DOMINOES – DELIVERABLE

D5.1 Formulation of alternative local market place enabled business models

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0.4	29.05.2018	BM ISEP: HVAC aggregator for market participation (finally removed)
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Authors

Ana Guimarães, VPS
Fernando Lezama, ISEP
Gisela Mendes, CNET
Gonçalo Faria, EDP D
Gonçalo Mendes, LUT
Jorge Landeck, VPS
Luis Gomes, ISEP
Olli Kilkki, Empower
Pedro Faria, ISEP
Ricardo Faia, ISEP
Salla Annala, LUT
Samuli Honkapuro, LUT
Zita Vale, ISEP

Executive Summary

D5.1 provides a definition of alternative DSO business models, including a specification of the frameworks formulating relationship environment between the local market and its stakeholders, and related strategic use of contracts. D5.1 presents six alternative business models for local markets. Topics addressed by the defined business models include: a) definition of processes and stakeholders in transactive energy exchanges; b) definition of the necessary transactions and the corresponding and required information models; c) definition of contracts; d) strategic use of contracts for third party resources. The deliverable is part of task 5.1.

List of Acronyms

ADS	Active demand and supply
BM	Business Models
BRP	Balance Responsible Party
CM	Community Manager
DER	Distributed Energy Resources
DR	Demand Response
DSO	Distribution System Operator
ESCO	Energy Service Company
ESCP	Energy Service Community Provider
ESS	Energy Storage System
EV	Electric Vehicle
ICT	Information and Communication Technologies
IEEE	Institute of Electric and Electronic Engineering
MAS	Multi-Agent System
PV	Photovoltaic
SG	Smart grid
SO	System Operator
TE	Transactive Energy
TSO	Transmission System Operator
UC	Use Case
USEF	Universal Smart Energy Framework
VPP	Virtual Power Plant

1 Introduction

Business models (BM) play a key role to accomplish the energy transition envisaged in the smart grid (SG) paradigm. However, due to the complex environment that current power systems possess (with new stakeholders included in the mix as well as distributed resources with uncertainty) innovation in business models must be done in parallel with policy and system regulation, which make this process a complex task to fulfil [1].

The new alternatives of BM explored by DOMINOES will pursue an efficient use of distributed energy resources (DERs) in the so-called local energy communities. This new local environment will also require a proper definition of processes and participants to allow transactive energy exchanges addressing local constraints. Demand Response (DR), which is of paramount importance in the local energy context, will also be considered for the definition of transaction schemes in the available electricity markets. Moreover, beyond the definition of a local market context, the transactive relations between aggregators, as well as the connection of local markets to the wholesale market are addressed in the project vision.

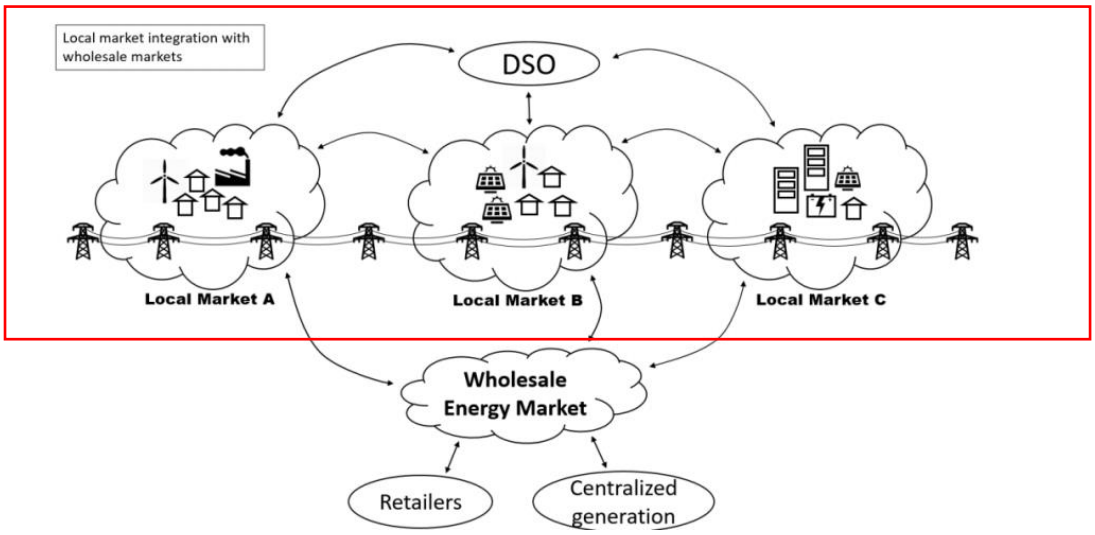

Figure 1: Local market overall concept and interactions. Special focus is posed in DSO and local communities.

BMs have a significant influence in shaping the electrical system. However, research in the area of energy retail/supply market is often limited to three main categories [2]:

1. Drivers for consumer switching [3], [4]
2. Barriers to market entry [5]
3. Effect of market competition on final prices [6]

The transformation of the grid, into the so-called SG, and the high penetration of distributed resources (with renewable generation in the distribution level of the grid) is posing a new degree of complexity in BMs preposition and design. Despite the challenging scenario in BMs innovation in the energy sector, it is well understood the importance of defining as clear as possible the “value proposition“ and “value capture“. These simple statements, yet fundamental in BM innovation, are somehow complex values to be defined in the current scenario since they must effectively capture several value streams across different parties, multiple spaces and times, and various systems [7].

D5.1 aims at defining BMs oriented to electricity systems, with special focus on the efficient use of distributed energy resources in local energy communities. Six BMs have been defined encompassing different stakeholders and addressing local constraints (as identified in WP1 and WP2 of this project. A 3-level framework is employed to define the main characteristics of each BM, i.e., provider, customer, and value proposition. Developing BMs in the multi-system scenario considered in DOMINOES requires an extensive knowledge and understanding of the customer needs, the voids not covered by the competition, and the technological and organizational structures available for the implementation of new solutions. Moreover, BMs are not only limited to their design but also to the adjustment and learning process depending on the evolution of related factors.

2 Processes and stakeholders in transactive energy exchanges to address local constraints

BMs and market structures are of paramount importance to incorporate local energy trading as envisaged in DOMINOES project. BM targeting the supply of energy on small local scales have the potential of expanding the penetration of renewables, accelerate demand management, improve energy efficiency and give value to the small customer resources [2].

However, the success of a BMs relies on determining the stakeholders involved in the negotiations, how a benefit will be delivered from a service/energy provider to customers, and how it will be captured the value of such delivered benefit [8], [9].

In this deliverable, alternative DSO business models will be proposed onto the local market reference architecture defined in D1.1 “Local market reference architecture and business requirements“ of DOMINOES. In DOMINOES project, the main stakeholders are:

- DSOs,
- prosumers/consumers,
- aggregators / VPPs,
- retailers,
- energy service providers,
- wholesale markets,
- energy provider (centralized and decentralized generation),
- TSOs,
- SOs,
- other service providers (analytics, etc.),
- technology providers,
- regulators, policy makers,
- and standardization organizations.

It was stated in D1.1. that the local market concept consists of market services, control services and customer applications provided by different stakeholders within the context. **Figure 2:** shows the interaction between a local market, DSO and wholesale markets as well as with its counterparts.

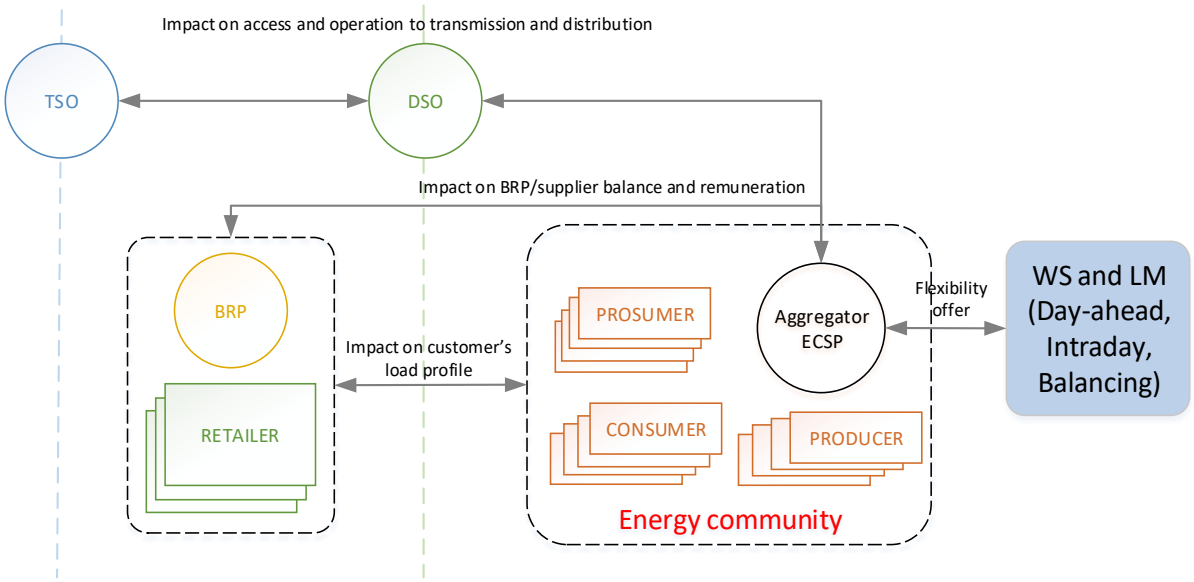

Figure 2: Stakeholders and impact of the aggregator assuming a central role.

The local markets will provide customers with the ability to share flexibility between each other as well as with the DSOs in the local context and the wholesale markets in the broader context. The DSO, the aggregator, retailer or an energy service provider should be able to act as an energy community service provider for providing the local market service. Prosumers and consumers can participate in the energy community as energy community participants enabling them to

- receive and share energy with other energy community participants
- participate in demand response services
- enable the participants to decide on the distribution of the value of their energy re-sources

Two main ways for unlocking the value of flexibility through participation in the local markets are envisaged in DOMINOES project, namely by trading flexibility to support grid operations (i.e., business models directed to DSO) or market operations (i.e., business models directed to other stakeholders).

In this deliverable, we will focus primarily on BMs directed to DSO in the proposed local market architecture. To that end, we use as a base the identified USEF flexibility services for DSO (see **Figure 3:**). It is worth mentioning that services directed to other stakeholders, namely retailers and energy service providers, are also considered.

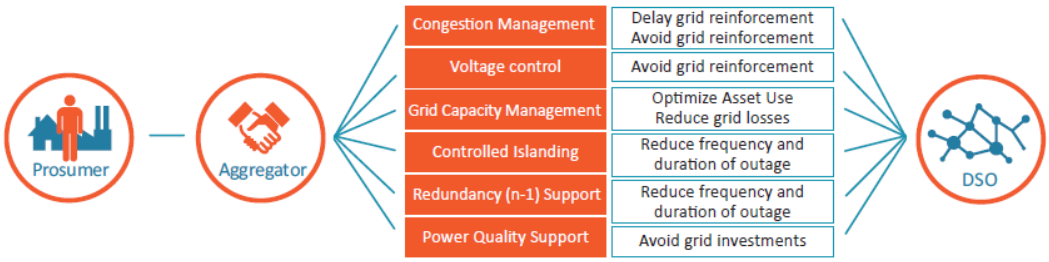

Figure 3: Flexibility services for the Distribution System Operator [10]**.**

We provide a brief description of the flexibility services directed to the DSO described in USEF:

Congestion management: This service refers to reduce peak loads in order to avoid thermal overload of system components. Different from a grid reinforcement project, the thermal overload of the system may cause a failure in the short-term horizon so that congestion management requires a swift response from the DSO. Therefore, demand response and flexibility services may find value for the DSO to defer (or in some cases even avoid) grid investments.

Grid capacity management: This service aims to use demand response and flexibility primarily to optimize operational performance. By using flexibility for grid capacity management, the DSO can benefit dispatch of resources by reducing peak loads, extending component lifetimes, distributing loads evenly, and so forth. In addition, reduction of grid losses may be also obtained.

Voltage problems: The DSO may face voltage problems when solar PV systems generate significant amounts of electricity. As a result, the voltage level in the grid will be "pushed up". Therefore, a service to use load flexibility, by increasing the load or decreasing generation, is an option to avoid exceeding the voltage limits. This service also can be used to reduce the need for grid investments (such as automatic tap changers) or prevent generation curtailment.

Controlled islanding aims to prevent supply interruption in a given grid section when a fault occurs in a part of the grid feeding into it.

Redundancy (n-1) support refers to actions that help reduce the frequency and duration of outages. For instance, supplying emergency power (or shedding loads) in the event of a severe power shortage, or supplying backup power during grid maintenance activities.

Power quality support. Power quality issues are rapid phenomena that occur in the sub-minute to millisecond range (e.g., harmonics, flicker, dips). For this service, fast devices and local control loops are required. Therefore, some equipment on prosumer premises (especially inverter-based equipment) might be technically capable of improving the grid's local power quality. As an example of this service, an Aggregator might provide the equipment to the prosumers and the service to the DSO. USEF has stated that a market-based approach is not very likely to provide a service to solve power

quality issues and is not include in their scope. In addition, the roles of the TSO, wholesale market parties, centralized generation, other service providers, technology providers as well as other parties such as regulators and standardization organizations are considered.

2.1 Transactive energy as an enabler for local transactions

Transactive energy (TE) enables the direct transaction between consumers, prosumers and producers. The GridWise Architecture Council defines transactive energy as “a system of economic and control mechanisms that allows the dynamic balance of supply and demand across the entire electrical infrastructure using value as a key operational parameter” [11], and it can be seen as the “democratisation of electricity” or the “eBay of electricity” [12].

TE uses a bidding methodology, between sellers and buyers, for energy transactions. However, it differs from the retail market because it can be used between end-customers in a distributed and local manner, in a near real-time timeframe. For instance, TE can be used for decentralized local markets allowing peer-to-peer customers energy transactions [13]. The end-customers can also use TE to buy renewable and clean energy, avoiding polluting sources. The TE uses auctions to determine the transactions that will be executed. The auction type is not specified and is open, therefore, it is up to the TE scheme to choose the proper auction type.

In [14], TE is used to fill the gap between the forecast and the actual consumption/generation, where each end-customer should pursue the forecast value using TE within its neighbours. This provides a goal for end-customers and gives more stability to the grid operator – because the forecast will be closer to the actual consumption/generation, avoid unpleasant surprises.

Proper methodologies for response, negotiation and execution are needed in a TE framework to enable efficient customers’ participation and local energy trading. The user must specify general parameters, such as the maximum price of buying and minimum price of selling. But because TE is a 24/7 process that deals with a huge amount of data to achieve the transactions between customers, an automated methodology should exist. And looking at this problem, an artificial intelligence concept that can be applied is Multi-Agent Systems (MAS). They are able to provide the desired independence between customers, the communication capability and the desire execution of contracts. This approach was successfully used in [13], where a MAS was used to represent the end-customers in a local market driven by TE.

At this moment, TE is a new concept in power systems, and for that reason, there is no standard of communications, unlike DR programs with openADR standard. Therefore, each implementation of TE must specify its own protocol and information that passes between end-consumers. IEEE project P825 is working on a standard for transactive energy application, design, deployment and operation for interconnections behind the meters between the grid and energy resources [15]. However, the result of P825 do not specify the communications necessary for TE applications.

To provide a truly distributed local market, TE can be combined with blockchain for a distributed database between end-customers. This enables the removable of a centralized management entity to regulate the local market transactions, while improving the security and fault prevention.

2.2 Business models' scope

In a local market framework, a wide variety of BMs can be defined depending on perspectives, relationships, expected goals, stakeholders involved, and many other factors. In an effort to encompass the objectives foreseen in DOMINOES project, six BMs have been developed in this deliverable:

1. Aggregation of small-scale flexible loads as a universal virtual power plant
2. Aggregator flexibility provision to DSO for network management
3. Using transactive energy for network congestion management
4. Sharing the exceeding PV generation in the scope of energy communities
5. Retailer as user of the local market
6. Energy service provider in enabling / assistive role for local markets and providing ECSP capability for retailers, communities or other service providers

Table 1 summarizes the main characteristics of the defined BMs, namely provider, services and target customers.

Table 1: Potential stakeholder roles within local market

ID	*Provider*	*Service*	*Client*
1	Flexibility service provider (aggregator/ community manager)	Aggregated flexibility as a service. The flexibility service provider will provide the aggregated flexibility as a solution to grid operators and balance responsible parties.	DSO/BRP/TSO
2	Aggregator	Aggregators offer a new flexibility service to help the DSO solving congestion problems.	DSO

3	DSO	A transactive platform where end-users can make local energy transactions. End-customers receive signals from the DSO to promote local energy transactions. DSO provides incentives to end-users when local transactions contribute to the reduction of penalties caused by congestion situations.	Energy customers
4	Community Manager	The Community Manager (CM) acts as an aggregator. Optimal scheduling and sharing of PV generation among the community are provided aiming at the reduction of bills and green self-consumption.	end-users (i.e., public buildings equipped with PV generation and community members)
5	Local market operator (Flexibility comes from actors in the local market).	Use of the local market flexibility to be valued in the wholesale market or to optimize the retailers' portfolio	Retailer
6	Energy service provider (role can be taken by multiple parties)	ICT infrastructure to manage local market that can be used a. For energy community benefits in and energy community service provider (ECSP) role b. As an ICT tool by other stakeholders for multiple purposes In addition, the service provider may provide communities with assistance in choosing/sizing generation/storage/control systems in cooperation with technology providers.	Energy communities

In DOMINOES project, the goals and objectives concerning the definition of BMs have a strong relationship with use cases (UC) defined in D1.3 (part of T1.2 "Use cases and application scenarios"). Five use cases are defined in this project, namely:

1. UC1: Local market flexibility and energy asset management for grid value
2. UC2: Local Market Data Hub Manager and technical validation and flexibility tool
3. UC3: Local community market with flexibility and energy asset management for energy community value
4. UC4: Local community flexibility and energy asset management for retailer value
5. UC5: Local community flexibility and energy asset management for wholesale and energy system market value

As can be seen, the use cases are defined considering several aspects of the local market environment. Use cases and BMs cross-information.**Error! Reference source not found.** presents the cross-relation between these two critical aspects (i.e., BMs and UCs) of the project.

It is important to point out that UC and BM relations were previously defined in Table 12 of D1.3 of this project (Appendix A). However, Table 2 from D5.1 slightly differs from Table 12 from D1.3, since BMs were updated according to an in-deep analysis and study product of this deliverable. The modifications that reflect these differences concerning Table 12 are as follows:

- **BM1:** This BM is based on the use of flexibility for different services. Therefore, the technical validation is of utmost importance to run this BM. Besides, flexibility can be activated to solve congestion management issues, so the relation of BM1 with UC2 is evident. Also, the scope of this BMs was delimited to flexibility services directed to TSO/DSO/BRP, so the retailers' participation and the connection with the wholesale market were removed;
- **BM2:** It was devised the importance of technical validation from DSO to run this BM properly;
- **BM3:** An agreement was settled about the retailer participation in this BM. In fact, this BM is focused on a transactive platform where end-users can make local energy trans-actions, so retailer participation is not considered;
- **BM4:** No modifications.

Notice that BM5 and BM6 were switched of position in the D5.1 regarding D1.3. This switch was just a matter of style. In this way, BM5 in Table 2 corresponds to BM6 in Table 12, whereas BM6 in Table 2 corresponds to BM5 in Table 12. Taking this BMs switch into account:

- **BM5:** No modifications.
- **BM6:** It was devised that the services that the ECSP provides in this BM are also directed to the retailer.

This section has provided a general scope of the developed BMs in DOMINOES, as well as their relation with UCs. The stakeholders, value of preposition, and main customers have been selected to cover the goals of T5.1 of DOMINOES project. Moreover, the cross-refence of Table 2 **Error! Reference source not found.** shows that UC are entirely covered by the BMs definition, adding value to the development of the project. In the next section, an in-deep definition of the six BMs is provided using a 3-level BM framework.

Table 2: Use cases and BMs cross-information.

	BM1 *Aggregation of small-scale flexible loads as a universal VPP*	*BM2* *Aggregator flexibility provision to DSO for network management*	*BM3* *Using TE for network congestion management*	*BM4* *Sharing PV generation in the scope of EC*	*BM5* *Retailer as user of the local market*	*BM6* *ECSP in LM for retailers, communities or other service providers*
UC 1 *Grid value*	X	X	X			
UC 2 *Technical validation*	X	X				X
UC 3 *Energy community value*	X		X	X		X
UC 4 *Retailer value*					X	X
UC 5 *Wholesale and energy system market value*			X		X	X

3 Business Models

A BM can describe in different ways the benefit an enterprise will deliver to customers or clients, how this will be done, and how it will capture a portion of the value it delivers [2].

To this end, we adopted a frame with three design levels which include the 1) *Strategic Level* that relates to the governance and actors features of the business model, the 2) *Customer and Market Level* that relates to the business content and focus, and the 3) *Value Chain Level* that relates to the delivery and financing structure.

The strategic level would cover four partial models: *The provider model- who?* - which specify who is giving the service - *the strategy model - why*? - which includes the reasoning of the strategic positions and development paths as well as business value proposition; *the resources model - who and what internally?* - which includes the competences, capacity and assets; and *the network model - who externally?* - which includes definition of BMs networks and partners.

The customer and market level would cover also three partial models: *the customer model - to whom?* - including the customer relationships and target groups and the channel configuration; *the market offer model - what?* - including the analysis of competitors, definition of market structure and offering of the value proposition; and *the revenue model - how they pay?* - which include the revenue streams and revenue differentiation.

The value chain level would also cover three partial models: *the delivery model - how we deliver?* - which includes operations model, manufacturing model and value generation; *the procurement model – how is being delivered to us?* - which include resource acquisition, and information; and *the financial model – how we pay for it?* - which includes finally the financial model, capital model and cost structure model.

Table 3 presents the 3-level frame of BM adopted in DOMINOES project. The six BMs are then defined in terms of this template. The reason behind the use of such template is to ease the understanding of the description of BMs. Having as a common frame this template, the details of each BMs can be easily envisaged.

Table 3: Template 3-level business model

First Level: Strategic Level	
the provider model- who?	Who gives the service

the strategy model - why?	which includes the reasoning of the strategic positions and development paths as well as business value proposition
the resources model - who and what internally?	which includes the competences, capacity and assets
the network model - who externally?	which includes definition of business models networks and partners

Second Level: Customer and Market Level

the customer model - to whom?	including the customer relationships and target groups and the channel configuration
the market offer model - what?	including the analysis of competitors, definition of market structure and offering of the value proposition
the revenue model - how they pay?	which include the revenue streams and revenue differentiation

Third Level: value chain level

the delivery model - how we deliver?	which includes operations model, manufacturing model and value generation
the procurement model – how is being delivered to us?	which include resource acquisition, and information
the financial model – how we pay for it?	which includes finally the financial model, capital model and cost structure model

In the following subsections, the six developed BMs are defined according the template from Table 3.

3.1 Aggregation of small-scale flexible loads as a universal virtual power plant

BM 1 defines an aggregated flexibility service provided by a Flexibility Service Provider (i.e., Aggregator or Energy Community Manager) to DSOs, Balancing Responsible Parties (BRPs), and TSOs. Figure 5 shows the stakeholders involved in this BM, and the 3-level BM framework is presented in Table 4.

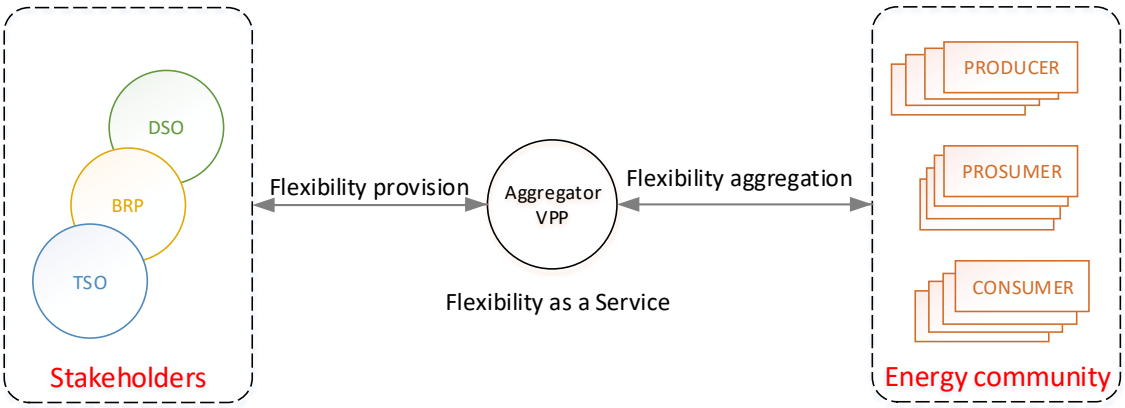

Figure 4 Stakeholders and relations in BM 1.

Table 4: Complete framework BM 1

First Level: Strategic Level	
The provider - who?	Flexibility service provider (aggregator/ community manager)
the strategy model - why?	The Energy Transition requires maximization of renewable power use by means of demand side flexibility – however so far this hasn't been done or proved viable in the case of the aggregation of multiple small-scale flexible loads. In this sense, the strategy model is based on the creation of a central coordination agent (i.e., the flexibility service provider) who will manage the flexibility resource pool from multiple prosumers, producers, consumers and active demand and supply (ADSs)[2] in a collective manner, in order to reach a minimum threshold of aggregated flexibility to be sold to DSOs/BRPs/TSOs.

[2] According to USEF [10], on a system balance level the reduction of the load is identical to the increase of the generation. Only the sign is relevant. Hence, ADS joint these two groups of applications.

the resources model - who and what internally?	Small loads and prosumers/consumers to whom the VPP have contractual relations for the acquisition of flexibility, represent the primary source of flexibility. Also, the flexibility service provider (aggregator/ community manager) will need: [physical resources] remote-metering and remote-control infrastructure to manage flexibility from small loads (from home appliances, buildings' HVAC, water heating systems, EVs, small batteries, among others), small production units, data management and communications IT infrastructure; [human capital resources] strong HR skills for big data management, energy management, IT, telecommunications and remote control; [organizational resources] operations management system to ensure coordination of flexibility actions and balancing requests, as well as processes to manage field maintenance. In addition, the flexibility service provider should validate the demand curve (i.e., the aggregated demand of end-customers) and potential flexibility of end-users by using mathematical models and consumption/production forecast.
the network model - who externally?	The flexibility provider will need to externalize some non-core activities such as field installations and maintenance. In addition, the flexibility provider must be able to participate in the electricity market, following the current regulation and market registration. Furthermore, the flexibility provider must curate the relationship with its portfolio of prosumers/consumers/ADSs, tendering personalized smart contracts with them in accordance with the specificities of their flexibility provision capabilities.

Second Level: Customer and Market Level

the customer model - to whom?	The flexibility service provider will sell the aggregated flexibility to DSO/BRP/TSO and share economic benefits with community members.
the market offer model - what?	Aggregated flexibility as a service. If consumers are flexible about whether and when to use energy, they could reduce grid stress and their own energy bills. The flexibility service provider will offer the aggregated flexibility as a solution for the provision of balancing services to grid operators and balance responsible parties. The community aggregator can sell the flexibility to be used for: reducing grid

	congestion; avoiding expensive grid upgrades; limiting any penalties for failing to balance supply and demand; and avoiding buying energy when prices are high.
the revenue model - how they pay?	The flexibility provider will be payed according to flexibility provided to its clients (DSO/BRP/TSO). Besides, the flexibility service provider can charge a fee to the community members for optimization of time-of-use, reducing cost of energy and optimizing the use of renewables production.

Third Level: value chain level

the delivery model - how we deliver?	Install remote metering and control systems for small load management within the resource portfolio (i.e., producers, prosumers, consumers and/ or ADSs) in accordance with the personalized smart contracts defined a priori. Delivery of flexibility services to the client portfolio in accordance with the personalized smart contracts defined a priori. Monitor and communicate regularly the value generated from flexibility management in each member site. Rectify promptly any system malfunction detected to main consumers (i.e., DSO/BRP/TSO).
the procurement model – how is being delivered to us?	Remote metering and control systems will be procured complying with grid balancing requirements and cost requirements.
the financial model – how we pay for it?	Engage with investors to support installation and ICT costs or engage with long term personalized contracts with community members – in this model, community members are able to increase their profits through the increase in their flexibility provision, which in turn reflects in increased aggregated flexibility services provided.

3.2 Aggregator flexibility provision to DSO for network management

BM 2 defines a service provided by an aggregator/ECSP directed to the DSO to solve congestion management. Figure 5 shows the stakeholders involved in this BMs, and the 3-level BM framework is presented in Table 5.

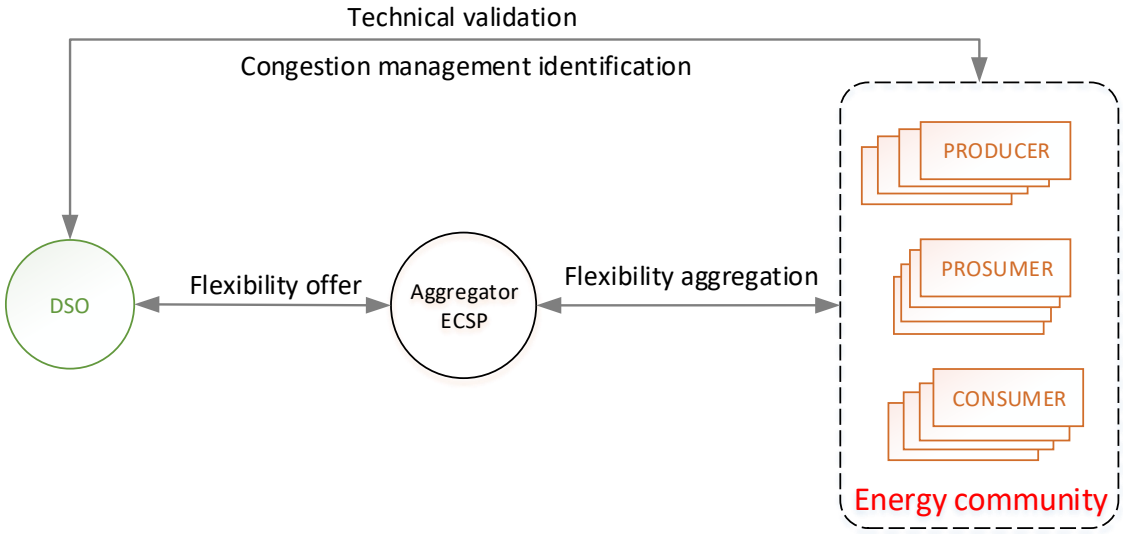

Figure 5 Stakeholders and relations in BM 2.

Table 5: Complete framework BM 2.

First Level: Strategic Level	
The provider - who?	The aggregator.
the strategy model - why?	The Aggregator can deploy flexibility services to the DSO to solve or mitigate congestion management. The aggregator gathers the flexibility to be deployed from its aggregated resources (e.g., end-users, producers, prosumers).
the resources model - who and what internally?	The Aggregator staff is able to put in place the operational aspects of the business model, namely in what regards: its promotion to the aggregated resources, ensuring the existence of the required flexibility platform (developing it internally or contracting its deployment externally), managing the flexibility offers and the flexibility deployment to the DSO, ensuring additional means to enhance the offered service (e.g., load and generation forecasting, consumption and generation profiling), which can be

	ensured by internal teams or be contracted with external entities.
the network model - who externally?	Contracts with aggregated resources to deploy flexibility. Depending on the internal capabilities, partnership and/or contracting with other entities for the tasks not to be done internally (e.g. forecasting services, flexibility platform).

Second Level: Customer and Market Level

the customer model - to whom?	The service is deployed to help the DSO solving congestion situations. It is assumed that the DSO performs a technical validation about grid status, identifying the situations in which flexibility might be procured to avoid congestion issues.
the market offer model - what?	DSO congestion management situations are usually solved internally by the DSO. Aggregators offer a new service to help the DSO solving such situations. Competitors can be producers, consumers and prosumers with direct contracts with the DSO (namely large dimension players), and some specific types of aggregators, namely Curtailment Service Providers.
the revenue model - how they pay?	The DSO will have to pay the required services to the aggregator. The services will be paid in Euro / MWh (required). The aggregator acts as an intermediary between the DSO and the aggregated resources. The aggregator pays the flexibility deployment to its aggregated resources. This can be done paying for the flexibility which is made available (e.g., monthly Euro /MW). The payment for the deployed flexibility can result from an asymmetric pool model (Euro / MWh). For that, the aggregator makes a call auction to its aggregated resources, which will present their bids. The asymmetric pool model will be applied, where all the accepted bids, required to meet the flexibility amount required by the DSO in MWh, are paid at the clearing price (equal to the most expensive accepted bid, in Euro / MWh).

Third Level: value chain level

the delivery model - how we deliver?	The deployed flexibility is delivered to the distribution system in reply to the DSO request, materialized as a reduction or an increase of the load.
the procurement model – how is being delivered to us?	The aggregated resources contribute to the committed load/generation reduction or increase.
the financial model – how we pay for it?	The Aggregator may obtain the required capital to put the business model in place by bank credit. The sell/provisioned of flexibility must return a sufficient income to cover the payment of such bank credit.

3.3 Using transactive energy for network congestion management

BM 3 defines a service provided by the DSO and directed to end-users. DSO incentivice local energy transactions to avoid congestion problems. **Figure 6** shows the stakeholders involved in this BMs, and the 3-level BM framework is presented in Table 6.

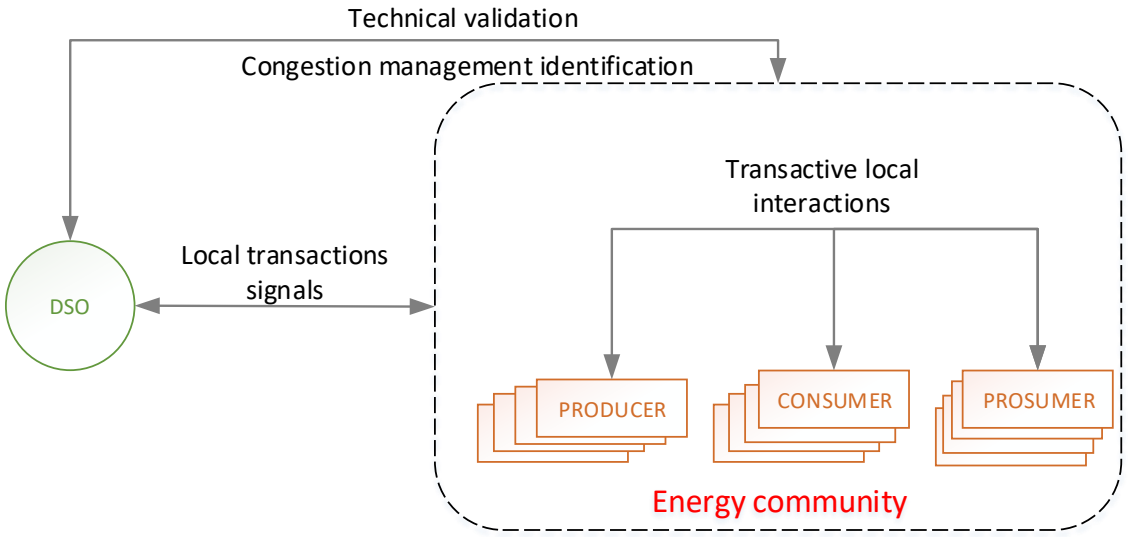

Figure 6 Stakeholders and relations in BM 3.

Table 6: Complete framework of BM 3.

First Level: Strategic Level	
The provider - who?	DSO
the strategy model - why?	Solve or mitigate distribution network congestion situations by incentivising transactive energy among end-customers. This business model is an indirect method that “eliminates the man in the middle” – aggregators – enabling DSOs to act together with customers to avoid network congestion and reduce its costs. Customers can get incentives for making local transactions.

the resources model - who and what internally?	Congestion management or information system teams using network congestion prevision and real-time, or near real-time, monitoring in the congested area.
the network model - who externally?	Customers of all types – consumers, producers and prosumers – that are transactive energy-capable.

Second Level: Customer and Market Level

the customer model - to whom?	Target customers are the energy customers that can directly decrease the line(s) congestion and are transactive energy-capable. DSO must recruit potential customers for the business model prior to the congestion situations to form a customer database that can be used when network congestion situations occur. Moreover, the DSO will provide the transactive platform in which end-customers can perform local energy transactions.
the market offer model - what?	DSO provides a transactive platform where end-users can make local energy transactions with their neighbours. End-customers receive signals from the DSO to promote local energy transactions aiming at alleviating network congestion issues. The DSO can provide incentives to end-users when their local transactions contribute to the reduction of penalties caused by congestion situations.
the revenue model - how they pay?	DSO will not be directly paid; however, this business model prevents penalty costs. Therefore, the DSO will get a revenue calculated by the difference of penalty cost avoidance minus the incentives paid to the end-consumers. It should be taken into account that regulation in Europe and the rest of the world might be different so that the revenues' calculation could vary depending on particular circumstances.

Third Level: value chain level

the delivery model - how we deliver?	DSO will incentivise transactive energy between customers using an incentive fee that will be paid to boost energy transactions. Customers will be warned about the time periods in which

	incentives for transactive energy are possible (although not certain). The communications between the DSO and the customers will be handled by the DSO considering the customer preferences (e.g., SMS or email). In order to accomplish an automated response, the DSO can have direct load control capabilities, or consumers can have home energy management systems. The value comes from the avoidance of penalties and the avoidance of third-parties for the network congestion mitigation.
the procurement model – how is being delivered to us?	DSOs must develop and/or use network congestion prevision methods. The DSO will need monitoring capabilities on the customer-side and in the distribution grid for the real-time, or near real-time, monitoring and control that supports the business model.
the financial model – how we pay for it?	The DSO will pay the incentives only if the network congestion is solved or mitigated and, consequently, penalties are reduced. The DSO will use a part of the avoided penalties cost for transactive energy incentives. The capital required to put the business model in place can be obtained by bank credit.

3.4 Sharing the exceeding PV generation in the scope of energy communities

BM 4 defines a service provided by an aggregator/ECSP directed to the DSO to solve congestion management. **Figure 7** shows the stakeholders involved in this BMs, and the 3-level BM framework is presented in Table 7.

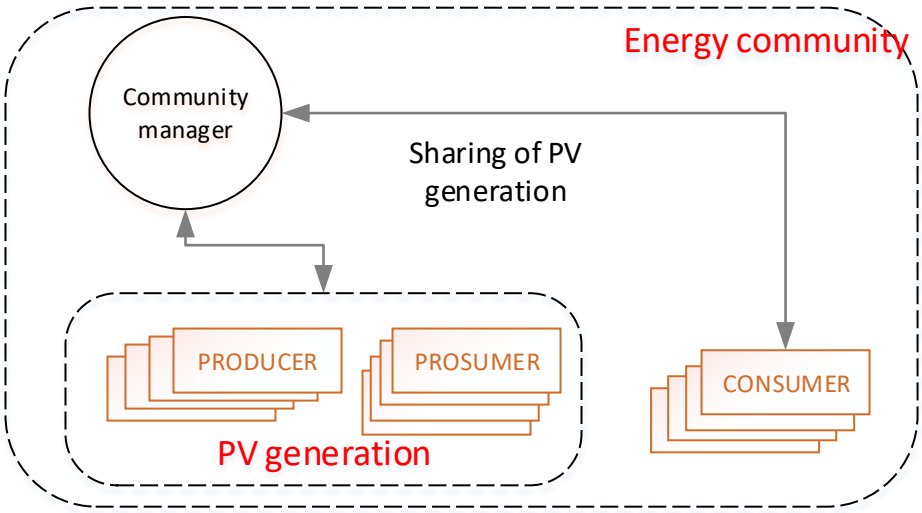

Figure 7 Stakeholders and relations in BM 4.

Table 7: Complete framework BM 4.

First Level: Strategic Level	
the provider - who?	The Community Manager (CM) acting as an aggregator.
the strategy model - why?	A community of energy consumers, producers, and prosumers can share the PV generation exceeding the consumption in public buildings, as well as their own PV generation, instead of delivering this energy to the grid.
the resources model - who and what internally?	The Community Manager (CM) acts as an aggregator of consumers with demand response (DR) capacity and of PV plant, providing the technological platform to share the information among players. The staff should be able to promote the business model to the aggregated resources, ensuring the existence of the required flexibility platform (developing it internally or contracting its deployment externally). Services like load and generation forecasting can also be provided as internal development or supplied by external services.

the network model - who externally?	The CM should establish contracts with consumers and the market in real time and other long-term markets in order to take optimized management of the PV and DR. Services like load and generation forecasting can also be supplied by external parties. The flexibility platform can also be contracted as a third-party resource.
Second Level: Customer and Market Level	
the customer model - to whom?	To end-users (i.e., public buildings equipped with PV generation and community members) who wants to share PV generation and get some compensation.
the market offer model - what?	The Community Manager (CM) acts as an aggregator of consumers with demand response (DR) capacity and of public PV plant, providing the technological platform to share the information among players. Optimal scheduling and sharing of PV generation among the community is provided aiming at the reduction of bills and green self-consumption. Competitors can be the regulated entities that pay for the PV generation delivered to the grid.
the revenue model - how they pay?	The service will be paid as a fixed fee to the CM or aggregator. The CM will also receive a fee for the service paid by the community members. Also, the DR and energy delivered to the market will be paid to the CM so it can share some incomes with the community. The consumers providing DR will receive the benefits of PV in the proportion of the contribution made by DR, as a discount in their bills.
Third Level: value chain level	
the delivery model - how we deliver?	The consumers provide DR to the CM. the CM provide DR and PV to the community.
the procurement model – how is being delivered to us?	The consumers contribute with the committed load reduction and the public buildings host the PV generation. In order to accomplish an automated response, the CM can have direct load control capabilities. In addition, consumers can have home energy management systems to execute local transactions with other community members.

the financial model – how we pay for it?	The CM may obtain the required capital to put the business model in place by bank credit. The revenues of selling PV generation and member subscription fees can cover those bank cost quickly and provide support for buying more PV equipment.

3.5 Retailer as user of the local market

BM 5 defines a business case in which a retailer can have access to the local market flexibility for optimizing their market participation in the wholesale market. **Figure 8** shows the stakeholders involved in this BMs, and the 3-level BM framework is presented in Table 8.

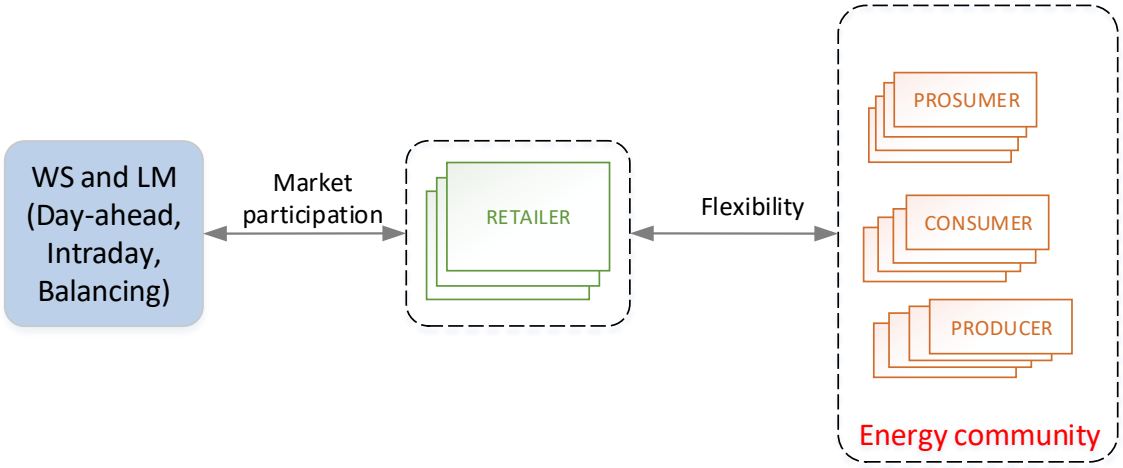

Figure 8 Stakeholders and relations in BM 5.

Table 8: Complete framework BM 5.

First Level: Strategic Level	
Provider - who?	Flexibility available from consumers, prosumers, producers, DER and other actors playing in the local market. The flexibility will be made available through the local market operator
the strategy model - why?	Retailers can access the local market flexibility for optimizing their market participation in the wholesale market (day ahead and intraday) taking into consideration the fluctuation of energy prices throughout a day and the minimization of imbalances.
the resources model - with who and what internally?	Consumers, prosumers, producers, and other actors playing in the local market as flexibility providers; DSO to validate the transactions (technical validation taking into consideration the grid constraints); Local market operator to negotiate the requested flexibility with the retailer

the network model - who externally?	Metering system providers, metering device manufacturers, app/consumer interface providers, Appliance/generation/control technology providers, ICT companies

Second Level: Customer and Market Level

the customer model - to whom?	This Business model is focused on the retailer
the market offer model - what?	Use of the local market flexibility to be valued in the wholesale market or to optimize the retailers' portfolio Potential competitors: Aggregators or other retailers
the revenue model - how they pay?	1. Revenues from optimizing the participation in the wholesale market. 2. Revenues from reducing imbalances in the retailer's portfolio

Third Level: value chain level

the delivery model - how we deliver?	The flexibility provided by the local market shall be used by the retailer when it may have more value to economically optimize the sourcing of energy in the day ahead scenario. In the intra-day, the flexibility can be used to reduce imbalances. The retailer shall use forecasts and a platform to analyze the different scenarios and to interface with the different markets
the procurement model – how is being delivered to us?	Platform development or acquisition to platform providers; procurement of the flexibility through the local market.
the financial model – how we pay for it?	Retailer should pay for the allocated flexibility. Subscription fee to participate in the local market; Development and operation of the retailers' platform to operate and interface with the different markets. HR costs.

3.6 Energy service provider in enabling / assistive role for local markets and providing ECSP capability for retailers, communities or other service providers

BM 6 defines a service provided by an energy service provider that could: 1) manage a community of consumers/prosumers and represent them as a single entity towards the wholesale markets; 2) facilitate local sharing and trading of flexibility services for BRPs, DSOs and TSOs; 3) provide the necessary ICT infrastructure and expertise for retailers/aggregators/DSOs/third parties to manage the local market. **Figure 9** shows the stakeholders involved in this BMs, and the 3-level BM framework is presented in Table 9.

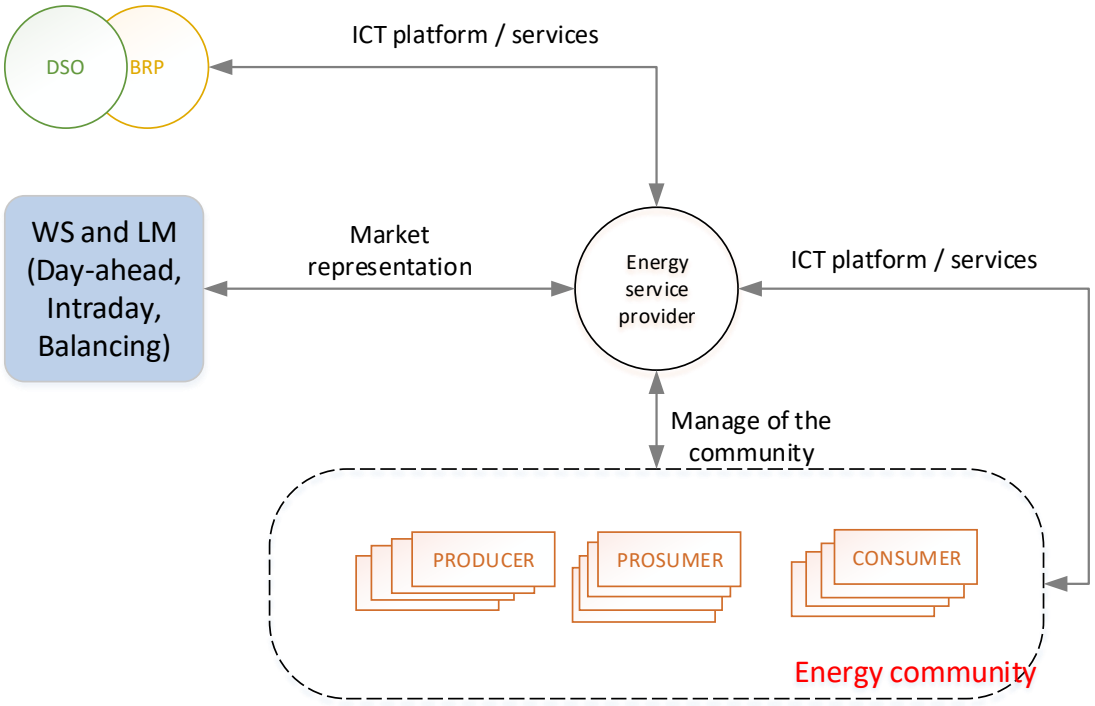

Figure 9 Stakeholders and relations in BM 6.

Table 9: Complete framework BM 6.

First Level: Strategic Level	
Provider - who?	Energy service provider (role can be taken by multiple parties)

the strategy model - why?	End-users are increasingly turning into prosumers with own generation, controllable loads, and storages. However, they may not have the skills or interest to optimize the use of these assets especially if there is a need for community level optimization. Energy service provider could manage a community of consumers/prosumers and represent them as a single entity towards the wholesale markets. It could facilitate local sharing and trading. Flexibility services could be provided for BRPs, DSOs and TSOs. In addition, energy service provider could provide the necessary ICT infrastructure and expertise in information services for retailers/aggregators/DSOs/third parties to manage the local market.
the resources model - with who and what internally?	The service provider will need strong ICT capabilities. Service provider could manage the local sharing of energy and grid costs, and taxes.
the network model - who externally?	Parties responsible for metering or Datahubs to get end-users'/community members' consumption and production data. Retailers / aggregators / DSOs/ TSOs to offer them flexibility services provided by energy communities. Wholesale market operators to enable communities' wholesale market participation. Prosumers and consumers who want to engage in local sharing or trading. Appliance/generation/storage/control technology providers to provide necessary technologies for end-users.

Second Level: Customer and Market Level

the customer model - to whom?	Energy service provider can provide services directly to energy communities. In addition, it can offer ICT infrastructure for other stakeholders (i.e. retailers/DSO/aggregators/third parties) that want to provide services for energy communities.

the market offer model - what?	ICT infrastructure to manage local market that can be used a. For energy community benefits to (ECSP role) i. optimize the use of own/local generation and enabling energy sharing and trading ii. maintain loads below certain threshold (e.g. because of power-based tariffs) iii. optimize wholesale market purchases iv. provide flexibility services for the market v. provide information services to end-users/energy communities (e.g. timely distribution of consumption and generation; environmental impacts of own/community consumption; proactive condition monitoring for electric appliances) b. As an ICT tool by other stakeholders for multiple purposes i. DSOs: flexibility services (capacity management etc.) ii. Retailers: wholesale market optimization iii. Aggregators: aggregation of resources for market flexibility services iv. Third parties wanting to provide services for energy communities Other services can include: c. Forecasting d. Load/consumer profiling/segmentation • In addition, the service provider may provide communities with assistance in choosing/sizing generation/storage/control systems in cooperation with technology providers.
the revenue model - how they pay?	Fee for setting up the local market. Subscription fee for maintenance of the local market and/or share of benefits from provision of flexibility services and optimization of wholesale market participation (ESCO type models). • The fees can be collected from individuals taking part in the local market (if service provider acts in the ECSP role) or from the stakeholders using the ICT tool.

Third Level: value chain level

the delivery model - how we deliver?	Manage local market enabling local trade and flexibility services through ICT infrastructure. Manage supplier and grid connection contracts, and invoicing for energy community participants through ICT infrastructure. Information services to customers through online interfaces (apps, web services). Assistance in choosing assets in cooperation with technology providers.
the procurement model – how is being delivered to us?	Measurement data from metering responsible (or Datahubs). End-user interfaces (apps, websites) through subcontracting. If assets are sold/rented to end-users, cooperation with technology providers.
the financial model – how we pay for it?	• Initial investments and development financed with bank credit, operational costs paid with subscription fees (or share of flexibility benefits) from the customers.

4 Transactions and required information models for energy transactions

The corresponding and required information models for energy transactions with DR and DER are a fundamental part of the BMs. Despite information exchange models and market interfaces are in-deep analysed in D2.1 “Enabling technology for transparent local p2p energy markets” of DOMINOES project, in this section, a basic framework to show how such information models can be created is presented.

Particularly, some of the BMs defined in the previous section are used to illustrate how information models can be defined, namely “BM 2 Aggregator flexibility provision to DSO“ and “BM 3 Transactive energy for network congestion management“. The concepts can be later applied to the implemented BMs in D2.1.

4.1 Information model for BM 2 Aggregator flexibility provision to DSO for network management

This BM considers the DSO, the Aggregators and respective aggregated players (e.g., end-users, producers, prosumers). The Aggregator deploys flexibility services to the DSO to solve or mitigate congestion management, by gathering it from its aggregated resources. For such, the Aggregator announces a flexibility market pool to its resources, where these may present bids for supply. At the end of the market, the Aggregator must inform its resources about the accepted and refused bids, and the market price, deploying the available flexibility to the DSO.

The following transactions are identified in the business model:

1. The DSO requests load flexibility for a specific period to the Aggregator(s);
2. The Aggregator informs its resources about a local market pool auction for the specified period;
3. The aggregates submit their bids to the Aggregator/local market platform;
4. The Aggregator informs its aggregates about the market results: accepted/refused bids and market price;
5. The Aggregator deploys the available flexibility to the DSO;
6. The DSO validates the actual flexibility delivered;
7. The DSO pays to the aggregator the actual used flexibility.

Table 10 presents the corresponding and required information models for each transaction.

Table 10: Information models for each transaction for BM 2

Trans. Nr.	Information model			
	Transaction	**Performative**	**Param**	**Description**
1	Flexibility Request	request	requestId	The identifier of the request message
			periodId	The identifier of the specified transaction period
			demand	The amount of required power/energy
2	Flexibility Market Opening	call-for-proposals	cfpId	The identifier of the call-for-proposals message
			periodId	The identifier of the specified transaction period
			deadline	The deadline for bid submission
3	Bid submission	propose	proposeId	The identifier of the propose message
			cfpId	The identifier of the call-for-proposals message
			bid	A price/power pair for the specified period.
4	Market outcomes	accept-proposal / refuse-proposal	messageId	The identifier of the message
			proposeId	The identifier of the propose message
			result	The “accepted/refused bid”
5	Flexibility Response	response	responseId	The identifier of the response message
			requestId	The identifier of the request message
			availableDemand	The amount of available power/energy
6	Validation	inform	informId	The identifier of the inform message
			requestId	The identifier of the request message
			flexDelivered	The amount of delivered power/energy
7	Settlement	inform	informId	The identifier of the inform message
			requestId	The identifier of the request message
			payment	The payment of delivered flexibility

4.2 Information model for BM 3 transactive energy for network congestion management

This BM considers only the DSO and costumers that are TE capable. It “eliminates the man in the middle” (i.e., the Aggregator) enabling DSOs to act directly with costumers (e.g., consumers, producers and prosumers) to avoid network congestion and reduce penalties’ costs.

The following transactions are identified in the BM:

1. The DSO informs its costumers about the incentives available for load flexibility;
2. The costumers submit their purchase/supply bids to the DSO market platform;
3. The DSO platform informs the customers about the market results;
4. The DSO pays incentives to the customers in case of no congestion occurs.

Table 11 presents the corresponding and required information models for each transaction.

Table 11: Information models for each transaction for BM 3

Trans. Nr.	Information model			
	Transaction	**Performative**	**Param**	**Description**
1	Incentives for local market	inform	informId	The identifier of the inform message
			periodId	The identifier of the specified transaction period
2	Bid submission	propose	proposeId	The identifier of the propose message
			informId	The identifier of the inform message
			bid	A price/power pair for the specified period identifying if its purchase or supply bid.
3	Market outcomes	accept-proposal / refuse-proposal	messageId	The identifier of the message
			proposeId	The identifier of the propose message
			result	The “accepted/refused bid”
4	Incentives payment	confirm	confirmId	The identifier of the confirm message
			pricePerMWh	The price value per MWh
			total	The total price payed by the incentive

5 Definition of contracts - Static and Dynamic

A contract can be defined as an agreement made between parties under certain conditions. The scope of the project considers static and dynamic contracts. In static contracts, the initial conditions remain unaltered until the termination of the contract. Therefore, the main characteristic of a static contract is the cost associated with the goods contracted, as it will remain unchanged until the end of the contract (i.e., the price will be invariable to any external event). These contracts can be also classified as instant contracts or lasting contracts. In the case of lasting contracts, there must be a loyalty period, and when this period ends either entity may terminate the contract. On the other hand, a dynamic contract is defined as an agreement where some variables can vary with more or less frequency (e.g., dynamic pricing [16]) and may depend on the context [17]. As the name implies, there are some dynamic conditions in the contract that might change over time. These contracts are usually of a lasting character and a loyalty period must be considered (as in the case of some static contracts). In this case, the parties involved in the contract may depend on the context to fulfill the contractual obligations.

Similar to Sect. 4, we apply a basic framework to show how the definition of contracts can be done in the context of selected BMs. The framework is then applied to the rest of BMs.

5.1 Contracts for BM 1 Aggregation of small-scale flexible loads as a universal virtual power plant

In the case of BM presented in section 3.1, in which the power plant aggregates the flexibility from small-scale flexible loads (e.g., community members), and offer this as a service to the DSO/BRP/TSO, there should be contracts between the Flexibility Service Provider (VPP) and the small consumer, and contracts between the VPP and the significant stakeholders (i.e., the TSO/BRP[3] and DSO). The first and second contract (see C1 and C2 in Table 13) define the conditions between VPP and resource providers (i.e., producer, prosumer, consumer, and ADS), the third contract (C3) defines the conditions between DSO and VPP, and fourth contract (C4) defines a contractual relation between VPP and BRP. We have not included here the contracted connection that should exist between VPP, BRP and TSO following USEF model. Table 13 provides a summary of the main characteristics of the contracts previously enumerated.

[3] As it is explained in the USEF position paper “The Independent Aggregator“ [21], we adopt here the same rationale for positioning the BRP between the Aggregator and the TSO.

Table 12: Summary of contracts for BM 1

		C1	C2	C3	C4
Stakeholders	DSO			✓	
	BRP/TSO				✓
	VPP	✓	✓	✓	✓
	Small customers	✓	✓		
Type	Dynamic		✓	✓	✓
	Static	✓			
Payment Type	Daily				✓
	Monthly		✓	✓	✓
	Annual	✓			
Pricing	Action Base		✓		
	Static	✓			
	Incentives				
	Dynamic			✓	✓

Contracts for BM 1:

- **C1** – This is an agreement between the VPP and each of the small customers that will aim to enable them to participate in the flexibility market. This contract will have a fixed annual amount that customers must pay to the VPP. The value will be dependent on the flexibility value that small customers might offer.
- **C2** – This is a contract between the VPP and small end-consumers, where the VPP pay a monthly fee for each of its flexible loads. The monthly monetary payment depends on the amount of flexibility that end-customers can offer. For the pricing mechanism, the action base model with asymmetric pool is adopted. End-customers have an active and decisive position in the negotiations because they are able to submit their bids. In case that bids are not accepted, the VPP will not add any payment to end-consumers. Therefore, the established contract is considered as dynamic since the price per unit of flexibility is variable over time. The market clearing price is also variable and can change depending on the context.
- **C3 –** This contract includes an agreement between the VPP and the DSO. It is assumed that the DSO will make a monthly payment to the VPP related to the flexibility services. This contract is considered as a dynamic type because the payment depends on many factors that vary from time to time. For instance, the price can be influenced by the context in which negotiations are carried out.
- **C4 –** This contract defines the agreement between the VPP and the BRP. The BRP aims at reducing its sourcing cost and follows its electricity program submitted to the TSO to avoid imbalance charges. Therefore, VPP

provides demand-side flexibility from end-customers to optimize BRP portfolio. This contract is considered dynamic since flexibility contracts can be updated periodically (e.g., daily and weekly modifications could be found).

5.2 Contracts for BM 2 Aggregator flexibility provision to DSO for network management

In the case of BM 2 presented in section 3.2, in which the aggregator contributes in solving the congestion management problem of the DSO, there will be at least three different contracts. The first and second contract (see C1 and C2 in Table 13) define the conditions between Aggregator and End-consumers, while the third contract (C3) defines the conditions between DSO and Aggregator. Table 13 provides a summary of the main characteristics of the contracts previously enumerated.

Table 13: Summary of contracts for BM 2

		C1	C2	C3
Stakeholders	DSO			✓
	Aggregator	✓	✓	✓
	End-consumers	✓	✓	
Type	Dynamic		✓	✓
	Static	✓		
Payment Type	Monthly		✓	✓
	Annual	✓		
Pricing	Action Base		✓	
	Static	✓		
	Incentives			
	Dynamic			✓

Contracts of BM 2:

- **C1** – This is an agreement between the Aggregator and each of the End-consumers that will aim to enable each of the end-consumers to participate in the flexibility market. This contract will have a fixed annual amount that end-consumers will have to pay to the Aggregator. This value will be dependent on the flexibility value that the End-consumer offers.
- **C2** – This is a contract between the Aggregator and the End-consumers, where the Aggregator will pay a monthly fee for each of its End-consumers. The monthly amount is depended on the amount of flexibility that the end-consumers can offer. For pricing, the action base model with asymmetric pool is adopted. End-consumers have an active and decisive position in the negotiations because they are able to submit the bids. In case that bids are not accepted, the Aggregator will not add any payment to end-consumers. In this case, the established contract is considered as dynamic since the

price per unit of flexibility provisioned is variable over time. The market clearing price is also variable and can change depending on the context.

- **C3 –** This contract includes an agreement between the Aggregator and the DSO. The DSO will make a monthly payment to the Aggregator, related to the flexibility charges. This contract is considered as a dynamic type because the price depends on other factors and can change from instant to instant. This way the price can be influenced by the context of the negotiations.

5.3 Contracts for BM 3 Using transactive energy for network congestion management

BM 3 defines a BM in which flexibility negotiations are done in a transactive energy scenario. The particularity of this BM is that no intermediary (i.e., no aggregator) is needed for interactions between DSO and end-customers. For this reason, contract C1 in Table 14 defines the rules to fulfil this agreement.

Table 14: Summary of contracts for BM 3

		C1
Stakeholders	DSO	✓
	Aggregator	
	End-consumers	✓
Type	Dynamic	✓
	Static	
Payment Type	Monthly	✓
	Annual	
Pricing	Action Base	
	Static	
	Incentives	✓
	Dynamic	

Contracts of BM 3:

- **C1** – In this case, a contract is made between the DSO and each end-customer called a participation contract. In this case, the DSO will pay an incentive to the end-customers for making transactions between them, and thus avoid the congestion of the lines. This incentive may be paid monthly and is influenced by the penalty amount that the DSO would have to pay if grid congestion was detected, and by the number of transactions to be verified. These characteristics make the contract dynamic.

5.4 Contracts for BM 4 Sharing the exceeding PV generation in the scope of energy communities

The contractual activities related to the BM 4 (sharing the excessing PV generation in buildings) are present in Table 15. In the BM 4, the sharing the exceeding of PV generation can benefit the community members because they can reduce their billing. The CM is also responsible for establishing contracts with third-parties including the contracts of participation on the real-time market and long-term market.

Table 15: Summary of contracts for BM 4

		C1	C2	C3
Stakeholders	CM	✓	✓	✓
	Community members	✓		
	Costumers with PV generation		✓	
	Consumers with DR capabilities			✓
Type	Dynamic		✓	✓
	Static	✓		
Payment Type	Monthly		✓	✓
	Annual	✓		
Pricing	Action Base			
	Static	✓		
	Incentives			✓
	Dynamic		✓	

In BM 4 following contracts exist:

- **C1** – This is a subscription contract between CM and community member. Therefore, community members pay a fixed monthly fee to the CM for providing the means for sharing the excess of PV generation of public buildings and members with PV.
- **C2** – This contract is between CM and each customer with PV generation, the CM will share the savings from the use of an excess of PV generation fairly between energy community members. This payment is dependent on the quantity of exceeding generation produced by buildings and each prosumer with PV generation capabilities. The method of pricing is dynamic because the price of excess electricity can change over time.
- **C3** – This contract is between CM and each consumer with DR capabilities, the CM pay an incentive to consumers for each executes DR action in your consumption profile. This payment is considered monthly and represents the sum of all incentives during the month. The pricing method is considered incentive because the CM incentive the consumers to change your consumption profile.

5.5 Contracts for BM 5 The retailer as user of the local market

In this business model, the retailer will establish a contract with the manager of the local market. The flexibility is the commodity that the retailer will buy in order to optimise the energy sourcing at the wholesale market and minimise the deviations incurred in the intraday. Although both DER will provide the flexibility within the local market and flexible clients and prosumers, there are no contracts between the retailers and the individual providers of the flexibility. The manager of the local market will be responsible for managing the available flexibility, therefore, from the retailer's point of view, he acts as an aggregator that has a contractual relationship with the retailer. The functioning of the local market is not relevant to this BM, as the retailer is only interested in an aggregated amount of flexibility that will be directly negotiated with the local market manager.

Table 16 - Summary of the contacts for BM 5

		End-user services
		C1
Stakeholders	Retailer	✓
	Service provider	✓
Type	Dynamic	✓
	Static	
Payment Type	Monthly	✓
	Annual	
Pricing	Action Base	
	Static	✓
	Incentives	
	Dynamic	

In this BM, the contract established between the retailer and the manager of the local market has the following characteristics:

- **C1** – This is a contract between the retailer and the manager of the local market for the provision of flexibility requested by the retailer. It constitutes a dynamic contract since the value of the traded commodity varies throughout the day according to local market conditions. Also, the value that the retailer is willing to pay for flexibility will depend on the wholesale prices and the imbalances cost; therefore, it should be a dynamic contract. The payments can be made monthly.

5.6 Contracts for BM 6 Energy service provider in enabling / assistive role for local markets and providing ECSP capability for retailers, communities or other service providers

If the energy service provider acts as the ECSP it will naturally have to enter into contract (C1) with the end-users/prosumers taking part in the local market. If it represents the local market in the wholesale or ancillary services markets, it will need to enter into contracts also with the wholesale market operator (C2) and the system operator (C3). However, if the energy service provider does not operate as the ECSP but instead provides the ECSP capability for other stakeholders, it will need to enter into contract only with the stakeholder in question (C4) and this stakeholder will handle the contractual arrangements with the end-user, wholesale market and system operator, and possibly other parties. The contractual arrangements related to the BM 6 are presented in **Table 17**.

Table 17: Summary of contracts for BM 6

		C1	C2	C3	C4
Stakeholders	Energy service provider	✓	✓	✓	✓
	End-user/Prosumer	✓			
	DSO/retailer/aggregator/third party				✓
	Wholesale market operator		✓		
	System operator			✓	
	BRP		✓	✓	
Type	Dynamic	✓		✓	
	Static		✓		✓
Payment Type	Daily		✓		
	Monthly	✓	✓	✓	✓
	Annual		✓		✓
Pricing	Action Base			✓	
	Static	✓	✓		✓
	Incentives				
	Dynamic			✓	
	Shared savings/earnings	✓			

- **C1** – this is an agreement between the energy service provider and the end-user/prosumer. There are several pricing options for the service provided for the prosumers. Firstly, the energy service provider may charge a static monthly fee from the participants in the local market. Another option would be ESCO type contracts and pricing such as the shared savings (or earn-

ings) model. In this option, the energy service provider and the end-users/prosumers would agree on the sharing of savings/earnings from provision of flexibility services and/or wholesale market portfolio optimization.

- **C2** – this is an agreement between the energy service provider and the wholesale market operator for participating in the wholesale market. The wholesale market operator charges annual (€/year) and/or variable trading fees (€/MWh) from the market participants. The settlement of variable trading fees may take place daily or monthly depending on the market. In addition to the trading fees, the energy service provider must post collateral to guarantee that it can pay for the trades. If the energy service provider is not a balance responsible party (BRP), the BRP needs to be involved in the contract also.
- **C3** – this stands for agreement(s) between the energy service provider and the system operator for participating in reserve and balancing power markets. Entering into such contract does not guarantee any payments to the energy service provider as procurement of these services by the system operator depend on auctions (action base). The payment schedule for reserve products may vary between markets. In Finland, for example, monthly payments are applied. If the energy service provider is not a balance responsible party (BRP), the BRP needs to be involved in the contract also.
- **C4** – this is an agreement between the energy service provider and the stakeholder wishing to utilize the ICT infrastructure in order to manage end-users/prosumers. The stakeholder using the ICT infrastructure pays a static monthly or annual fee for the energy service provider. The fee may depend on the number of end-users/prosumers.

6 Strategic use of contracts for third party resources

In this section, a description of the benefits of using resources acquired from use contracts with third-parties is provided. It will identify the main stakeholders involved in the acquisition of resources as well as the reasons for their purchase. In this way, to fulfil the BMs developed in the DOMINOES, each stakeholder can make use of its own resources as well as of third-party resources for which it has use contracts (the use depends on the individual remuneration and possibly on agreed contexts). An example of the use of third-party resources to fulfil/acquire services in SG is the following work [18]. Here, one of the services contracted from third-parties is an application that allows users of electric vehicles (EVs) to automate their vehicles automatically. Another example can be found in [19], which describes a third-party, in an SG context, as a service supplier providing customers with energy efficient products and services. The introduction of third-party services into an organization´s supply chain can have significant organizational impacts, such as the creation of new business processes covering partners and stakeholders with different objectives [20]. Therefore, this section analyses the strategic use of contracts for acquiring third-party resources.

Figure 10 represents the vision schematically on the strategic use of third-party resources. It is possible to identify the relationships between stakeholders (i.e., DSO, aggregators, consumers, prosumers, BRP, ECSP, etc.) involved in the developed BMs, their own resources, and the possible contracted third-party resources.

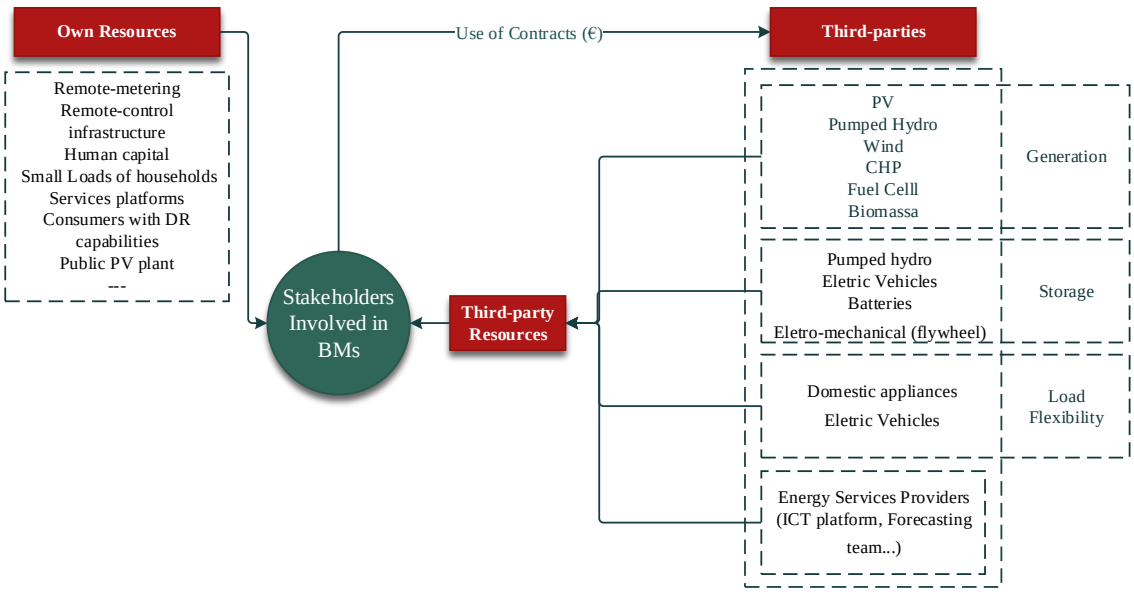

Figure 10 – Stakeholders and third-party resources

Figure 10 identifies third-party resources including electricity generation (including DGs and large generation utilities), energy storage systems (ESS), loads with flexibility capabilities (e.g., appliances with shifting or curtailment capabilities), and energy services providers (e.g., ESCO making available ICT platforms or forecasting services). In **Figure 10**, it is possible to identify the relationship between BMs and third-party resources. In this way, each stakeholder involved in the BMs can use their resources, as well as third-party resources for different purposes. A special focus is put in the providers, since they are the entities offering services in the BMs, and therefore, their main activities consist of capturing and transforming resources into value prepositions.

The availability of third-party resources enables the fulfilling of BMs when scarce resources are not enough to complete some contractual relations [20]. In such situations, providers can look for extra resources in third-party entities to avoid non-compliance of contracts and penalizations. However, how to deal strategically with the use of contracts with third-party resources is a complex task. Such management should be taking into account context and remuneration [17].

Since the strategic use of third-party contracts is more relevant for providers, Table 18 presents DOMINOES BMs, stakeholders involved in each BM, and the identified provider. For instance, the involved stakeholders in BMs 1 include DSO/TSO/BRP, flexibility service providers, community aggregators, and prosumers. Nevertheless, the flexibility service provider (the provider of this BMs), might be interested in the use of third-party resources depending on the context for the fulfillment of the contractual relations it may have while providing their BM activities. Therefore, the flexibility service provider might possess its own resources (e.g., ESS, DGs, and load flexibility), and in addition, contract third-party resources to guarantee the competition of their business activities.

Table 18 – Stakeholders and providers identification

BM	Name	Stakeholders	Provider
1	Aggregation of small loads as a universal virtual power plant	Flexibility service provider, DSO/TSO, and Community Aggregator	Flexibility service provider
2	Aggregator flexibility provision to DSO for network management	Aggregator, DSO and Aggregator resources	Aggregator
3	Using transactive energy for network congestion management / retailer operation	DSO, Energy community	DSO

4	Sharing the exceeding PV generation in public buildings in the scope of energy communities	Community Manager, Public PV plant, customers with PV generation, and consumers with DR capabilities	Community Manager
5	Retailer as user of the local market	Retailer, energy community, DSO and Local market operator	Retailer
6	Energy service provider in enabling / assistive role for local markets and providing ECSP capability for retailers, communities or other service providers	Energy service provider, Energy community, BRP, DSO, Retailers, Aggregators	Energy service provider

Table 19 presents a summary of the resources needed for DOMINOES BMs implementation, thus identifying the providers' own resources and the resources that may be contracted from third-parties. The summary presented in Table 19 was performed taking into account the information presented in section 3 where BMs were described. Analyzing Table 19, it can be seen that there are resources repeated in both columns, meaning that providers are able to contract resources from third-parties equal to their own. For instance, taking BM 2 as example, where the Aggregator (provider) resources may not be enough to fully provisioned the flexibility requested by the DSO (who pays for the service). In this case, the Aggregator may prefer to contract resources from third-parties to fully provide the service provisioned to the DSO, rather than incur in contract violations.

Table 19 - Resources characterization

BM	Provider	Own resources	Third-party resources
1	Flexibility service provider	Physical resources Human capital resources Organizational resources	Non-core activities such as field installations and maintenance
2	Aggregator	Flexibility from aggregated resources (e.g., end-users, producers, prosumers), forecasting capabilities and flexibility platform	Flexibility from aggregated resources, forecasting services and flexibility platform
3	DSO	Transactive platform Congestion management/Information capabilities	Flexibility from third-party customers.

4	Community Manager	DR capabilities of consumers, generation of public PV plant, flexibility platform, load and generation forecasting	Flexibility platform, load and generation forecasting
5	Retailer	Flexibility from providers (Consumers, prosumers, producers, and other actors)	Metering system, metering device, app / consumer interface providers, Appliance / generation / control technology providers and ICT companies
6	Energy service provider	ICT infrastructures, Community of consumers / prosumers	Metering devices or Datahubs services, appliance / generation / storage / control technology providers

The strategic use of third-party resources for providers is about selecting the resources to be contracted from the third-parties in order to deliver the service and obtaining profits from that delivery. In this sense, it is presented the following mathematical model that captures this strategic selection.

The model consists of an optimization of the use of contracts, aiming at the maximization of profits for the provider. Equation (1) presents the objective function as a difference between revenues (the received payment for a given service) and the costs for the used resources. With this function, it is understood that profits reflect the revenues maximization at the lowest possible cost.

$$\max Provider\ profit = Revenues - Costs \tag{1}$$

The equation (2) presents the *Costs* calculation as the sum of the costs of own resources $Own_{costs}^{resources}$ and the costs from the use of third-party resources. Therefore, $Third.parties_{costs}^{resources}$ are included in the equation as follows:

$$Costs = Own_{costs}^{resources} + Third.parties_{costs}^{resources} \tag{2}$$

Equation (3) presents the calculation from the use of own resources, which is obtained by the summation over the number of available/used own resources NR_{own}. The variable $resource_{own}^{i}$ represents the ith own resource, and $\lambda_{own}^{resorce^{i}}$ represents the cost of using the ith own resource. $Bin_{own}^{resource^{i}}$ is a binary variable that is active ('1') or not active ('0') depending on the use of the ith own resource:

$$Own_{costs}^{resources} = \sum_{i=1}^{NR_{own}} \left(resource_{own}^{i} \times \lambda_{own}^{resorce^{i}} \times Bin_{own}^{resource^{i}} \right) \tag{3}$$

In equation (4), similar to equation (3), is presented the cost calculation for third-party resources acquisition. Variable $NR_{Third.parties}$ represents the total number of available third-party resources, $resource_{third.party}^{i}$ represents a given ith third-party resource,

$\lambda_{Third.party}^{resorces^i}$ represents the cost of the ith third-party resource, and $Bin_{Third.party}^{resource^i}$ is a binary variable for the use or not (i.e., 1 if the resource is used and 0 otherwise) of the ith third-party resource:

$$Third.parties_{costs}^{resources} = \sum_{i=1}^{NR_{Third.parties}} \left(resource_{third.party}^{i} \times \lambda_{Third.party}^{resorces^i} \times Bin_{Third.party}^{resource^i} \right) \quad (4)$$

As can be seen, variables $Bin_{own}^{resource^i}$ and $Bin_{Third.party}^{resource^i}$ are optimization variables representing the use of third-party resources. Context can be modelled by using these variables as restrictions. For instance, supposing that a provider is forced to the use of third-party resource $i = 1$ (in a specific situation such a contractual obligation), then $Bin_{Third.party}^{resource^1} = 1$ can be set as a constraint of the optimization problem. In this way, decision variables can be used to model also context-aware situations representing specific scenarios.

Finally, equation (5) presents the main constraint for the optimization problem. The variable $Amount_{needed}^{resources}$ represents the total amount of resources needed to fulfill a given BM.

$$Amount_{needed}^{resources} = \left[\begin{array}{l} \sum_{i=1}^{NR_{own}} \left(resource_{own}^{i} \times Bin_{own}^{resource^i} \right) + \\ \sum_{i=1}^{NR_{Third.parties}} \left(resource_{third.party}^{i} \times \lambda_{Third.party}^{resorces^i} \right) \end{array} \right] \quad (5)$$

Notice that there may be other restrictions depending on the specific BM. As is the case of the need for a particular resource to be active, or the resource can be a continuous value, and its quantity also has to be optimized between a minimum and a maximum value.

7 Conclusions

D5.1 “Formulation of alternative local market place enabled business models” provides the definition of six BMs that encompasses the vision of DOMINOES project. The developed BMs considered different stakeholders taken from the reference architecture (D1.1) of the project. The list of BMs is as follows:

1. Aggregation of small-scale flexible loads as a universal virtual power plant
2. Aggregator flexibility provision to DSO for network management
3. Using transactive energy for network congestion management
4. Sharing the exceeding PV generation in the scope of energy communities
5. Retailer as user of the local market
6. Energy service provider in enabling / assistive role for local markets and providing ECSP capability for retailers, communities or other service providers

All the stakeholders co-exist in the so-called local market. Therefore, the definition of BMs is of crucial importance to explore and delimitate the efficient use of DER in local energy communities, and how these interactions impact the system as a whole.

The success of the implementation of BMs relays to a significant extend in a proper definition of information models for energy transactions into the considered local market. Therefore, this deliverable has provided initial guidelines in the description of such information models. In-deep analyses and complete guidelines will be provided in D2.1 “Enabling technology for transparent local p2p energy markets” of DOMINOES project.

This deliverable has also explored the definition of contracts, needed to reach collective agreements between involved parts of a specific BM. Section 5 presented general guidelines for the definition of contracts (static and dynamic) and provided contracts for each of the defined BMs. The definition of contracts is of paramount importance at the moment of capitalizing the possible profits expected for the provision of a service; therefore, its effect cannot be neglected. Besides, Section 6 has shown how the main stakeholders involved in a given BM can strategically make use of third-party resources acquired through use contracts (the usage depends on the individual remuneration and possibly on agreed contexts). A simple mathematical model that captures such strategic selection has been presented in a manner that can apply to all BMs.

Finally, it is worth noting that all the available information has a strong connection with other parts of the project, namely UC developed to provide insights into the achievement of the goals of the project. Special attention is given to DSO operation and services that can be directed to this fundamental stakeholder.

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