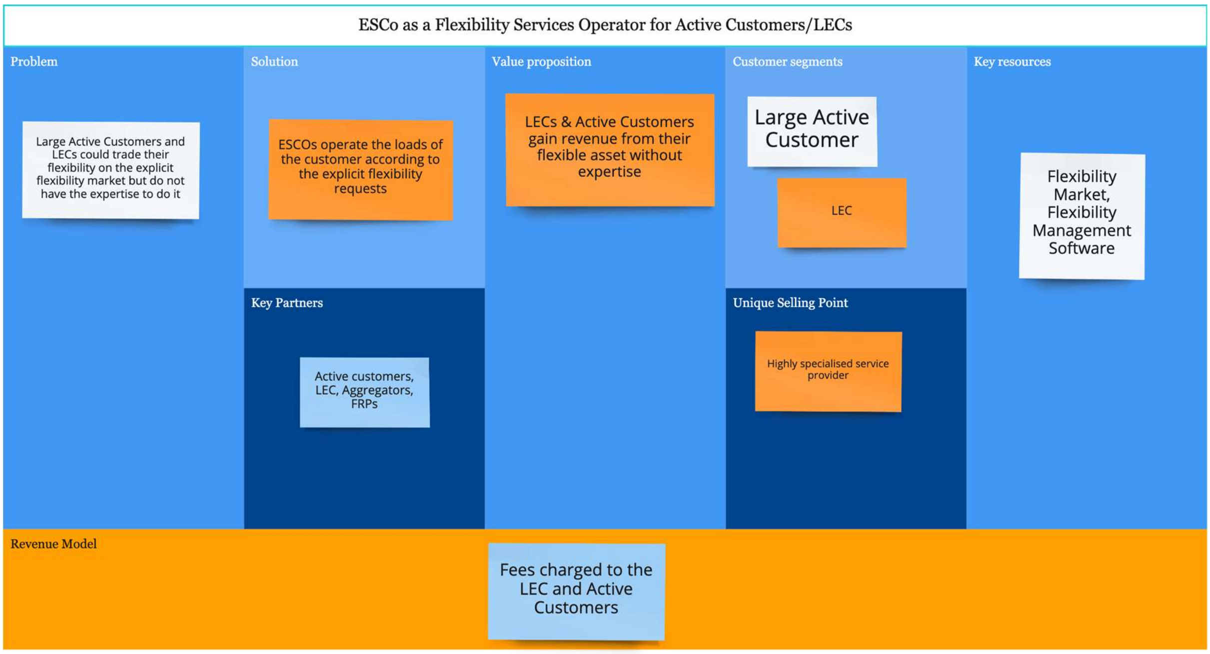

Figure 22: ESCo as a Flexibility Services Operator for Active Customers/LECs BM

6. Conclusions

An iterative and lean business modelling approach was used to construct the MAESHA business models. A number of workable business models have been developed, starting with the initial business cases, taking into account relevant literature and the perspectives of market participants.

Most of the BMs have been built upon the availability of the Flexibility Market Trading Platform to be deployed during the project and the introduction of three new market roles (Aggregator, LEC and ESCo) currently not present on the island. The accomplishments of MAESHA work towards providing both conditions for this energy market ampliation. Also, for some BMs to become a reality, some conditions external to the project have to be made available, as the introduction of ToU tariffs and changes in the current regulatory framework (e.g., incentives for self-consumption).

The first group of BMs focuses on the role of the aggregator. Four aggregator BMs have been proposed and their compatibility with the different possible implementation models has been specified. Additionally, an example of how some consortium partners could potentially take on this role has been provided.

The second group of BMs comprise the LECs business models. These are oriented to providing major savings to their members but also to offer energy access services to the citizens with no access to the grid. The latter has been established as one of the use cases for Mayotte.

The third group is made up of ESCo business models, which can offer either pure FLESCo services (shifting loads to maximize the advantage from a ToU pricing scheme) or flexibility-enhanced ESCo services (as an energy efficiency contracting service provider).

Finally, all the BMs have been contrasted against the current legislation to ensure that all of them are applicable and feasible to the MAESHA case. For some of the proposed BMs, an application seems not feasible in Mayotte at the time, due to (a lack of) regulations and incentives. Areas in which more favourable regulation would be needed include:

- Economic incentives for self-consumption that can compete with local energy prices and FiTs
- Introduction of a regulatory framework for energy sharing and self-consumption by LECs

The trading of power among community members is a BM that has not been implemented because of regulatory restrictions. In this BM, they may eventually benefit from lower grid pricing for the locally traded energy and would not be required to have a supply contract with the same source. In fact, most European member states cannot now implement P2P energy community programs because the legislation on the subject is still in its infancy.

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