GLocalFlex

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GLocalFlex overarching BUCs & KPIs

WP5

TASK 5.1

TASK 5.2

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ABBREVIATIONS AND ACRONYMS

Acronym	Description
aFRR	Automatic Frequency Restoration Reserve
BM	Business Model
BRP	Balance Responsible Party
BSP	Balancing Service Provider
BUC	Business Use Case
CCP	Central Counter Party
CHP	Combined Heat and Power
CSP	Congestion Service Provider
DER	Distributed Energy Resource
DSO	Distribution System Operator
EFM	Energy Flexibility Marketplace
EM	Energy Manager
EMS	Energy Management System
ESCO	Energy Service COmpany
EV	Electric Vehicle
FCR	Frequency Containment Reserve
HEMS	Home Energy Management System
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
IoT	Internet of Things

KPI	Key Performance Indicator
LEC	Local Energy Community
LFC	Load Frequency Control
MCO	Market Coupling Operator
mFRR	Manual Frequency Restoration Reserve
MV	Medium Voltage
NEMO	Nominated Electricity Market Operator
PV	Photovoltaic
RES	Renewable Energy Sources
RR	Replacement Reserve
ToU	Time of Use
TSO	Transmission System Operator
UC	Use case

Note that standard balancing products (FCR, aFRR, mFRR, RR) are defined in the Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing [1] and that definitions for different roles are provided in the Harmonised Electricity Market Role Model [2].

Executive Summary

Energy flexibility provision and empowering consumers are crucial elements to enable an efficient and reliable energy transition. The GLocalFlex project aims to mobilise demand-response, by proposing a novel marketplace, where consumers of different sizes can provide their flexibility, which is afterwards used by different actors of the power system, such as retailers, aggregators, transmission system operators (TSOs) or distribution system operators (DSOs). The GLocalFlex marketplace will be demonstrated in six different pilots, which exploit the flexibility of different types of flexibility providers, are located in different countries with different weather and geographical conditions, and will make use of flexibility for different purposes, so that the marketplace is tested under several different conditions. The particular applications in the various pilots are described through pilot-specific Business Use Cases (BUCs) and this document presents an overarching framework for the analysis of the BUCs to be deployed by the different GLocalFlex pilots.

Starting from the BUC definitions in the six pilots, common elements were investigated, in order to identify some overarching BUCs that cover all the scopes selected by the pilots. From the 23 BUCs proposed by the pilots, 8 overarching BUCs were identified, which were then discussed with the pilots, so that the BUCs proposed by them could be fine-tuned.

In addition, the Key Performance Indicators (KPIs) for the GLocalFlex project are presented in this document. These KPIs help demonstrate that GLocalFlex meets its expected outcomes, by evaluating (either in a qualitative or in a quantitative way) technical, societal, and economic aspects. GLocalFlex project KPIs refer to the whole project implementation, while each pilot also defined pilot-specific KPIs to evaluate the performance of each pilot in particular. However, the dialogue between pilots and Work Package 5 (WP5) (where this document was produced) allowed pilots to check KPI definitions with each other and, if needed, fine-tune them.

In summary, this document presents the generic framework for both defining the generic types of BUCs that will be considered within GLocalFlex and the KPIs that will be used for the evaluation of the performance of the project. This general framework comes from a consensus with pilots, which could also use it to fine-tune their activities.

Keywords

Business use case, Demand response, Electric load management, Flexibility market, Power markets, KPI

1. Introduction

1.1. Background

The main objective of GLocalFlex is to mobilise demand-response solutions & services in replicated manner for prompt horizontal scaling of flexible local energy systems by means of easy access and low barrier energy flexibility markets to increase the participation of the consumers across all energy-sectors. The GLocalFlex approach promotes viable interoperable solutions and products at all levels of the grid (consumers, producers, retailers, aggregators & market) by selecting modular standards and tools during development. The considered markets for consumers' participation include both energy markets (such as the day-ahead market) or markets operated by TSOs and DSOs for the operation of power systems.

For that purpose, it is necessary, on the one hand, to describe and evaluate new business models (BMs), supported by innovative and interoperable solutions which are enabled by connecting systems from different sectors and, on the other hand, to be able to develop, deploy, demonstrate and evaluate the newly developed flexibility solutions and services. For that purpose, GLocalFlex is demonstrating near real time, scalable, flexibility trading in six different locations in Europe.

Therefore, the GLocalFlex pilots will be used both to demonstrate that the solutions developed within the project are technically viable and to provide the necessary practical background in order to assess whether those solutions are economically sound. Hence, the new BMs will be strongly related to the demonstration activities to be performed in the GLocalFlex pilots.

In this regard, this document presents an overarching framework for the analysis of the BUCs to be deployed by the different GLocalFlex pilots.

Starting from the BUCs to be deployed by the different GLocalFlex pilots, a common terminology and representation for all of them has been proposed (D2.1, [3], D3.1 [4]) and the complementarity and consistency among the different demonstrators has been ensured. For that purpose, eight overarching BUCs have been identified, which reflect the main objectives of the 23 BUCs that have been identified by the pilots. In a similar fashion, the pilot-specific KPIs to evaluate the performance of those BUCs have been defined, which, again, served as the main input to identify the GLocalFlex overarching KPIs. These overarching KPIs include both KPIs aimed at evaluating overall project objectives and common KPIs for the evaluation of the demonstrators.

This document provides an overview of both overarching BUCs and KPIs.

1.2. Methodology for the definition of the overarching BUCs

The overarching BUCs were defined in tight cooperation with the six pilots that will be implemented within GLocalFlex. As a first stage for the definition of the BUCs to be deployed by each GLocalFlex pilot, an initial survey (see 6. Annex: First BUC questionnaire) was launched in order to collect the sources of available flexibility in each pilot site. This first round of consultations aimed to establish a clear understanding of the flexibility equipment and to gain insight into the specific/particular BUCs each site is most interested in exploring. The outcome of this first questionnaire and the valuable findings served as a basis for a new survey.

In a second stage, the pilot sites had to fill in a set of specific BUC templates according to the short template provided by the IEC 62559-2 standard [5], as well as a common online questionnaire. The main objective of this second round was to outline some BUCs deemed viable and/or of interest to one or more of the pilot participants. The correct definition of such BUCs is quite relevant within GLocalFlex project, since they will be used as a basis to propose and define the new BMs to be considered through the project. Therefore, a close collaboration was established between pilot owners and WP5 participants, in order to identify pilot-specific needs and to be able to provide an overarching framework which uses a common terminology, ensures complementarity and avoid gaps.

This process allowed both WP5 and the pilots to improve the definition of BUCs. On the one hand, the list of overarching BUCs to be considered was modified, by adding and removing some potential overarching BUCs, or by refining their definitions. On the other, pilots could also be fine-tuned, enabling pilot owners to identify new BUCs that may be of interest for them, or discarding some other BUCs which, after the process, seemed less appealing.

Once the specific BUCs have been defined by the pilots, the overarching BUCs covering the specific BUCs have been proposed. For the classification of the specific BUCs into the global overarching BUCs, affinities among the particular BUCs concerning their key elements, the nature of the proposed business idea and the scope within the energy industry have been taken into account (e. g. operation within the same areas of activity or sectors, proposition of similar services in terms of their nature and elements, involved actors, etc.). Since some specific BUCs fit into various categories, they are included in more than one overarching BUC.

As a result, eight overarching BUCs have been defined:

1. Optimise consumption, generation and storage the day before delivery.
2. Optimise flexibility trading the day before delivery.
3. Optimise consumption, generation and storage within the day of delivery.
4. Optimise flexibility trading up to real-time.
5. Optimise and operate markets for local energy communities.
6. Provide services for the power system operation.
7. Optimise multi-vector use for energy sector coupling.
8. Provide energy consulting services.

2. Proposal of specific BUCs by GLocalFlex pilots

The GLocalFlex pilots will serve as demonstrators for the system toolchains of the flexibility market integration and its BMs. GLocalFlex consists of six heterogenous pilot sites demonstrating flexibility potential, solutions, and services ranging from consumers to industries, which interact with automated marketplaces to increase the participation of consumers at all grid levels.

The pilot site testing objectives and detailed implementation plans for the pilots are provided in D2.1 [3] (France, Spain and Switzerland) and D3.1 [4] (Czechia, Finland and Germany). Next sections provide a summary of the specific BUCs defined by each pilot, as well as their main objectives, scope and roles[1] involved.

2.1. Czech pilot

The pilot represents a dispersed building portfolio consisting of 5 demo sites with various building types, including residential, administrative/commercial, and other services, spread across Kladno city, the Central Bohemia region and Prague. The primary objective of this pilot is to demonstrate innovative tools and services designed specifically for the building sector, supporting coordinated demand response actions from individual heating, ventilation and air-conditioning (HVAC) systems, as well as on-site renewable energy sources (RES).

The Czech pilot aims to test two different BUCs:

1. **CZ_BUC01: Dynamic price-aware energy management**:
    a. Scope: Efficiently optimising the energy demand of individual building facilities in response to dynamic tariff variations, activating implicit flexibility.
    b. Objective(s):
        i. Spot-market/dynamic price signal responsiveness.
        ii. Lowering energy cost.
        iii. Maintaining the end-consumers comfort level.
        iv. Savings for building administrators by automated adjustments.
        v. Reducing environmental impact through optimised energy usage and demand response strategies.
    c. Short description: Supervisory control software for optimal respond to dynamic pricing through ongoing flexibility prediction and setpoint adjustments, enhancing operational efficiency and ensuring occupant comfort.

[1] In some cases, the specific BUCs presented in deliverables D2.1 and D3.1 do not include roles, but, for completeness, the information provided in the surveys for data gathering have been included in this report.

d. Roles:

i. *Building service entity (building operator, facility manager or energy management provider) (System)*: A company specializing in building automation systems facilitating data collection and energy system management within buildings. Typically servicing larger facility portfolios, these building service entities manage building clusters, making them ideal candidates to act as technical aggregators offering small scale flexibility directly or as partner of (trading) aggregator.

ii. *Owner (system)*: The building owner plays a crucial role in decision-making by upgrading specific components within their existing automation systems. Through their procurement decisions, owners significantly impact the upgrade process, collaborating with service entities to enhance building performance and participate in broader energy management strategies.

iii. *Occupant/ End-user*: The occupant/end user represents the inhabitants of various spaces within the building environment, including offices, residential units, and public areas. Their experience and satisfaction within these spaces are directly influenced by the efficiency and accuracy of flexibility activation. The occupant's comfort and operational conditions in public areas are crucial. Any adjustments made should ensure an optimal balance between energy efficiency measures and maintaining comfortable indoor and operational conditions. Additionally, occupant satisfaction is closely tied to building owner directives, such as leasing conditions and environmental goals.

iv. *Balance responsible party (Registered energy trader)*: The Balance Responsible Party (BRP)/Registered energy trader facilitates the supply and sale of electricity to the retail sector. Operating as a balance responsible party, they bear financial responsibility for discrepancies between their purchased energy and the actual consumption or generation within their portfolio. This actor has the potential to trigger implicit demand responses by offering dynamic price tariffs to end-customers, simultaneously mitigating risks associated with market volatility. Furthermore, closer collaboration between the building service entity/facility manager and the BRP/Registered energy trader can lead to enhanced utilisation of building flexibility, enabling active participation in intra-day markets or other future flexibility markets. This collaboration aims to minimize potential imbalance costs by leveraging the building's flexibility effectively.

v. *Flexibility aggregator*: The flexibility aggregator functions as an energy trader specialized in balancing services, acting as an intermediary between TSOs and multiple balancing or controllable energy providers. Their primary aim is to ensure that the aggregated energy block can effectively respond to signals from the TSOs supporting grid resiliency. This aggregation typically includes diverse devices such as cogeneration power plants, batteries, district heating boilers, or other demand-side flexibility resources. Similar to BRPs, flexibility aggregators can leverage building flexibility within

intra-day or other future flexibility markets, and potentially even in ancillary services markets if compliance with TSO codes is met.

vi. *DSO*: The DSO is primarily responsible for operating and maintaining the physical electricity distribution network to ensure the stability and reliability of electricity supply to consumers connected to their grid. DSOs typically manage metering, oversee grid infrastructure, and address distribution-related issues. Participation in electricity trading activities is prohibited for the DSO. Their operational activities are partially funded through fees regulated by the Energy Regulatory Authority derived from various distribution tariffs.

vii. *TSO*: The TSO is responsible for maintaining the stability and reliability of the transmission power grid. TSOs have the authority to procure tradeable ancillary services from multiple market actors, predominantly from aggregators, across various operational processes. These services may include Frequency Restoration Reserve in automatic Frequency Restoration Reserve (aFRR) and manual Frequency Restoration Reserve (mFRR) products, essential for ensuring grid stability and responding to frequency deviations.

viii. *Energy Regulatory Authority (ERA)*: The ERA is responsible for overseeing the operation of energy markets and their participants ensuring they function in a competitive, fair, and transparent manner. They also represent and protect the end-consumer.

2. **CZ_BUC02: Facility management aggregation to support traded balancing mechanisms**:

   a. Scope: Effective demand response activation of the clustered facility on the request of grid-related actors (i.e., aggregator, energy trader, DSO).

   b. Objective(s):

      i. Aggregating the individual flexibility resources into a scale that is relevant for grid-related actors.

      ii. Establishing a predictable and manageable flexibility offer.

      iii. Automating the activation / purchasing process to generate profit.

      iv. Maintaining the end-consumers' comfort level.

      v. Promoting grid resilience enhancing integration of RES.

   c. Short description: Technical aggregation of energy flexibility across building cluster, empowering grid-related actors to govern dispersed HVAC devices, optimising activation and transparency for balancing capacity in intra-day market transactions.

   d. Roles:

      i. *Building service entity (building operator, facility manager or energy management provider) (System)*: A company specializing in building automation systems facilitating

data collection and energy system management within buildings. Typically servicing larger facility portfolios, these building service entities manage building clusters, making them ideal candidates to act as technical aggregators offering small scale flexibility directly or as partner of (trading) aggregator.

ii. *Owner (system)*: The building owner plays a crucial role in decision-making by upgrading specific components within their existing automation systems. Through their procurement decisions, owners significantly impact the upgrade process, collaborating with service entities to enhance building performance and participate in broader energy management strategies.

iii. *Occupant/ End-user*: The occupant/end user represents the inhabitants of various spaces within the building environment, including offices, residential units, and public areas. Their experience and satisfaction within these spaces are directly influenced by the efficiency and accuracy of flexibility activation. The occupant's comfort and operational conditions in public areas are crucial. Any adjustments made should ensure an optimal balance between energy efficiency measures and maintaining comfortable indoor and operational conditions. Additionally, occupant satisfaction is closely tied to building owner directives, such as leasing conditions and environmental goals.

iv. *BRP (Registered energy trader)*: The BRP/Registered energy trader facilitates the supply and sale of electricity to the retail sector. Operating as a balance responsible party, they bear financial responsibility for discrepancies between their purchased energy and the actual consumption or generation within their portfolio. This actor has the potential to trigger implicit demand responses by offering dynamic price tariffs to end-customers, simultaneously mitigating risks associated with market volatility. Furthermore, closer collaboration between the building service entity/facility manager and the BRP/Registered energy trader can lead to enhanced utilisation of building flexibility, enabling active participation in intra-day markets or other future flexibility markets. This collaboration aims to minimize potential imbalance costs by leveraging the building's flexibility effectively.

v. *Flexibility aggregator*: The flexibility aggregator functions as an energy trader specialized in balancing services, acting as an intermediary between TSOs and multiple balancing or controllable energy providers. Their primary aim is to ensure that the aggregated energy block can effectively respond to signals from the TSOs supporting grid resiliency. This aggregation typically includes diverse devices such as cogeneration power plants, batteries, district heating boilers, or other demand-side flexibility resources. Similar to BRPs, flexibility aggregators can leverage building flexibility within intra-day or other future flexibility markets, and potentially even in ancillary services markets if compliance with TSO codes is met.

vi. *DSO*: The DSO is primarily responsible for operating and maintaining the physical electricity distribution network to ensure the stability and reliability of electricity supply

to consumers connected to their grid. DSOs typically manage metering, oversee grid infrastructure, and address distribution-related issues. Participation in electricity trading activities is prohibited for the DSO. Their operational activities are partially funded through fees regulated by the Energy Regulatory Authority derived from various distribution tariffs.

vii. *TSO*: The TSO is responsible for maintaining the stability and reliability of the transmission power grid. TSOs have the authority to procure tradeable ancillary services from multiple market actors, predominantly from aggregators, across various operational processes. These services may include Frequency Restoration Reserve in aFRR and mFRR products, essential for ensuring grid stability and responding to frequency deviations.

viii. *Energy Regulatory Authority (ERA)*: The ERA is responsible for overseeing the operation of energy markets and their participants ensuring they function in a competitive, fair, and transparent manner. They also represent and protect the end-consumer.

2.2. Finnish pilot

The Finnish pilot area is located at the municipality of Utajärvi, Northern Finland, 60 kilometers South-East from Oulu. The pilot consists of two branches: Business Park and Municipality Center branches. At the Business Park branch, all the participants are industrial actors (sawmill, log carving mill, biochar production plant, recycling company and geothermal heating company), a large-scale (20 MW) solar park is being installed and a closed distribution network (owned by users) will be built. At the municipality center, the pilot environment consists of municipality's public facilities and local district heating network. At the Business Park branch, the target is to develop and test smart grid technologies and flexibility capabilities at industrial scale and how a microgrid can act as an entity in the flexibility markets, whereas the goal at the municipality center is to utilise renewable energy and heat recovery in the energy production of the district heating network.

The Finnish pilot aims to test six different BUCs:

1. **FI_BUC01: Optimising consumption**:
    a. Scope: Optimising the consumption of consumers by utilising demand flexibility.
    b. Objective(s):
        i. Lessen the overall demand during peak consumption hours.
        ii. Avoid the usage of fossil energy sources.
        iii. Savings for the consumers at the high-price rates.
        iv. Incentives for the consumers.
    c. Short description: Consumer can participate on the flexibility markets by shifting or shaving intended consumption. Consumer gets savings during the peak price hours + gets incentives

from the network operators as the markets can then avoid using the highest cost energy production forms.

d. Roles:

   i. *Renewable energy provider*: Actor who organizes and operates the creation of energy / electricity using renewable natural resources.

   ii. *Energy storage operator*: Actor who uses stored energy as means for trading.

   iii. *Energy consumer*: Actor who utilises energy / electricity in its operations.

   iv. *DSO*: Actor who is responsible for transferring energy between production and consumption points.

   v. *Energy retailer*: Actor who purchases energy from producers and sells it to the consumers. Retailers are also responsible for maintaining balance in the network by ensuring that the amount of purchased and sold electricity is the same at any given time.

   vi. *TSO*: Actor who is responsible for transferring electricity and maintaining the balance in the national grid.

   vii. *Nominated Electricity Market Operator (NEMO)*: An entity designated by the competent authority to perform tasks related to single day-ahead or single intraday coupling.

2. **FI_BUC02: Storing overproduction**:

   a. Scope: Using battery technology for storing overproduction of electricity.

   b. Objective(s):

      i. Storing overproduction for peak production shaving and for price optimisation.

   c. Short description: Providing a mechanism to store overproduction of a renewable energy (solar, wind). With renewables, it is difficult to match the production with the consumption and many times the correlation is even negative (high production, low consumption). Therefore, energy storage technologies need to be used to store the overproduction for later use when the demand is higher.

   d. Roles:

      i. *Renewable energy provider*: Actor who is responsible for creating energy / electricity using renewable natural resources.

      ii. *Energy storage operator*: Actor who uses stored energy as means for trading or balancing the production.

      iii. *DSO*: Actor who is responsible for transferring energy between production and consumption points.

iv. *TSO*: Actor who is responsible for transferring electricity and maintaining the balance in the national grid.

3. **FI_BUC03: Responding to low production**:
    a. Scope: Using energy storage to compensate low production periods.
    b. Objective(s):
        i. Storing overproduction. Optimising consumption.
    c. Short description: Providing a mechanism to ensure steady provision of electricity to the customers in the microgrid.
    d. Roles:
        i. *Renewable energy provider*: Actor who organizes and operates the creation of energy / electricity using renewable natural resources.
        ii. *Energy storage operator*: Actor who uses stored energy as means for trading.
        iii. *Energy consumer*: Actor who utilises energy / electricity in its operations.
        iv. *DSO*: Actor who is responsible for transferring energy between production and consumption points.
        v. *Energy retailer*: Actor who purchases energy from producers and sells it to the consumers. Retailers are also responsible for maintaining balance in the network by ensuring that the amount of purchased and sold electricity is the same at any given time.
        vi. *TSO*: Actor who is responsible for transferring electricity and maintaining the balance in the national grid.

4. **FI_BUC04: Participating in reserve markets**:
    a. Scope: Providing reserve electricity source to balance national grid.
    b. Objective(s):
        i. Releasing electricity from the electricity storage to balance the network.
    c. Short description: Providing a mechanism to release electricity from storage to balance the national grid when needed. Participating in reserve markets.
    d. Roles:
        i. *Renewable energy producer*: Actor who is responsible for creating energy / electricity using renewable natural resources.
        ii. *Energy storage operator*: Actor who uses stored energy as means for trading.
        iii. *DSO*: Actor who is responsible for transferring energy between production and consumption points.

iv. *Energy retailer*: Actor who purchases energy from producers and sells it to the consumers. Retailers are also responsible for maintaining balance in the network by ensuring that the amount of purchased and sold electricity is the same at any given time.

v. *TSO*: Actor who is responsible for transferring electricity and maintaining the balance in the national grid.

vi. *NEMO*: An entity designated by the competent authority to perform tasks related to single day-ahead or single intraday coupling.

5. **FI_BUC05: Market demand matching**:

   a. Scope: Selling electricity to match microgrid external demand.

   b. Objective(s):

      i. Selling electricity when microgrid external market price is lucrative.

   c. Short description: Selling electricity either from solar power plant or from electricity storage to national markets when market price is over defined threshold value.

   d. Roles:

      i. *Renewable energy provider*: Actor who organizes and operates the creation of energy / electricity using renewable natural resources.

      ii. *Energy storage operator*: Actor who uses stored energy as means for trading.

      iii. *DSO*: Actor who is responsible for transferring energy between production and consumption points.

      iv. *Energy retailer*: Actor who purchases energy from producers and sells it to the consumers. Retailers are also responsible for maintaining balance in the network by ensuring that the amount of purchased and sold electricity is the same at any given time.

      v. *TSO*: Actor who is responsible for transferring electricity and maintaining the balance in the national grid.

      vi. *NEMO*: An entity designated by the competent authority to perform tasks related to single day-ahead or single intraday coupling.

6. **FI_BUC06: Optimising district heating**:

   a. Scope: Optimising the efficiency and renewable production of district heating.

   b. Objective(s):

      i. Maximize the use of renewable energy sources in producing district heat.

      ii. Minimize CO_2 emissions.

      iii. Minimize heat losses in the grid.

      iv. Maximize the efficiency factor of the district heating system.

v. Enable flexibility and co-use of multiple energy sources including use of RES and heat recovery from cooling systems.

c. Short description: Enable multiple energy sources to be used in producing district heating: renewable energy sources for operating heat pumps, heat recovery from cooling systems. Enable district heating system to act as a demand flexing component by adjusting the use of heat pumps.

d. Roles:

i. *Renewable energy provider*: Actor who organizes and operates the creation of energy / electricity using renewable natural resources.

ii. *Energy storage operator*: Actor who uses stored energy as means for trading.

iii. *District heating operator*: Actor who produces distributes heat for consumers.

iv. *DSO*: Actor who is responsible for transferring energy between production and consumption points.

v. *Energy retailer*: Actor who purchases energy from producers and sells it to the consumers. Retailers are also responsible for maintaining balance in the network by ensuring that the amount of purchased and sold electricity is the same at any given time.

vi. *TSO*: Actor who is responsible for transferring electricity and maintaining the balance in the national grid.

vii. *NEMO*: An entity designated by the competent authority to perform tasks related to single day-ahead or single intraday coupling.

2.3. French pilot

The French pilot site is in the town of Clamart and will be driven by Vallée Sud Habitat, a social landlord that manages several hundred rented homes and will provide first-level contact with its tenants, and the R&D division of EDF, who will provide different areas of expertise on sociology and technical solutions for the connected homes. The main objective of the French pilot is to demonstrate the GLocalFlex approach to implement demand response programs based on smart Home Energy Management Systems (HEMS) solutions.

The French pilot aims to test six specific BUCs:

1. **FR_BUC01: Enable the flexibility of residential consumers through a fully automated approach using an energy box and the associated IoT ecosystem**:

a. Scope: This use case is devoted to the flexibility of residential consumers. An energy box and the associated Internet of Things (IoT) ecosystem are installed at the consumers' premises to control different types of appliances. The control approach is fully automated.

b. Objective(s):

i. Enable the provision of flexibility by residential consumers through a fully automated control approach.

c. Short description: Flexibility is provided through the automated control of selected appliances at the residential consumers' premises. The control is carried out by an energy box and the associated IoT ecosystem. Based on the smart meter data and data collected from the controlled appliances, the energy box forecasts the potential flexibility for the next periods of time, along with the associated prices, prepares flexibility bids and sends them to the technical aggregator. For the accepted and/or activated bids, the energy box sends the appropriate control signals to the appliances to ensure a sufficient energy margin and/or to trigger flexibility delivery. A mobile application allows the consumer to specify its preferences in the energy box (for instance in terms of comfort, energy or economic savings) and to receive information about its consumption and the flexibility provision activities (activations, flexibility delivered, remuneration, etc.).

d. Roles:

i. *Residential consumer (role)*: Provides the flexibility of its appliances.

ii. *Technical aggregator (role)*: Market platform operator. Operator of the GlocalFlex Platform.

iii. *HEMS service provider*: Operator of the HEMS supervising platform and provider of HEMS services.

iv. *Electricity supplier (role)*: Electricity supply to the consumer and billing

v. *Metering data operator (DSO) (role)*: Operates the metering devices, collects, and processes the corresponding data, provides the metered data to the authorized users.

2. **FR_BUC02: Enable the flexibility of residential consumers through a behavioural approach using an energy box and the associated IoT ecosystem**:

a. Scope: This use case is devoted to the flexibility of residential consumers. An energy box and the associated IoT ecosystem are installed at the consumers' premises to monitor different types of appliances. The control of the appliances is carried out by the consumer itself.

b. Objective(s):

i. Enable the provision of flexibility by residential consumers through a behavioural approach.

c. Short description: Flexibility is provided through the control of selected appliances at the residential consumers' premises. The control is carried out by the consumer itself. The appliances are monitored by an energy box and the associated IoT ecosystem. Based on the smart meter data and data collected from the appliances, the energy box forecasts the potential flexibility for the next periods of time, along with the associated prices, prepares flexibility bids and sends them to the technical aggregator. For the accepted and/or activated bids, the energy

box sends the consumer, through a mobile application, appropriate activation signals and indications on how to proceed to ensure a sufficient energy margin to be able to activate the flexibility propositions and/or to trigger delivery. The mobile application also allows the consumer to set the energy box parameters and to receive information about its consumption and the flexibility provision activities (activations, flexibility delivered, remuneration, etc.).

d. Roles:

   i. *Residential consumer (role)*: Provides the flexibility of its appliances.

   ii. *Technical aggregator (role)*: Market platform operator. Operator of the GlocalFlex platform.

   iii. *HEMS service provider*: Operator of the HEMS supervising platform and provider of HEMS services.

   iv. *Electricity supplier (role)*: Electricity supply to the consumer and billing.

   v. *Metering data operator (DSO) (role)*: Operates the metering devices, collects, and processes the corresponding data, provides the metered data to the authorized users.

3. **FR_BUC03: Enable the flexibility of public consumers already equipped with an energy manager**:

   a. Scope: This use case is devoted to the flexibility of public consumers such as schools, sport facilities, public parking with electric vehicles (EVs), public buildings, who have an energy manager. This energy manager may be an automated system, a person, or a combination of both. The control of the assets providing flexibility is carried out by the energy manager.

   b. Objective(s):

      i. Enable the provision of flexibility by public consumers through interactions with their energy manager.

   c. Short description: Flexibility is provided through the control of selected assets at the public consumers' facilities. The control is performed by the consumer's energy manager. The assets are monitored by the energy manager, which sends the consumption and production data to the flexibility management platform, along with metered data if they are available. Based on these data, the flexibility management platform forecasts the potential flexibility for the next periods of time, along with the associated prices, prepares flexibility bids and sends them to the technical aggregator. For the accepted and/or activated bids, the platform sends the energy manager appropriate control signals to ensure a sufficient energy margin to be able to activate the flexibility propositions and/or to trigger delivery. Both at their levels, the energy manager and the platform monitor the delivery of flexibility. The flexibility management platform sends information to the consumer / energy manager about the flexibility provision activities (activations, flexibility delivered, remuneration, etc.).

   d. Roles:

i. *Public consumer (energy manager) (role)*: Provides the flexibility of its assets through the control carried out by its Energy Manager.

ii. *Technical aggregator (role)*: Market platform operator. Operator of the GlocalFlex platform.

iii. *Flexibility management service provider (role)*: Operator of the flexibility management platform.

iv. *Electricity supplier (role)*: Electricity supply to the consumer and billing.

v. *DSO (role)*: Operation of the distribution network: electricity physical delivery. Operation of the smart meter and the metering system.

4. **FR_BUC04: Provision of flexibility to the energy markets and to BRPs**:

   a. Scope: The scope of this use case is limited to the flexibility of residential and public consumers. This flexibility is aggregated to be proposed to day-ahead and intraday energy markets, or to BRPs. The processes and optimisations carried out at consumers' level (e.g., by the energy box or the energy manager) to provide flexibility are out of scope of this use case and are described in BUCs FR_BUC01, FR_BUC02, and FR_BUC03. The aggregator registration processes are not considered in this use case. The compensation process of the supplier by the aggregator is taken into account but the two models applicable in France are not described in detail in this business use case.

   b. Objective(s):

      i. Aggregation of consumers' flexibility in order to trade it on the day-ahead and intraday energy markets or to propose it to a BRP.

      NB. The description of the mechanisms to offer flexibility to BRPs is only briefly addressed in this BUC.

   c. Short description: Flexibility of residential and public consumers is procured by the aggregator from the GLocalFlex platform (operated by the technical aggregator) and incorporated in the aggregator's optimisation, along with other resources in its portfolio to submit bids to day-ahead and intraday energy markets or to propose flexibility to BRPs. For accepted bids/offers, the aggregator dispatches the procured consumers' flexibility along with other resources of its portfolio. On the day-ahead and intraday energy markets, two strategies for the aggregator with different levels of uncertainties and risk coverage needs can be considered and compared:

      i. The aggregator first submits bids to the markets on the basis of the resources in its portfolio and for the accepted bids procures consumers' flexibility from the technical aggregator to possibly reduce its costs.

      ii. The aggregator first procures consumers' flexibility from the technical aggregator and uses it to prepare and submit bids to the markets.

   d. Roles:

i. *Residential and public consumer (role)*: Provides the flexibility of its assets.

ii. *Technical aggregator (role)*: Market platform operator. Operator of the GlocalFlex platform.

iii. *Aggregator (role)*: Aggregates the flexibility of the consumers with the flexibility of other resources in its portfolio to trade them on the energy markets or to propose them to BRPs.

iv. *Energy market operator (role)*: Operates the day ahead and/or intraday energy markets.

v. *BRP (role)*: Ensures, for a given portfolio or group of players (balancing group), the financial liability for imbalance between realized energy injection and consumption. Carries out the operational planning of imbalances within its balancing group.

vi. *TSO (role)*: Secures and manages the physical generation-consumption balance. Responsible for the financial settlement of imbalances.

vii. *Metering data operator (DSO) (role)*: Operates the metering devices, collects, and processes the corresponding data, provides the metered data to the authorized users.

viii. *Supplier (role)*: Supplies electricity to the consumer. Electricity supply billing.

5. **FR_BUC05: Provision of flexibility to the TSO for balancing and frequency regulation services**:

   a. Scope: The scope of this use case is limited to the flexibility of residential and public consumers. This flexibility is aggregated to provide balancing and frequency control ancillary services such as Frequency Containment Reserve (FCR), aFRR, mFRR and Replacement Reserve (RR), and specific balancing mechanisms. Congestion management services are considered only if they can be procured through the balancing mechanisms. The processes and optimisations carried out at consumers' level (e.g., by the energy box or the energy manager) to provide flexibility are out of scope of this use case and are described in business use cases FR_BUC01, FR_BUC02, and FR_BUC03. The prequalification processes are not considered in this use case.

   b. Objective(s):

      i. Aggregation of consumers' flexibility to provide balancing and frequency regulation services to the electricity TSO.

   c. Short description: Flexibility of residential and public consumers is procured by the aggregator from the GLocalFlex platform (operated by the technical aggregator) and incorporated in the aggregator's optimisation, along with the other resources in its portfolio to submit bids to the balancing and frequency regulation markets and services procurement mechanisms (operated by the TSO). For accepted and/or activated bids, the aggregator dispatches the procured consumers' flexibility along with other resources of its portfolio. Two strategies with different levels of uncertainties and risk coverage needs for the aggregator can be considered and compared:

i. The aggregator first submits bids to the markets on the basis of the resources in its portfolio and for the accepted bids procures consumers' flexibility from the technical aggregator to possibly reduce its costs.

ii. The aggregator first procures consumers' flexibility from the technical aggregator and uses it to prepare and submit bids to the markets.

d. Roles:

i. *Residential and public consumer (role)*: Provides the flexibility of its assets.

ii. *Technical aggregator (role)*: Market platform operator. Operator of the GlocalFlex platform.

iii. *Aggregator (role)*: Aggregates the flexibility of the consumers with the flexibility of the other resources in its portfolio to trade them on the balancing and frequency ancillary service markets.

iv. *Balancing market operator (TSO) (role)*: Operates the balancing and frequency regulation markets.

v. *Metering data operator (DSO) (role)*: Operates the metering devices, collects, and processes the corresponding data, provides the metered data to the authorized users.

6. **FR_BUC06: Provision of flexibility to the DSO at local level**:

a. Scope: The scope of this use case is limited to the flexibility of residential and public consumers. This flexibility is aggregated to provide flexibility services to the DSO for the operation of the distribution network. The processes and optimisations carried out at consumers' level (e.g., by the energy box or the energy manager) to provide flexibility are out of scope of this use case and are described in BUCs FR_BUC01, FR_BUC02, and FR_BUC03. The flexibility procurement mechanism based on calls for tenders set up by the largest French DSO is considered in this use case.

b. Objective(s):

i. Aggregation of consumers' flexibility to provide services to the electricity DSO at the local level for the operation of the distribution grid.

c. Short description: The DSO launches calls for tenders to procure local flexibilities to support the operation of the distribution network. The aggregator answers the calls and submits flexibility offers to the DSO, integrating the flexibility potentials of the residential and public consumers participating in the GLocalFlex platform. For accepted offers, when an activation signal is received from the DSO, the aggregator procures flexibility of residential and public consumers from the GLocalFlex platform (operated by the technical aggregator) and incorporates it in its optimisation and dispatch, along with the other resources in its portfolio to meet the DSO's flexibility request.

d. Roles:

i. *Residential and public consumer (role)*: Provides the flexibility of its assets.

ii. *Technical aggregator (role)*: Market platform operator. Operator of the GlocalFlex platform.

iii. *Aggregator (role)*: Aggregates the flexibility of the consumers with the flexibility of the other resources in its portfolio to trade it on the DSO's flexibility procurement mechanism.

iv. *DSO (Role)*: Operates the electrical distribution network in a given area. Procures flexibility for this purpose.

v. *Metering data operator (DSO)*: Operates the metering devices, collects, and processes the corresponding data. Provides the metered data to the authorized users.

vi. *Supplier (role)*: Supplies electricity to the consumer. Electricity supply billing

2.4. German pilot

The German pilot consists of two geographically separated locations. The first location is TU Dortmund University's Smart Grid Technology Lab, which is a laboratory testbed with various real hardware devices and powerful testing capabilities through its real-time simulators and, hence, enables the realization of Power Hardware in the Loop simulations in various testing scenarios with real-time interaction of flexible assets and its hardware devices for communication. The second location is SWW Wunsiedel GmbH's distribution system. The field environment is an operational power system for the local supply of the municipality and is equipped with flexible assets to be considered in the context of GLocalFlex. The trial site is located in Schönbrunn, a village near Wunsiedel, chosen due to its high-density RES and a large Combined Heat and Power (CHP) plant with a Photovoltaic (PV) array and heat storage tank. The purpose of the pilot is to develop, demonstrate and replicate appropriate services and BMs for the GLocalFlex market platform with primary consideration of physical grid restrictions.

The German pilot aims to test three different BUCs:

1. **DE_BUC01: Basic flexibility trading toolchain**:
    a. Scope: Enable basic flexibility trading between flexible asset and a DSO.
    b. Objective(s):
        i. Market integration of flexible assets and small users.
        ii. Market integration of a DSO.
        iii. Placing of orders.
        iv. Processing of market feedback.
        v. Physical realization of traded flexibility.
        vi. Gaining financial benefit.

c. Short description: Flexibility trading between owners of flexible assets and a single buyer/seller in the form of a small-scale DSO. Comprises offer generation, placement, feedback processing and physical realisation and validation.

d. Roles:

i. *Flexibility operator (Producer, Consumer, Renewable Energy Provider)*: An operator that owns the flexible asset and wants to make a profit from using its flexibility through automated processes. Can be a party that consumes electricity, generates electricity or generates electricity from renewable sources and feeds it into the grid. The variability of their production can create a need for flexibility services to balance supply and demand on the grid.

ii. *Energy Service Company (ESCO)*: It provides professional energy services to the end-user, which can include energy audits, project design and implementation, maintenance and operation, and energy financing. Assumed to be the provider of the hardware-software toolchain for a local Energy Management System (EMS)+STB integration.

iii. *DSO (Energy Retailer)*: The DSO ensures the stability of the power grid. They can purchase flexibility from market participants such as households to help maintain grid balance. Also, due to being the local supplier serves as the energy retailer sells electricity to consumers and may offer various tariff schemes. Can purchase flexibility for congestion management, physical balancing or for marketing on a wholesale market through a demand response aggregator.

iv. *Demand response aggregator*: Manages a pool of residential and/or commercial energy consumers, utilising their combined energy flexibility to offer services to the electricity grid or energy market. Is contracted to the DSO and can use the flexibility purchased on the GLocalFlex market for wholesale market trades. So, no direct connection to flexibility operators is in place.

v. *NEMO*: An entity designated by the competent authority to perform tasks related to single day-ahead or single intraday coupling. Ensures the ability to place market orders, perform matching, and inform actors.

vi. *Digital payment service provider*: The digital payment service provider operates a platform that enables transactions in digital currencies. This could be used for financial transactions within the flexibility market, such as compensating residential consumers for providing flexibility.

vii. *Energy regulatory authority*: It is responsible for overseeing the operation of energy markets, ensuring they function in a competitive, fair, and transparent manner.

2. **DE_BUC02: Grid-aware flexibility purchase**:

a. Scope: Ensure physical grid restrictions are not violated when purchasing flexibility.

b. Objective(s):

i. Market integration of flexible assets and small users.

ii. Market integration of a DSO.

iii. Placing of orders.

iv. Processing of market feedback.

v. Physical realization of traded flexibility.

vi. Gaining financial benefit.

vii. Enable a toolset so that the DSO can evaluate the physical effects of a flexibility activation on the power system.

viii. Use the system state deviations for limitations on trades.

c. Short description: The single DSO is buying/selling flexibility for the wholesale market with consideration of local grid restrictions.

d. Roles:

i. *Flexibility operator (Producer, Consumer, Renewable Energy Provider)*: An operator that own the flexible asset and wants to make a profit from using its flexibility through automated processes. Can be a party that consumes electricity, generates electricity or generates electricity from renewable sources and feeds it into the grid. The variability of their production can create a need for flexibility services to balance supply and demand on the grid. A single flexibility operator is one of the sellers on the platform. Can be of varying scale in dependency of the asset dimensions and regulatory relation.

ii. *ESCO*: An ESCO provides professional energy services to the end-user, which can include energy audits, project design and implementation, maintenance and operation, and energy financing.

iii. *DSO (Energy Retailer)*: The DSO ensures the stability of the power grid. They can purchase flexibility from market participants such as households to help maintain grid balance. Also, due to being the local supplier serves as the energy retailer sells electricity to consumers and may offer various tariff schemes. Is the single buyer on the platform and can purchase flexibility for congestion management, physical balancing or for marketing on a wholesale market through a demand response aggregator.

iv. *Demand response aggregator*: It manages a pool of residential and/or commercial energy consumers, utilising their combined energy flexibility to offer services to the electricity grid or energy market.

v. *NEMO*: An entity designated by the competent authority to perform tasks related to single day-ahead or single intraday coupling.

vi. *Digital payment service provider*: The digital payment service provider operates a platform that enables transactions in digital currencies. This could be used for financial

transactions within the flexibility market, such as compensating residential consumers for providing flexibility.

vii. *Energy regulatory authority*: It is responsible for overseeing the operation of energy markets, ensuring they function in a competitive, fair, and transparent manner.

3. **DE_BUC03: Mitigation of external power volume**:
    a. Scope: Purchase flexibilities based on a central power flow measurement.
    b. Objective(s):
        i. Market integration of flexible assets and small users.
        ii. Market integration of a DSO.
        iii. Placing of orders.
        iv. Processing of market feedback.
        v. Physical realization of traded flexibility.
        vi. Gaining financial benefit.
        vii. Steer the power flow at a grid connection point towards and explicit power band.
        viii. Use direct control to minimize the power flow.
    c. Short description: The DSO is looking to minimize the high-voltage (HV)/ medium voltage (MV) connection power flow to minimize grid usage fees that have to be paid to the upstream TSO in Germany.

2.5. Spanish pilot

The focus of the Spanish pilot is on two separate sites, one rural and the other in an urban environment. The rural site is a rural Local Energy Community (LEC) located in the Peón valley (Villaviciosa, Asturias), whereas the urban site is situated in the centre of Gijón (Asturias), in Garcia Rama's offices. The primary objective of both sites is to implement demand response programs that are based on increasing flexibility capacity and energy sharing amongst households in rural energy communities as well as in urban areas. Additionally, these sites aim to promote the adoption and usage of connected interoperable energy smart home appliances, such as EV charging and home storage solutions, in order to accelerate the deployment of demand-side flexibility services. This will ultimately reduce the entry barrier and facilitate replication.

The Spanish pilot aims to test four different BUCs:

1. **ES_BUC01: Optimise home energy consumption and generation**:
    a. Scope: Identification, optimisation and adaptation of flexible energy sources and consumption patterns in residential households.
    b. Objective(s):

i. Systematization of consumption and generation data to identify flexibility sources.

ii. Adapt and optimise residential energy consumption patterns in response to market signals.

iii. Improve understanding of flexibility markets for consumers.

iv. Contribute to grid stability and carbon emission reduction through demand optimisation and load shifting.

c. Short description: FlexiHome Energy Optimisation is a project designed to unlock the potential of demand-side flexibility in the energy market. Through the analysis of household consumption and generation patterns, flexibility sources that can be optimised to adapt to variations in electricity and flexibility market prices are identified, particularly focusing on schedulable consumption and storage system charging and discharging patterns. FlexiHome automatically collects data on consumption and battery charge from a LEC, combining it with weather forecasts and announced electricity prices for the next day. Two predictive components are developed that estimate the hourly electrical consumption needs for the next day and the anticipated generation and storage capacity based on weather predictions. The optimisation system identifies the optimal consumption and battery charge pattern to minimise the cost of purchased electricity, taking into account the sale of surpluses at lower prices. The multipliers and slack variables of the optimisation problem allow identification of the hours in which flexibility can be offered in the market and the minimum charge price for the flexibility to be profitable.

d. Roles:

i. *Household consumers (role)*: The household owner is responsible for the HEMS, deciding how to balance comfort, cost, and sustainability in line with recommendations.

ii. *Energy retailer*: The energy retailer sells electricity to consumers and may offer various tariff schemes. These could include time-of-use tariffs, which would be particularly relevant to users.

iii. *DSO*: The DSO ensures the stability of the power grid. They can purchase flexibility from market participants such as households with FlexiHome systems to help maintain grid balance.

2. **ES_BUC02: Flexibility Trading Platform Assistance**:

a. Scope: The project focuses on developing and maintaining an automated system to facilitate participation in a comprehensive flexibility energy trading platform. This will include automated tools for bidding in flexibility auctions, aggregation of energy offers, and automated economic and financial management. It should be designed to be accessible to a wide range of users, from large corporations to individual prosumers, with the goal of improving efficiency in the buying and selling of energy flexibility and supporting the transition towards a more efficient, flexible, and sustainable energy system.

b. Objective(s):

i. Facilitate interaction with flexibility trading platforms: Provide users with an efficient way to interact with flexibility trading platforms that function as auctions or continuous markets, linked to digital trading and payment platforms.

ii. Automate the process of participation in the flexibility market: Implement automated functionalities using advanced algorithms and artificial intelligence to automate the bidding process in flexibility markets, including the calculation of minimum acceptable prices for flexibility service providers.

iii. Automated contractual, economic and financial management: Extend the automated operational functionality to financially manage transactions on the digital payment platform, including the formalization of contracts and processing of payments, and provide a clear view of the user's economic performance in the flexibility market.

iv. Facilitate access and usability for a wide range of users: Design the service to be user-friendly and accessible to a broad range of users, from large companies to individual prosumers.

c. Short description: This service assists users in efficiently interacting with flexibility trading platforms, which operate as auctions and are typically linked to a digital payment platform. A flexibility offers aggregator, and an automated way of operating are provided, including the calculation of bids in the flexibility auction and financial management on the payment platform.

d. Roles:

i. *Household consumers (role)*: The household owner is responsible for the HEMS, deciding how to balance comfort, cost, and sustainability.

ii. *Producer (role)*: A party that generates electricity.

iii. *Digital payment service provider (role)*: The digital payment service provider operates a platform that enables transactions in digital currencies. This could be used for financial transactions within the flexibility market, such as compensating residential consumers for providing flexibility.

3. **ES_BUC03: Consulting services for home domotics**:

a. Scope: Consulting services for implementing smart home automation solutions.

b. Objective(s):

i. Provide expert consulting services to residential customers for implementing home domotics solutions.

ii. Assess customer requirements and analyse their existing infrastructure to develop tailored solution proposals.

iii. Offer guidance on selecting, integrating and customising smart devices and automation technologies.

iv. Connecting homeowners or property owners with suitable home automation solutions.

v. Providing customised recommendations based on specific needs and preferences.

vi. Ensuring compatibility of the proposed automation systems with the property's infrastructure.

c. Short description: The project offers consulting services for home domotics, which involves evaluating the infrastructure and analysing energy consumption patterns to provide customised solutions for homeowners' specific needs.

d. Role:

i. *Household consumer*: Individuals or families residing in residential properties seeking guidance and tailored solutions to optimise their home through the implementation of smart automation systems.

ii. *ESCO*: An ESCO provides professional energy services to the end-user, which can include energy audits, project design and implementation, maintenance and operation, and energy financing.

iii. *Smart appliance manufacturer*: A smart appliance manufacturer produces devices (like smart thermostats, dishwashers, or electric vehicle chargers) that can adjust their operation based on commands from an EMS, contributing to the energy flexibility of a home or business.

iv. *Appliance automation device manufacturer*: The manufacturer designs and produces devices that enable the automation of non-smart appliances. These devices can receive signals from an EMS and use these signals to control the operation of the appliances.

4. **ES_BUC04: Domotic solutions for household energy sources**:

a. Scope: Installation of automation systems for flexible energy sources in residential households.

b. Objective(s):

i. Demonstrating the functionality and capabilities of the home automation system related to flexibility markets.

ii. Assisting users in setting up and utilising the system effectively.

iii. Tracking and managing installed systems.

iv. Enhancing the overall energy efficiency and flexibility of residential households.

v. Provide ongoing support, maintenance, and updates to ensure the smooth functioning of the automation infrastructure.

c. Short description: Installation of devices for automated management of household energy sources. Automation solutions manage and optimise energy consumption, integrate renewables, and monitor systems for enhanced energy and cost savings.

d. Roles:

i. *Household consumer*: Individuals or families residing in residential households seeking to optimise energy consumption and reduce costs.

ii. *ESCO*: An ESCO provides professional energy services to the end-user, which can include energy audits, project design and implementation, maintenance and operation, and energy financing.

iii. *Smart appliance manufacturer*: A smart appliance manufacturer produces devices (like smart thermostats, dishwashers, or electric vehicle chargers) that can adjust their operation based on commands from an EMS, contributing to the energy flexibility of a home or business.

iv. *Appliance automation device manufacturer*: The manufacturer designs and produces devices that enable the automation of non-smart appliances. These devices can receive signals from an EMS and use these signals to control the operation of the appliances.

2.6. Swiss pilot

The Swiss pilot is composed of two sites.

The Valle Verde site, located in Massagno (in the Lugano Canton), is the current site of interest as it is already operational and would allow to implement the targeted developments for the smart EMS and the GLocalFlex platform. It consists of a building containing 12 multi-family households, erected in 2019 and which are rented to tenants, with a total surface area of 1200 m^2.

The Figino site, located in Lugano, remains in construction and will, therefore, be a second pilot site for later stages of the project. It consists of a residential building with 8 housing units to be completed at the end of 2025. The total surface area will be of 1450 m^2.

The Swiss pilot aims at demonstrating the GLocalFlex approach to integrate the provision of flexibility from a variety of appliances and energy systems coupled with an advanced local EMS.

The Swiss pilot aims at testing two different BUCs:

1. **CH_BUC01: Local energy management and flexibility exploitation of residential consumers within an energy community**:

a. Scope: This use case focuses on the local energy management and flexibility exploitation of identified sources from residential consumers within an energy community using the NRGMaestro™ energy management software.

b. Objective(s):

i. The goal is to maximise the self-consumption of the energy community to become a net zero energy building. This is coupled with a time of use (ToU) optimisation for cost reduction, promoting the engagement of consumers to increase their flexibility.

c. Short description: This BUC envisions identifying and optimising flexible energy resources within residential energy communities to lower costs and foster consumer flexibility using the NRGMaestro™ energy management software. The software analyses generation and consumption patterns to identify the flexibility sources. The local management of energy to reduce energy costs is done through the smart scheduling of storage & flexible prosumption to maximise self-consumption and to benefit from the best tariffs. This also entails engaging the consumer to increase its flexibility. It aims to efficiently manage these assets (collective or individual) to improve investment returns, providing comfort needs (heat, air conditioning, hot water, timely EV charging), while minimising operating costs (including hidden costs like car battery degradation). Transparency is a key goal to ensure consumers understand their energy use, costs and the opportunity to increase their flexibility for financial and environmental benefits.

d. Roles:

i. *Residential consumer*: The residential consumer is an electricity consumer, and flexibility provider. The consumer provides flexibility through their white goods.

ii. *Energy community*: Group of consumers with shared assets. The energy community consumers electricity, generates electricity, and provides flexibility. The energy community has a photovoltaic system for renewable energy generation coupled with a battery energy storage system.

iii. *Smart appliance manufacturer*: A smart appliance manufacturer produces devices (like smart thermostats, dishwashers, or electric vehicle chargers) that can adjust their operation based on commands from an EMS, contributing to the energy flexibility of a home or business.

iv. *Energy community manager*: The energy community manager oversees and ensures reliable and transparent operations across all residential consumers and collective assets.

v. *Energy retailer (DSO)*: The energy retailer sells electricity to consumers and may offer various tariff schemes. The energy retailer, in this case the local DSO, provides tariffs that will dictate the ToU optimisation carried out by the local EMS.

2. **CH_BUC02: Flexibility trading from energy communities to energy markets for intraday optimisation and local congestion management**:

a. Scope: This use case focuses on the flexibility trading of residential consumers within an energy community. The flexibility of the energy community is aggregated for trading on the intraday energy markets, or for local congestion management. The processes and optimisations carried

out at the energy community level using NRGMaestro™ are described in CH-BUC01. The aggregator registration processes are assumed to be completed in this use case. The sequence diagram's highest level is limited to the interactions with the aggregator.

b. Objective(s):

   i. The goal is to estimate the aggregated flexibility of the energy community to trade it on the intraday energy markets or use it for local congestion management services.

c. Short description: The aggregated flexibility of the energy community is traded on the intraday energy markets or local flexibility markets to support the operation of the distribution network, in particular for congestion management. The flexibility from the energy community is communicated through the GLocalFlex platform to the aggregator, which is a BRP or a congestion service provider. The aggregator incorporates this flexibility into its portfolio to propose it to the intraday energy market or to the local flexibility market for congestion management. Based on the accepted bids or offers, the aggregator dispatches the resources in its portfolio. The GLocalFlex platform then activates the energy community flexibility.

d. Roles:

   i. *Energy community*: Group of consumers with shared assets. The energy community consumers electricity, generates electricity, and provides flexibility. The energy community has a photovoltaic system for renewable energy generation coupled with a battery energy storage system.

   ii. *Demand response aggregator*: The demand response aggregator manages a pool of residential and/or commercial energy consumers, utilising their combined energy flexibility to offer services to the electricity grid or energy market. The aggregator is assumed to be a BRP.

   iii. *BRP*: Ensures, for a given portfolio or group of players (balancing group), the financial liability for imbalance between realized energy injection and consumption. Carries out the operational planning of imbalances within its balancing group.

   iv. *Congestion Service Provider (CSP)*: A CSP is a market participant who offers congestion management services to the TSO or DSOs. After prequalification the CSP may, on behalf of its portfolio/connected parties make redispatch bids. In contrast to the balancing services, congestion management services are location-bound. The role of CSP is not formally implemented yet, work is ongoing to make it a regular market role in the near future.

   v. *Energy market operator*: The energy market operator operates the intraday energy markets, and/or the local flexibility markets.

   vi. *DSO*: The DSO ensures the stability of the power grid. It can purchase flexibility from market participants such as households to help maintain grid balance. The DSO requests the local congestion management service.

3. Overarching BUCs definition

The set of twenty-three particular BUCs gathered from GLocalFlex pilots can be consolidated under eight overarching BUCs, which are described in the following sections. Some of them are further divided into sub-BUCs, in order to take into account slight modifications in the way of implementing the BUC, although the general scope and objectives remain the same.

In all the cases, BUCs are intended to create monetary value for one or several actors.

Figure 1 below shows the complementarity of the different overarching BUCs across the value chain.

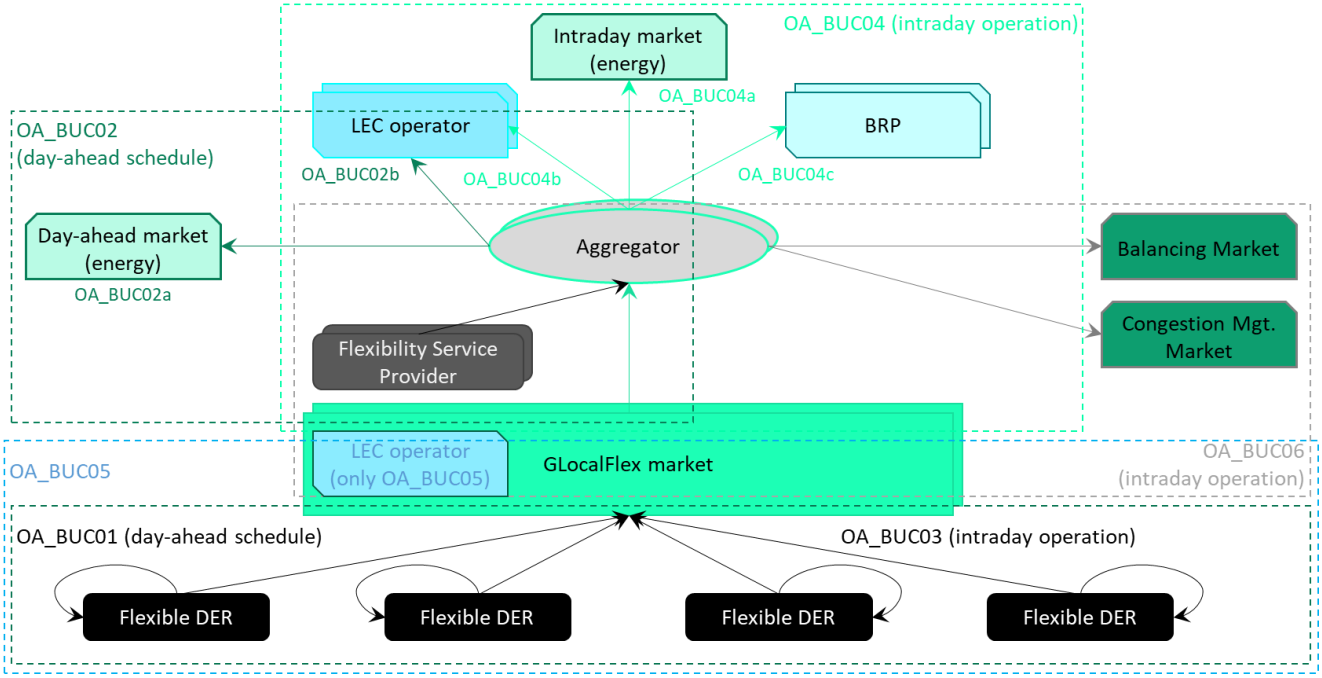

Figure 1. Complementarity of the overarching BUCs across the value chain

3.1. OA_BUC01: Optimise consumption, generation and storage the day before delivery

This overarching BUC focuses on the optimisation of energy usage within flexible energy sources. The use and trade of flexibility is optimised the day before delivery[2], in order for small-scale Distributed Energy Resources (DER) to sell their flexibility into the GLocalFlex market. This optimisation process can be either a) manual, or b) automatic.

[2] Flexibility could also be traded in longer time horizons (week-ahead, month-ahead or year-ahead delivery), which would result in a very similar BUC description to this OA_BUC01, so only day-ahead delivery is considered for simplicity reasons.

The value chain of OA_BUC01 is presented in Figure 2.

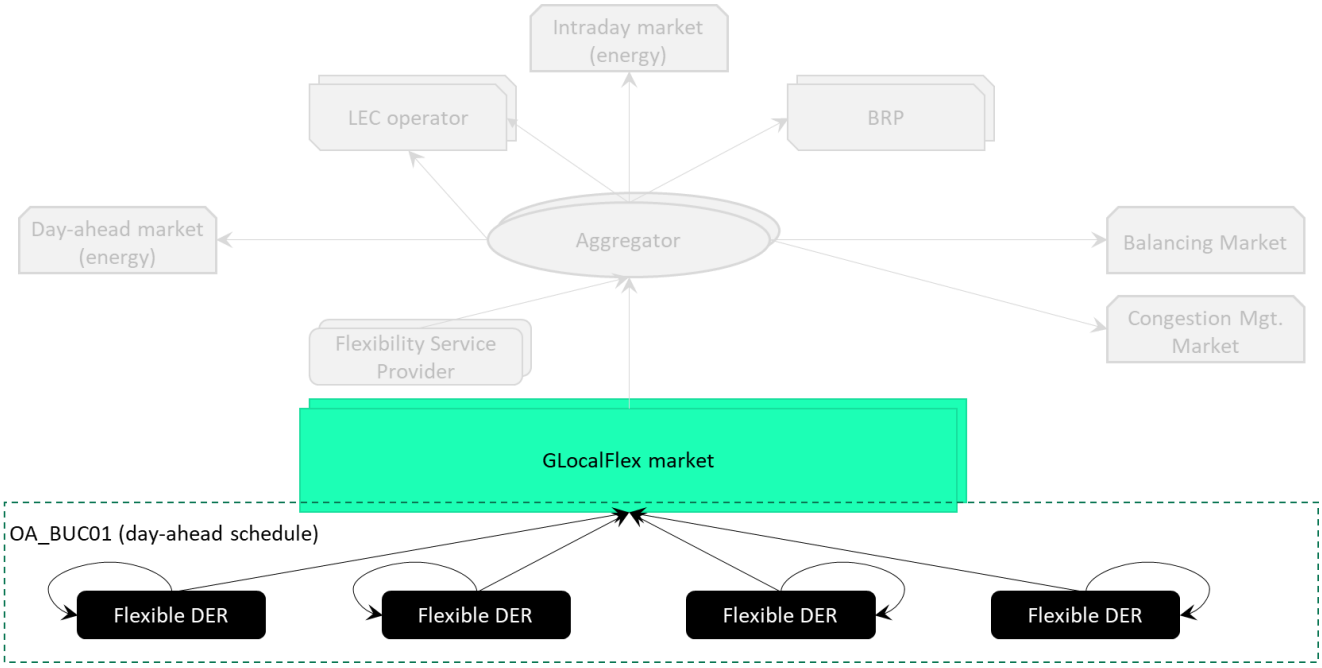

Figure 2. Value chain of the OA_BUC01

Objectives related to this OA_BUC01 are:

1. Reduce consumption peaks, in order to avoid increasing the contracted connection size with the power system.
2. Savings for consumers at high-price rates, as they can either reduce consumption or increase the export of locally produced energy in high-price periods.
3. Maximise self-consumption, in order to become a net zero energy consumer/building/community.
4. Energy democratisation, as small-scale consumers will be able to contribute to energy transition, despite the small size of their available flexibility.
5. Maintaining consumers' comfort level or utility of energy use, since their first aim is to use energy and, only then, to be flexible.
6. For many consumers, automating the activation / trading process can also be interesting, as they may not have the skills, time or willingness to trade and activate flexibility resources on their own. Some other consumers, on the contrary, will be willing to activate the use of flexibility themselves, as they may have the required skills and time to do so, and they prefer to have control over the actions in their facilities.
7. Reduce the usage of fossil energy sources/Increase RES use/Reduction of CO_2 emissions.

Although all these objectives relate to consumers and flexibility owners, the government is also interested in promoting energy democratisation, reducing CO_2 emissions and avoiding or deferring the construction of energy infrastructures (lines, substations, power plants).

There are few **prerequisites** for the execution of OA_BUC01:

- Battery characteristics (capacity and lifetime effects of charge/discharges) are known.
- The energy flexibility sources have been identified.
- The following forecasts are available:
    - Consumption (based on historical data, weather forecasts and user preferences)
    - Generation (based on historical data and weather forecasts)
    - Day-ahead prices
    - Flexibility availability

The **roles** to be considered in the OA_BUC01 are:

- *Consumer* [2]*:* A party that consumes energy. This is a type of party connected to the grid.
- *Producer* [2]*:* A party that generates electricity. This is a type of party connected to the grid.
- *Flexibility Service Provider* [6][3]*:* A party providing flexibility services to energy stakeholders via bilateral agreements or flexibility markets. A FSP can also be a Balancing Service Provider (BSP) if enabled to the Load Frequency Control (LFC) services. In the Bridge HEMRM, FSP is an extension of BSP. FSP offer services potentially to all the system operators, directly or through market operators.
- *Energy trader* [2]*:* A party that is selling or buying energy.
- *Energy Supplier* [2]*:* An energy supplier delivers energy to or takes energy from a party connected to the grid at an accounting point. An accounting point can have only one energy supplier. When additional suppliers (with firm (block) energy contracts) are involved, the energy supplier delivers/takes the difference between contracted and established (e. g. measured or calculated) production/consumption.
- *BRP* [2]*:* A party financially accountable for its imbalances. A balance responsibility requires a contract proving financial security with the imbalance settlement responsible of the scheduling area entitling the party to operate in the market. Imbalance means an energy volume calculated for a BRP and representing the difference between the allocated volume attributed to that BRP and the final position of that BRP, including any imbalance adjustment applied to that BRP, within a given imbalance settlement period.
- *Metering:*

[3] In general, the definitions in the HEMRM [2] have been used, except in the cases where the definitions provided by BRIDGE [6] are closer to the roles to be considered in GLocalFlex.

- *Metered data responsible* [2]*:* A party responsible for the establishment and validation of measured data based on the collected data received from the metered data collector. The party is responsible for the history of metered data for a metering point.
- *Metered data administrator* [2]*:* A party responsible for storing and distributing validated measured data.
- *Metered data collector* [2]*:* A party responsible for meter reading and quality control of the reading.

- *Market operator* [2]*:* A party that provides a service whereby the offers to sell energy are matched with bids to buy energy. This activity can be conducted in the forward, days-ahead and/or intraday timeframes, and can be combined with transmission capacity allocation in the context of market coupling. This is usually an energy/power exchange or platform.
- *Imbalance settlement responsible* [2]*:* A party that is responsible for settlement of the difference between the contracted quantities with physical delivery and the established quantities of energy products for the balance responsible parties in a scheduling area.

Eleven **specific BUCs** are assigned to OA_BUC01:

1. CZ_BUC02: Facility management aggregation to support traded balancing mechanisms.
2. ES_BUC01: Optimise home energy consumption and generation.
3. ES_BUC02: Flexibility trading platform assistance.
4. ES_BUC04: Domotic solutions for household energy sources.
5. FI_BUC01: Optimising consumption.
6. FI_BUC02: Storing overproduction.
7. FI_BUC03: Responding to low production.
8. FI_BUC06: Optimising district heating.
9. FR_BUC01: Enable the flexibility of residential consumers through a fully automated approach using an energy box and the associated IoT ecosystem.
10. FR_BUC02: Enable the flexibility of residential consumers through a behavioural approach using an energy box and the associated IoT ecosystem.
11. FR_BUC03: Enable the flexibility of public consumers already equipped with an energy manager.

3.2. OA_BUC02: Optimise flexibility trading the day before delivery

In this overarching BUC, the aggregator (or retailer) uses the flexibility procured the day before delivery in the GLocalFlex market or by any other means to trade in energy markets, which can be either a) the wholesale day-ahead market, or b) local markets to trade energy within energy communities.

The value chain in OA_BUC02 is the one presented in Figure 3.

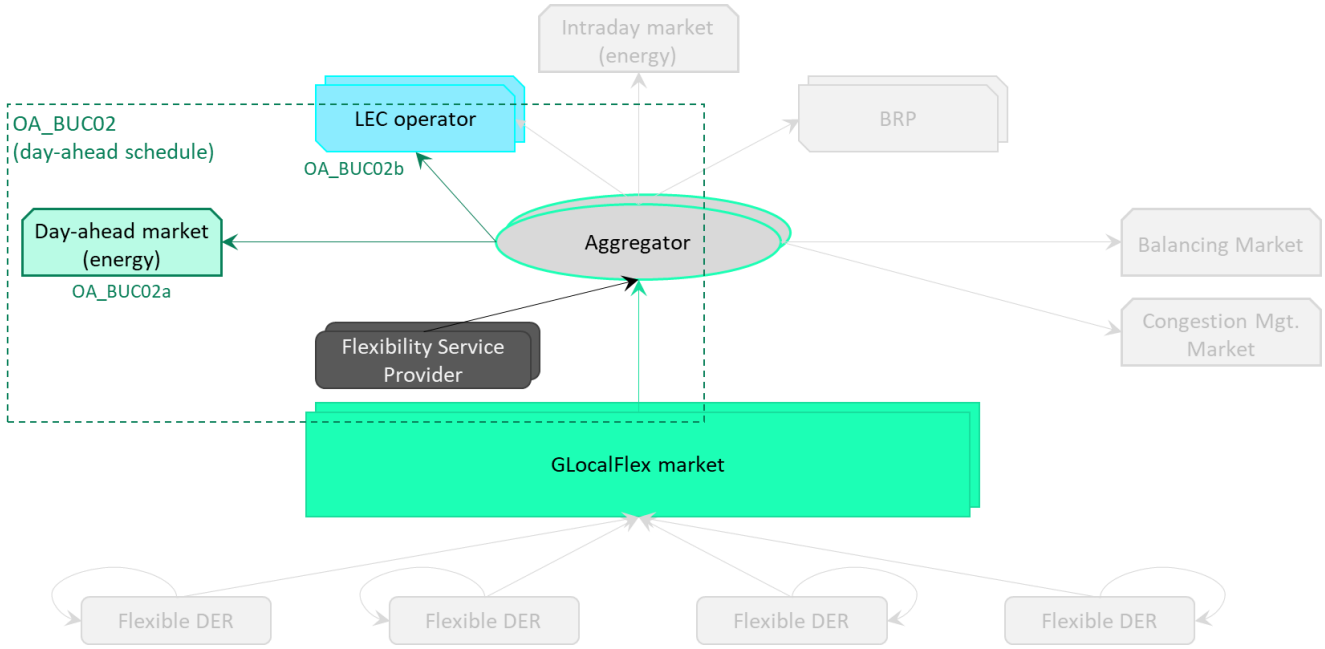

Figure 3. Value chain of the OA_BUC02

The main **objective** related to this OA_BUC02 is to trade energy either in energy markets or through bilateral agreements.

The **prerequisite** in this case is:

- Flexibility is procured in the GlocalFlex market or by any other means. The trade in the GLocalFlex market may happen either before or after trading flexibility in energy markets or signing bilateral agreements.

The **roles** to be considered in the OA_BUC02 are:

- *Resource aggregator* [2]*:* A party that aggregates resources for usage by other market participants. The aggregation must be defined by market rules.
- *Energy trader:* A party that is selling or buying energy [2]. In this case, the LEC operator would also be included here.
- *Flexibility service provider* [6]*:* A party providing flexibility services to energy stakeholders via bilateral agreements or flexibility markets. A FSP can also be a BSP if enabled to the LFC services. In the Bridge HEMRM, FSP is an extension of BSP. FSP offer services potentially to all the system operators, directly or through market operators.
- *Market operator* [2]*:* A party that provides a service whereby the offers to sell energy are matched with bids to buy energy. This activity can be conducted in the forward, days-ahead and/or intraday timeframes, and can be combined with transmission capacity allocation in the context of market coupling. This is usually an energy/power exchange or platform.

- *NEMO* [2]*:* An entity designated by the competent authority to perform tasks related to single day-ahead or single intraday coupling. A NEMO performs MCO (Market Coupling Operator) and CCP (Central Counter Party) functions. A NEMO runs a power exchange related to day-ahead or intraday market. A NEMO is a type of Market Operator.
- *BRP* [2]*:* A party financially accountable for its imbalances. A balance responsibility requires a contract proving financial security with the imbalance settlement responsible of the scheduling area entitling the party to operate in the market. Imbalance means an energy volume calculated for a BRP and representing the difference between the allocated volume attributed to that BRP and the final position of that BRP, including any imbalance adjustment applied to that BRP, within a given imbalance settlement period.
- *Metering:*
    - *Metered data responsible* [2]*:* A party responsible for the establishment and validation of measured data based on the collected data received from the metered data collector. The party is responsible for the history of metered data for a metering point.
    - *Metered data administrator* [2]*:* A party responsible for storing and distributing validated measured data.
    - *Metered data collector* [2]*:* A party responsible for meter reading and quality control of the reading.
- *Imbalance settlement responsible* [2]*:* A party that is responsible for settlement of the difference between the contracted quantities with physical delivery and the established quantities of energy products for the balance responsible parties in a scheduling area.

Two **specific BUCs** are assigned to OA_BUC02:

1. FI_BUC05: Matching market and demand.
2. FR_BUC04: Provision of flexibility to the energy markets and to BRPs.

3.3. OA_BUC03: Optimise consumption, generation and storage within the day of delivery

This overarching BUC also focuses on the optimisation of energy usage within flexible energy sources, but, on the contrary to OA_BUC01, the use and trade of flexibility is optimised within the same day of delivery, up to real-time. Small-scale DER sell flexibility within the day of delivery into the GLocalFlex market in different time horizons, based on either economic or technical requirements (e.g., due to a change in expected prices or electricity generation/consumption forecasts). The value chain of OA_BUC03 is presented in Figure 4.

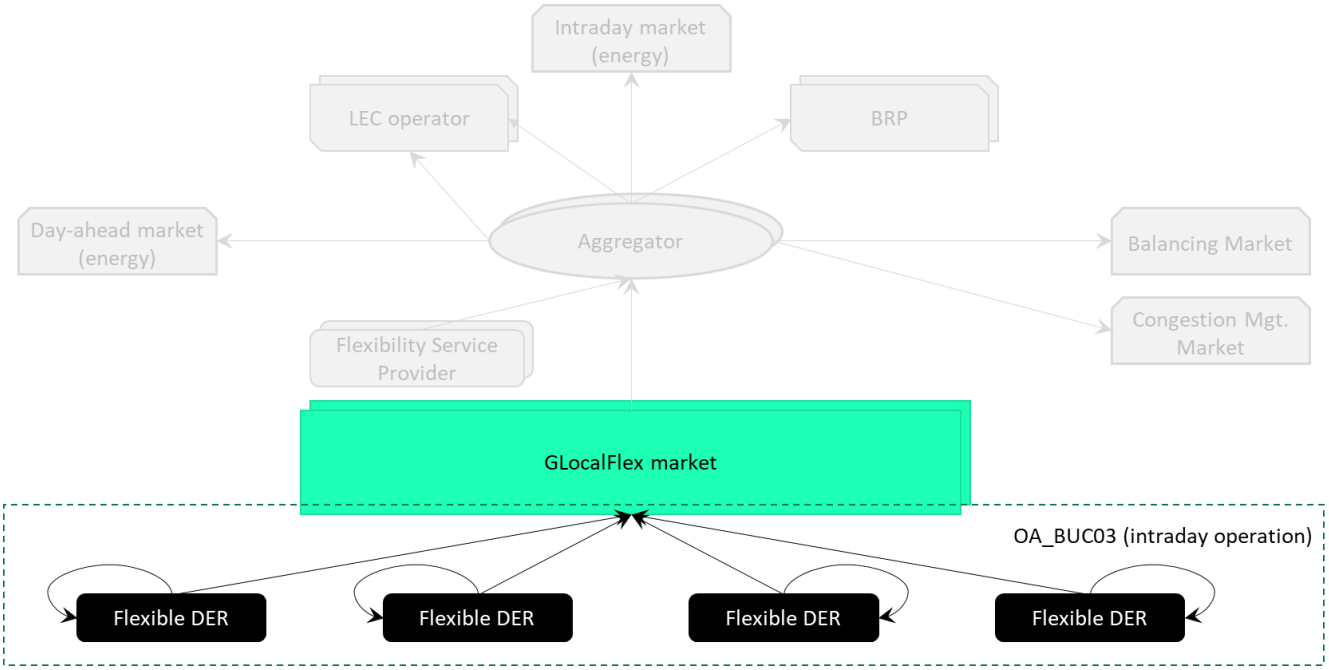

Figure 4. Value chain of the OA_BUC03

Objectives related to this OA_BUC03 are almost the same as for OA_BUC01:

1. Reduce consumption peaks, in order to avoid increasing the contracted connection size with the power system.
2. Savings for consumers at high-price rates, as they can either reduce consumption or increase the export of locally produced energy in high-price periods.
3. Maximise self-consumption, in order to become a net zero energy consumer/building/community.
4. Energy democratisation, as small-scale consumers will be able to contribute to energy transition, despite the small size of their available flexibility.
5. Maintaining consumers' comfort level or utility of energy use, since their first aim is to use energy and, only then, to be flexible.
6. For many consumers, automating the activation / trading process can also be interesting, as they may not have the skills, time or willingness to trade and activate flexibility resources on their own. Some other consumers, on the contrary, will be willing to activate the use of flexibility themselves, as they may have the required skills and time to do so, and they prefer to have control over the actions in their facilities. However, for flexibility delivery times close to real-time, automated control may be compulsory.
7. Reduce the usage of fossil energy sources/Increase RES use/Reduction of CO_2 emissions.

Although all these objectives relate to consumers and flexibility owners, the government is also interested in promoting energy democratisation, reducing CO_2 emissions and avoiding or deferring the construction of energy infrastructures (lines, substations, power plants).

There are few **prerequisites** for the execution of OA_BUC01:

- Battery characteristics (capacity and lifetime effects of charge/discharges) are known.
- The energy flexibility sources have been identified.
- The following forecasts are available:
    - Consumption (based on historical data, weather forecasts and user preferences)
    - Generation (based on historical data and weather forecasts)
    - Day-ahead prices and, possibly, intraday prices.
    - Flexibility availability
- For flexibility delivery times close to real-time, automated control may be compulsory.

The **roles** to be considered in the OA_BUC03 are the same as the identified ones for OA_BUC01 since the main difference between such OA_BUCs is only related to the schedule horizon (day-ahead for OA_BUC01 and intraday for OA_BUC03):

- *Consumer* [2]*:* A party that consumes energy. This is a type of party connected to the grid.
- *Producer* [2]*:* A party that generates electricity. This is a type of party connected to the grid.
- *Flexibility service provider* [6]*:* A party providing flexibility services to energy stakeholders via bilateral agreements or flexibility markets. A FSP can also be a BSP if enabled to the LFC services. In the Bridge HEMRM, FSP is an extension of BSP. FSP offer services potentially to all the system operators, directly or through market operators.
- *Energy trader* [2]*:* A party that is selling or buying energy.
- *Energy supplier* [2]*:* An energy supplier delivers energy to or takes energy from a party connected to the grid at an accounting point. An accounting point can have only one energy supplier. When additional suppliers (with firm (block) energy contracts) are involved, the energy supplier delivers/takes the difference between contracted and established (e. g. measured or calculated) production/consumption.
- *BRP* [2]*:* A party financially accountable for its imbalances. A balance responsibility requires a contract proving financial security with the imbalance settlement responsible of the scheduling area entitling the party to operate in the market. Imbalance means an energy volume calculated for a BRP and representing the difference between the allocated volume attributed to that BRP and the final position of that BRP, including any imbalance adjustment applied to that BRP, within a given imbalance settlement period.
- *Metering:*
    - *Metered data responsible* [2]*:* A party responsible for the establishment and validation of measured data based on the collected data received from the metered data collector. The party is responsible for the history of metered data for a metering point.

- *Metered data administrator* [2]*:* A party responsible for storing and distributing validated measured data.
- *Metered data collector* [2]*:* A party responsible for meter reading and quality control of the reading.

- *Market operator* [2]*:* A party that provides a service whereby the offers to sell energy are matched with bids to buy energy. This activity can be conducted in the forward, days-ahead and/or intraday timeframes, and can be combined with transmission capacity allocation in the context of market coupling. This is usually an energy/power exchange or platform.
- *Imbalance settlement responsible* [2]*:* A party that is responsible for settlement of the difference between the contracted quantities with physical delivery and the established quantities of energy products for the balance responsible parties in a scheduling area.

Sixteen **specific BUCs** are assigned to OA_BUC03:

1. CH_BUC01: Local energy management, and flexibility exploitation of residential consumers within an energy community.
2. CH_BUC02: Flexibility trading from energy communities to energy markets, and to DSOs for local congestion management.
3. CZ_BUC01: Dynamic price-aware facility management.
4. CZ_BUC02: Facility management aggregation to support traded balancing mechanisms.
5. DE_BUC01: Basic flexibility trading toolchain.
6. ES_BUC01: Optimise home energy consumption and generation.
7. ES_BUC02: Flexibility trading platform assistance.
8. ES_BUC04: Domotic solutions for household energy sources.
9. FI_BUC01: Optimising consumption.
10. FI_BUC02: Storing overproduction.
11. FI_BUC03: Responding to low production.
12. FI_BUC04: Participating on reserve markets.
13. FI_BUC06: Optimising district heating.
14. FR_BUC01: Enable the flexibility of residential consumers through a fully automated approach using an energy box and the associated IoT ecosystem.
15. FR_BUC02: Enable the flexibility of residential consumers through a behavioural approach using an energy box and the associated IoT ecosystem.
16. FR_BUC03: Enable the flexibility of public consumers already equipped with an energy manager.

3.4. OA_BUC04: Optimise flexibility trading up to real-time

As in OA_BUC02, the aggregator (or retailer) uses the flexibility procured either the day before delivery or within the day of delivery in the GLocalFlex market or by any other means to trade in energy markets, which can be a) the wholesale intraday market, or b) local markets to trade energy within energy communities, or flexibility can also be used to c) reduce imbalances of a BRP.

The value chain in OA_BUC04 is the one presented in Figure 5.

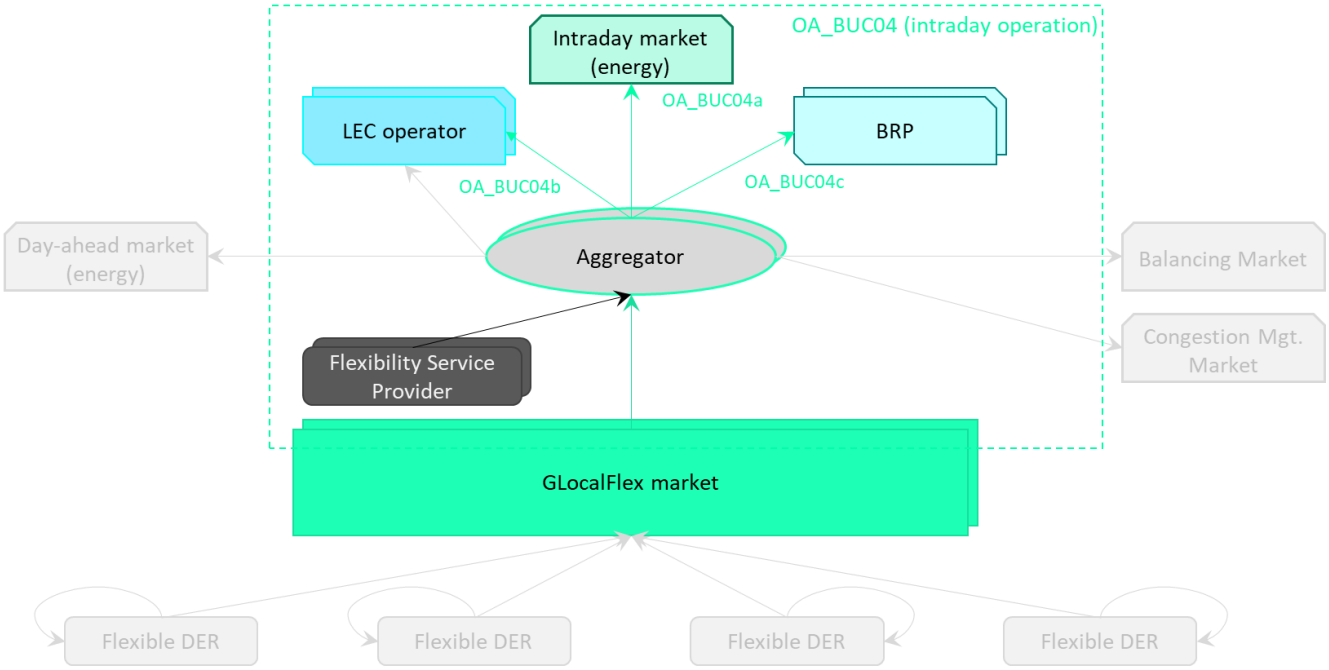

Figure 5. Value chain of the OA_BUC04

The main **objective** related to this OA_BUC04 is to trade energy either in energy markets or through bilateral agreements.

The **prerequisite** in this case is:

- Flexibility is procured in the GLocalFlex market or by any other means. The trade in the GLocalFlex market may happen either before or after trading flexibility in energy markets or signing bilateral agreements.

The **roles** to be considered in the OA_BUC04 are:

- *Resource aggregator* [2]*:* A party that aggregates resources for usage by other market participants. The aggregation must be defined by market rules.
- *Energy trader:* A party that is selling or buying energy. [2]. In this case, the LEC operator would also be included here.
- *Flexibility Service Provider* [6]*:* A party providing flexibility services to energy stakeholders via bilateral agreements or flexibility markets. A FSP can also be a BSP if enabled to the LFC services. In the Bridge

HEMRM, FSP is an extension of BSP. FSP offer services potentially to all the system operators, directly or through market operators.

- *Market operator* [2]*:* A party that provides a service whereby the offers to sell energy are matched with bids to buy energy. This activity can be conducted in the forward, days-ahead and/or intraday timeframes, and can be combined with transmission capacity allocation in the context of market coupling. This is usually an energy/power exchange or platform.
- *NEMO* [2]*:* An entity designated by the competent authority to perform tasks related to single day-ahead or single intraday coupling. A NEMO performs MCO (Market Coupling Operator) and CCP (Central Counter Party) functions. A NEMO runs a power exchange related to day-ahead or intraday market. A NEMO is a type of market operator.[2]
- *BRP* [2]*:* A party financially accountable for its imbalances. A balance responsibility requires a contract proving financial security with the imbalance settlement responsible of the scheduling area entitling the party to operate in the market. Imbalance means an energy volume calculated for a BRP and representing the difference between the allocated volume attributed to that BRP and the final position of that BRP, including any imbalance adjustment applied to that BRP, within a given imbalance settlement period.
- *Metering:*
    - *Metered data responsible* [2]*:* A party responsible for the establishment and validation of measured data based on the collected data received from the metered data collector. The party is responsible for the history of metered data for a metering point.
    - *Metered data administrator* [2]*:* A party responsible for storing and distributing validated measured data.
    - *Metered data collector* [2]*:* A party responsible for meter reading and quality control of the reading.
- *Imbalance settlement responsible* [2]*:* A party that is responsible for settlement of the difference between the contracted quantities with physical delivery and the established quantities of energy products for the balance responsible parties in a scheduling area.

Seven **specific BUCs** are assigned to OA_BUC04:

1. CH_BUC02: Flexibility trading from energy communities to energy markets, and to DSOs for local congestion management.
2. CZ_BUC02: Facility management aggregation to support traded balancing mechanisms.
3. DE_BUC02: Grid aware flexibility purchase.
4. FI_BUC01: Optimising consumption.
5. FI_BUC04: Participating on reserve markets.
6. FI_BUC05: Matching market demand.

7. FR_BUC04: Provision of flexibility to the energy markets and to BRPs.

3.5. OA_BUC05: Optimise and operate markets for local energy communities

In this overarching BUC, an operator of a local energy community creates and operates the GLocalFlex market to procure flexibility that is afterwards used to optimise the generation, consumption and storage charge/discharge schedules within the energy community, either in a) day-ahead or b) intraday.

The value chain in OA_BUC05 is the one presented in Figure 6.

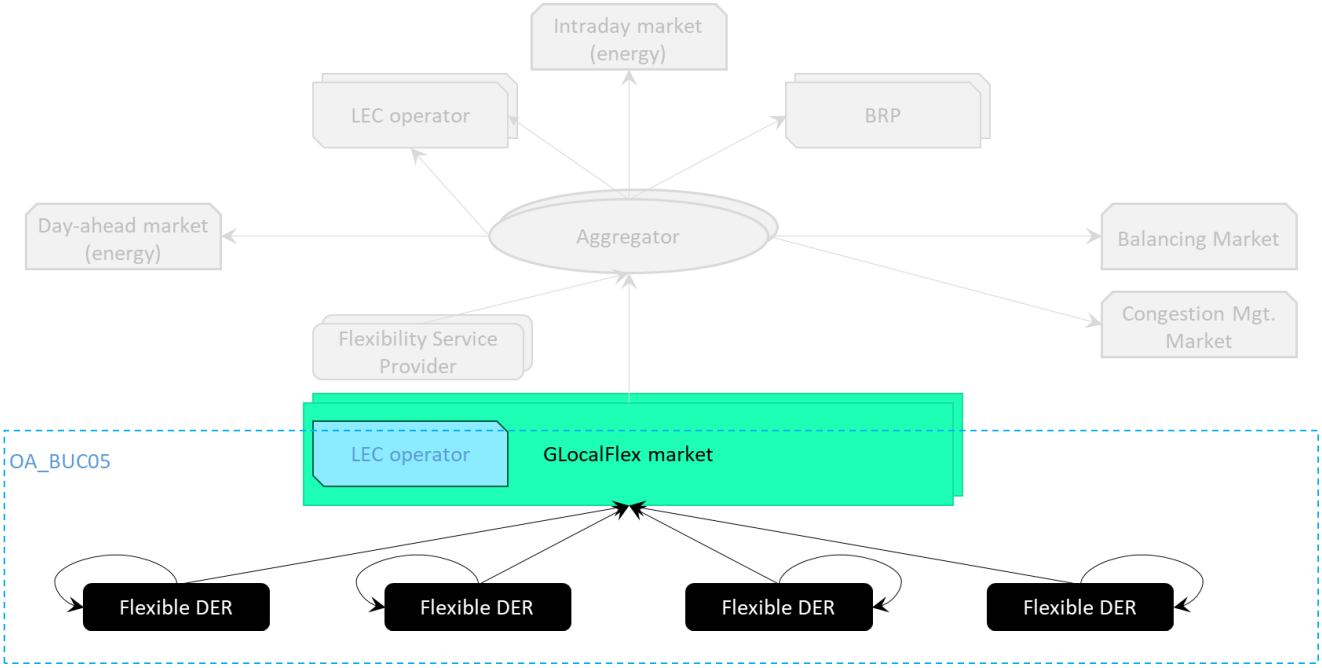

Figure 6. Value chain of the OA_BUC05

The only difference between OA_BUC01 (or OA_BUC03 for the intraday trading) and OA_BUC05 is on who operates the GLocalFlex market, being this role developed by the LEC operator in OA_BUC05. Therefore, it is considered that the **objectives** to be achieved are the same in both cases:

1. Reduce consumption peaks, in order to avoid increasing the contracted connection size with the power system.
2. Savings for consumers at high-price rates, as they can either reduce consumption or increase the export of locally produced energy in high-price periods.
3. Maximise (collective) self-consumption, in order to become a net zero energy consumer/building/community.
4. Energy democratisation, as small-scale consumers will be able to contribute to energy transition, despite the small size of their available flexibility.

5. Maintaining consumers' comfort level or utility of energy use, since their first aim is to use energy and, only then, to be flexible.
6. For many consumers, automating the activation / trading process can also be interesting, as they may not have the skills, time or willingness to trade and activate flexibility resources on their own. Some other consumers, on the contrary, will be willing to activate the use of flexibility themselves, as they may have the required skills and time to do so, and they prefer to have control over the actions in their facilities. However, for flexibility delivery times close to real-time, automated control may be compulsory.
7. Reduce the usage of fossil energy sources/Increase RES use/Reduction of CO_2 emissions.

The **prerequisite** in this case is:

- The operator of the local energy community is also the operator of the GLocalFlex market.

The **roles** to be considered in the OA_BUC05 are:

- *Consumer* [2]*:* A party that consumes energy. This is a type of party connected to the grid.
- *Producer* [2]*:* A party that generates electricity. This is a type of party connected to the grid.
- *Flexibility Service Provider* [6]*:* A party providing flexibility services to energy stakeholders via bilateral agreements or flexibility markets. A FSP can also be a BSP if enabled to the LFC services. In the Bridge HEMRM, FSP is an extension of BSP. FSP offer services potentially to all the system operators, directly or through market operators.
- *Energy trader* [2]*:* A party that is selling or buying energy.
- *Energy supplier* [2]*:* An energy supplier delivers energy to or takes energy from a party connected to the grid at an accounting point. An accounting point can have only one energy supplier. When additional suppliers (with firm (block) energy contracts) are involved, the energy supplier delivers/takes the difference between contracted and established (e.g., measured or calculated) production/consumption.
- *BRP* [2]*:* A party financially accountable for its imbalances. A balance responsibility requires a contract proving financial security with the imbalance settlement responsible of the scheduling area entitling the party to operate in the market. Imbalance means an energy volume calculated for a BRP and representing the difference between the allocated volume attributed to that BRP and the final position of that BRP, including any imbalance adjustment applied to that BRP, within a given imbalance settlement period.
- *Metering:*
    - *Metered data responsible* [2]*:* A party responsible for the establishment and validation of measured data based on the collected data received from the metered data collector. The party is responsible for the history of metered data for a metering point.
    - *Metered data administrator* [2]*:* A party responsible for storing and distributing validated measured data.

- *Metered data collector* [2]*:* A party responsible for meter reading and quality control of the reading.

- *Market operator:* A party that provides a service whereby the offers to sell energy are matched with bids to buy energy. This activity can be conducted in the forward, days-ahead and/or intraday timeframes, and can be combined with transmission capacity allocation in the context of market coupling. This is usually an energy/power exchange or platform [2]. In this OA_BUC, the only market that is taken into account is the GLocalFlex market and, hence, the relevant role is Market Operator, and not the NEMO, as trade does not happen in organised day-ahead or intraday markets.
- *Resource aggregator* [2]*:* A party that aggregates resources for usage by other market participants. The aggregation must be defined by market rules.

Four **specific BUCs** are assigned to OA_BUC05:

1. FI_BUC01: Optimising consumption.
2. FI_BUC02: Storing overproduction.
3. FI_BUC03: Responding to low production.
4. FI_BUC06: Optimising district heating.

3.6. OA_BUC06: Provide services for the power system operation

As in OA_BUC02 and OA_BUC04 the aggregator (or retailer) uses the flexibility procured either the day before delivery[4] or within the day of delivery in the GLocalFlex market or by any other means to trade, but in this case, in markets operated by system operators, such as those for balancing, congestion management, etc.

The value chain in OA_BUC06 is the one presented in Figure 7.

[4] For congestion management markets, long-term procurement may also be possible.

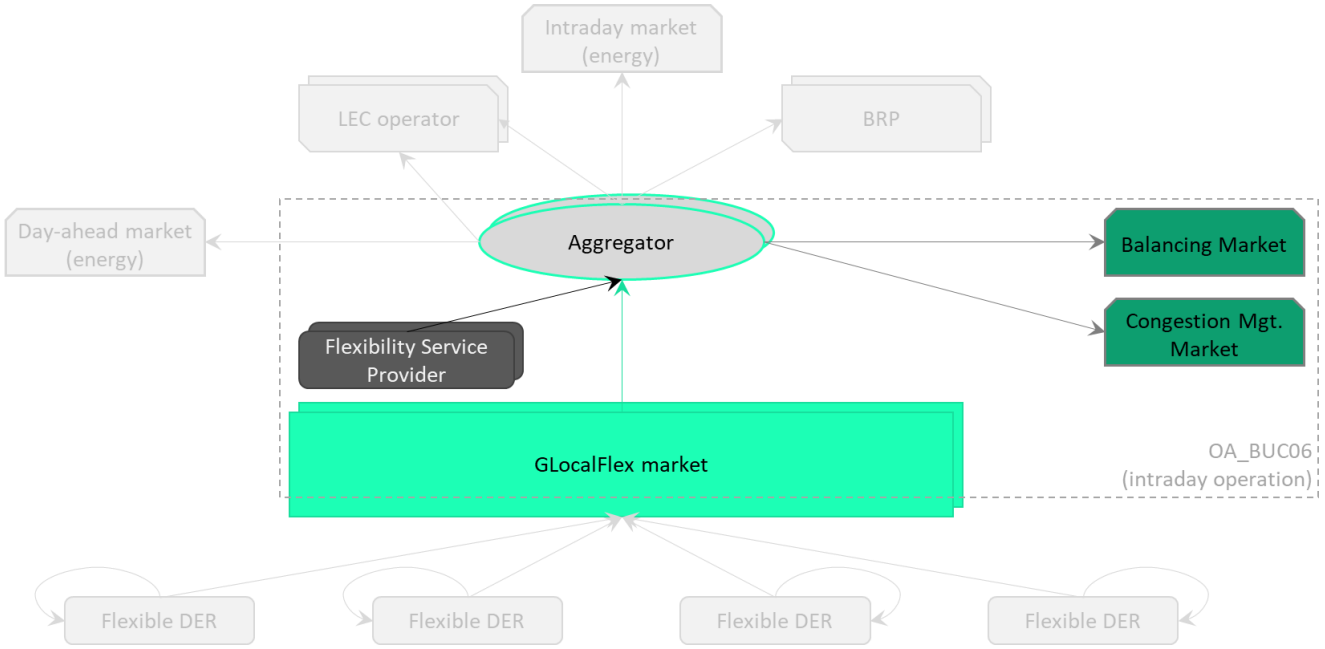

Figure 7. Value chain of the OA_BUC06

Objectives related to this OA_BUC06 are:

1. Aggregation of available flexibility into the required size for the participation either in the balancing market (TSO) or in the congestion management market (DSO).
2. Integration of the DSO in the market by procuring flexibility for local management services.
3. Ensuring grid resilience with increasing shares of intermittent RES.

The **prerequisites** in this case are:

- Flexibility is procured in the GLocalFlex market or by any other means.
- (Automated) Devices for the real-time operation of flexible resources are available.
- The aggregator or retailer, together with flexibility providers, has successfully passed a prequalification process to ensure that it will be able to respond to the activation signals provided by TSOs/DSOs.

The **roles** to be considered in the OA_BUC06 are:

- *Market Operator* [2]*:* A party that provides a service whereby the offers to sell energy are matched with bids to buy energy. This activity can be conducted in the forward, days-ahead and/or intraday timeframes, and can be combined with transmission capacity allocation in the context of market coupling. This is usually an energy/power exchange or platform.
- *Resource aggregator* [2]*:* A party that aggregates resources for usage by other market participants. The aggregation must be defined by market rules.
- *BSP* [2]*:* A party providing energy balancing services to the energy market. Balancing services can be balancing energy and/or balancing capacity. This is a type of flexibility service provider.

- *Flexibility Service Provider* [6]*:* A party providing flexibility services to energy stakeholders via bilateral agreements or flexibility markets. A FSP can also be a BSP if enabled to the LFC services. In the Bridge HEMRM, FSP is an extension of BSP. FSP offer services potentially to all the system operators, directly or through market operators.
- *System Operator*: A party responsible for operating, ensuring the maintenance of and, if necessary, developing the 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 or transmission of energy [2]. For the purpose of this OA_BUC, three potential system operators can be considered:
    - *DSO* [6]*:* The DSO is a system operator. DSO is responsible for security of supply and reliability of the distribution grid. For this reason, it monitors the grid in order to identify possible arising issues and, if there is a need, it makes use of resources to solve such problems, by network reconfiguration and/or by requests to market operators or directly to properly contracted customers.
    - *TSO* [6]*:* The TSO is a system operator. TSO is responsible for security of supply and reliability of the transmission grid. For this reason, it monitors the grid in order to identify possible arising issues and, if there is a need, it makes use of resources to solve such problems, by network reconfiguration and/or by requests to market operators or directly to properly contracted customers.
    - *LFC Operator* [2]*:* Responsible for the load frequency control for its LFC Area or LFC Block.
- *BRP* [2]*:* A party financially accountable for its imbalances. A balance responsibility requires a contract proving financial security with the imbalance settlement responsible of the scheduling area entitling the party to operate in the market. Imbalance means an energy volume calculated for a BRP and representing the difference between the allocated volume attributed to that BRP and the final position of that BRP, including any imbalance adjustment applied to that BRP, within a given imbalance settlement period.
- *Metering:*
    - *Metered data responsible* [2]*:* A party responsible for the establishment and validation of measured data based on the collected data received from the metered data collector. The party is responsible for the history of metered data for a metering point.
    - *Metered data administrator* [2]*:* A party responsible for storing and distributing validated measured data.
    - *Metered data collector* [2]*:* A party responsible for meter reading and quality control of the reading.

Seven **specific BUCs** are assigned to OA_BUC06:

1. CH_BUC02: Flexibility trading from energy communities to energy markets, and to DSOs for local congestion management.

2. CZ_BUC02: Facility management aggregation to support traded balancing mechanisms.
3. DE_BUC02: Grid aware flexibility purchase.
4. DE_BUC03: Real time flexibility control on external signal.
5. FI_BUC04: Participating on reserve markets.
6. FR_BUC05: Provision of flexibility to the TSO for balancing and frequency regulation services.
7. FR_BUC06: Provision of flexibility to the DSO at local level.

3.7. OA_BUC07: Optimise multi-vector use for energy sector coupling

This overarching BUC focuses on a multi-vector optimisation of energy use, through energy sector coupling, to store excess electrical energy for other uses, such as providing heating/cooling for district networks, etc.

This OA_BUC07 only comprises one specific BUC, FI_BUC06, related to the optimisation of the district heating. The main **objectives** are:

1. Increase RES use/Reduction of CO_2 emissions.
2. Maximize the efficiency factor of the district heating system.
3. Minimize heat losses in the grid.
4. Enable flexibility and co-use of multiple energy sources including use of RES and heat recovery from cooling systems.

The **prerequisites** in this case are:

- The energy flexibility sources have been identified.
- The following forecasts are available:
    - Consumption (based on historical data, weather forecasts and user preferences).
    - Generation (based on historical data and weather forecasts).
    - Day-ahead prices.
    - Flexibility availability.

The **roles** to be considered in the OA_BUC07 are:

- *Consumer* [2]*:* A party that consumes energy. This is a type of party connected to the grid.
- *Producer:* A party that generates electricity. This is a type of party connected to the grid. [2]. In this particular OA_BUC, it also includes producers of heat and not only electricity.
- *Resource aggregator* [2]: A party that aggregates resources for usage by other market participants. The aggregation must be defined by market rules.
- *Flexibility service provider* [6]*:* A party providing flexibility services to energy stakeholders via bilateral agreements or flexibility markets. A FSP can also be a BSP if enabled to the LFC services. In the Bridge

HEMRM, FSP is an extension of BSP. FSP offer services potentially to all the system operators, directly or through market operators.

- *Energy supplier* [2]*:* An energy supplier delivers energy to or takes energy from a Party Connected to the grid at an accounting point. An accounting point can have only one energy supplier. When additional suppliers (with firm (block) energy contracts) are involved, the energy supplier delivers/takes the difference between contracted and established (e.g., measured or calculated) production/consumption.
- *BRP* [2]*:* A party financially accountable for its imbalances. A balance responsibility requires a contract proving financial security with the imbalance settlement responsible of the scheduling area entitling the party to operate in the market. Imbalance means an energy volume calculated for a BRP and representing the difference between the allocated volume attributed to that BRP and the final position of that BRP, including any imbalance adjustment applied to that BRP, within a given imbalance settlement period.
- *Metering:*
    - *Metered data responsible* [2]*:* A party responsible for the establishment and validation of measured data based on the collected data received from the metered data collector. The party is responsible for the history of metered data for a metering point.
    - *Metered data administrator* [2]*:* A party responsible for storing and distributing validated measured data.
    - *Metered data collector* [2]*:* A party responsible for meter reading and quality control of the reading.
- *Energy storage operator:* Actor who uses stored energy as means for trading. This role is not defined in [2], since it is not related to the electricity market.
- *District heating operator:* Actor who produces distributes heat for consumers. This role is not defined in [2], since it is not related to the electricity market.

One **specific BUC** is assigned to OA_BUC07:

1. FI_BUC06: Optimising district heating.

3.8. OA_BUC08: Provide energy consulting services

In this overarching BUC, an external agent provides support for the evaluation, creation and implementation of flexibility measures, at individual user, at building or at energy community level.

The main **objectives** of the OA_BUC08 are:

1. To provide expert consulting services to residential customers for implementing home domotic solutions, including assessment of customer requirements, proposal of customized solutions based on needs and preferences, connection with suitable home automation solutions, etc.

2. To support household users with the utilisation of the deployed solution: Tracking and managing installed systems, enhancing the overall energy efficiency, providing ongoing support, etc.

The **prerequisites** in this case are:

- The following forecasts are available:
    - Consumption (based on historical data, weather forecasts and user preferences)
    - Generation (based on historical data and weather forecasts)
    - Storage (system charging and discharging patterns)
    - Day-ahead prices

The **roles** to be considered in the OA_BUC08 are:

- *Consumer* [2]*:* A party that consumes energy. This is a type of party connected to the grid.
- *ESCO* [2]*:* A party offering energy-related services to the party connected to grid, but not directly active in the energy value chain or the physical infrastructure itself. The ESCO may provide insight services as well as energy management services.

Two **specific BUCs** are assigned to OA_BUC08:

1. ES_BUC03: Consulting services for home domotics.
2. ES_BUC04: Domotic solutions for household energy sources.

3.9. Mapping overarching and specific BUCs

As explained in previous sections, the 23 specific BUCs gathered from the GLocalflex pilots are assigned to the eight proposed overarching BUCs. Table 1 below shows the relation between such overarching BUCs (columns) and the specific BUCs (rows) reported by each pilot site. Some specific BUCs may fit into various categories.

Title	**OA_BUC01:** Optimise consumption, generation and storage the day before delivery	**OA_BUC02:** Optimise flexibility trading the day before delivery	**OA_BUC03:** Optimise consumption, generation and storage within the day pf delivery	**OA_BUC04:** Optimise flexibility trading up to real-time	**OA_BUC05:** Optimise and operate markets for local energy communities	**OA_BUC06:** Provide services for the power system operation	**OA_BUC07:** Optimise multi-vector use for energy sector coupling	**OA_BUC08:** Provide energy consulting services
CH_BUC01: Local energy management and flexibility exploitation of residential consumers within an energy community			X					
CH_BUC02: Flexibility trading from energy communities to energy markets for intraday optimisation and local congestion management			X	X		X		
CZ_BUC01: Dynamic price-aware facility management			X					
CZ_BUC02: Facility management aggregation to support traded balancing mechanisms	X		X	X		X		
DE_BUC01: Basic flexibility trading toolchain			X					
DE_BUC02: Grid-aware flexibility purchase				X		X		
DE_BUC03: Mitigation of external power volume						X		
ES_BUC01: Optimise home energy consumption and generation	X		X					
ES_BUC02: Flexibility trading platform assistance	X		X					
ES_BUC03: Consulting services for home domotics								X
ES_BUC04: Domotic solutions for household energy sources	X		X					X
FI_BUC01: Optimising consumption	X		X	X	X			
FI_BUC02: Storing overproduction	X		X		X			
FI_BUC03: Responding to low production	X		X		X			
FI_BUC04: Participating in reserve markets	X		X	X		X		
FI_BUC05: Market demand matching	X	X		X				
FI_BUC06: Optimising district heating	X		X		X		X	
FR_BUC01: Enable the flexibility of residential consumers through a fully automated approach using an energy box and the associated IoT ecosystem	X		X					
FR_BUC02: Enable the flexibility of residential consumers through a behavioural approach using an energy box and the associated IoT ecosystem	X		X					
FR_BUC03: Enable the flexibility of public consumers already equipped with an energy manager	X		X					
FR_BUC04: Provision of flexibility to the energy markets and to BRPs		X		X				
FR_BUC05: Provision of flexibility to the TSO for balancing and frequency regulation services						X		
FR_BUC06: Provision of flexibility to the DSO at local level						X		

Table 1: Relation specific BUCs – overarching BUCs

4. Project KPIs

Project KPIs reflect GLocalFlex project objectives, and they help in demonstrating that GLocalFlex meets its expected outcomes. As the expected outcomes reflect to project objectives, it is natural to construct KPIs to facilitate working towards the objectives. The project KPIs cover all aspects of the project and evaluate these aspects from technical, societal, and economic points of view. Both quantitative (numerical) and qualitative KPIs will be used. For qualitative KPIs the explanation structure is used to ease communicating the actual outcome and its meaning.

This chapter updates and defines only the project level KPIs. Pilots, BUCs, communication and dissemination activities, and other activities may have their own sets of **focused KPIs** to facilitate the work in the project.

4.1. Project KPI definitions

The project KPIs are presented together with the project objectives in order to reflect the scope of each KPI. Each KPI is structured according to the closest project objective, but, in reality, some KPIs are relevant for multiple objectives. A type (technical, societal or economic) is assigned to each KPI, but, depending on the point of view, some KPIs can be technical, societal, and economic.

The project KPI definitions are provided in Table 2. O1 – O9 refer to GLocalFlex project objectives.

KPI description	Type T(echnical), S(ocietal), E(conomic), note if qualitative
O1: Create an extensive catalogue of flexibility services, solutions, and flexibility potential of appliances	
KPI1: Ratio of available flexibility at target and amount covered by GLocalFlex solutions	T
KPI2: Tradable full flexibility potential of each pilot	T, E (business value)
KPI3: Total number of services provided by pilots through flexible appliances/devices	T
O2: Develop low barrier & low-cost sustainable energy flexibility marketplaces (EFMs) to increase consumer participation	
KPI4: Expected cost for a consumer to participate in EFM (excluding asset investment)	T, S (lower barrier), E (profitability)
KPI5: Lowest possible flexibility amount that can be traded on EFM	T, S (lower barrier), E (potential customers)
KPI6: Share of consumers keen on EFM after the pilots	S, E

KPI description	Type T(echnical), S(ocietal), E(conomic), note if qualitative
O3: Develop interoperable solutions and products, available to all grid levels, to increase flexibility in energy consumption and positive impact on balancing demand/response with an increasing share of renewable energy sources	
KPI7: Total volume of flexibility trades by each pilot on EFMS	T, E
KPI8: Latency of flexibility marketplace platform operations	T
KPI9: Accuracy of delivered flexibility	T
O4: Demonstrate replicability of different components of flexibility systems and services across whole value chain (from appliance to market) through vibrant cross-sectoral pilot sites in Europe	
KPI10: Total number of replicable components, models, algorithms, and services from one pilot site to another.	T, E (scalability)
KPI11: Replicability of replicated components, models, algorithms, and services	T, E (scalability), qualitative
O5: Develop Self Sovereign Identity (SSI) equipped marketplaces (EFM) & demonstrate identity interoperability (SSIs for flexible appliances, solutions, and pilots for cross-marketplace	
KPI12: Performance of marketplace identity interoperability demonstration (participant's ability to switch from one EFM to another)	T qualitative
O6: Develop opportunities for consumers, SMEs, energy communities among others to participate into flexibility markets	
KPI13: Assessment of how the platform reaches different groups (commercial, communities, different socio-economic groups etc.)	T, S, E qualitative
O7: Increase awareness in local energy communities and industries for reduction in their energy costs, local energy balancing & demonstrating earning capacities through EFMs	
KPI14: How effectively were the KPIs for dissemination and communication met in "one-way communication activities targeting the general public"?	S
O8: Ensure that privacy, cybersecurity, and grid security are taken into account	
KPI15: Outcome of the privacy and cybersecurity assessment report D4.3	T, S qualitative
O9: Successfully demonstrate sustainable flexibility in marketplaces and involving energy consumers and producers in developing new BMs for people, SMEs, and start-ups	
KPI16a: Total number of BMs identified	E
KPI16b: Total number of BMs demonstrated	E
KPI17: Assessment of economic feasibility of the demonstrated BMs	E qualitative

Table 2: Project KPIs

4.2. KPI evaluation

This section explains in more detail how each KPI is intended to be measured or evaluated. The project has agreed not to set target values for KPIs, as the pilots are very diverse, and they have different scopes. Therefore, fair target setting would become extremely hard. For the same reason, there is no intention to use KPIs to compare pilots with each other.

Most quantitative KPIs are at a high level and simple to quantify. Qualitative KPIs have a value range: unsatisfactory, fair, satisfactory, good, excellent. The meaning of the words used for quantitative KPI values can be constructed either by a constructive scale method or by finetuning generic meanings of qualitative values.

The constructive scale method begins by selecting a small number of factors to distinguish levels. Then using these factors, the worst and the best plausible outcomes are written. From these, the verbal descriptions of intermediate scale levels are derived.[5]

Alternatively, the following generic service quality characterizations can be finetuned for evaluating a particular qualitative KPI. Service end user point of view should be captured, but keeping in mind that consumers as end users may have no previous experience and unrealistic expectations.

- **Unsatisfactory**: The service did not meet expectations at all. There were significant issues or problems that were not addressed or resolved.
- **Fair**: The service met some expectations but fell short in several areas. There is room for improvement.
- **Satisfactory**: The service met basic expectations. It was adequate but nothing stood out as exceptional.
- **Good**: The service met and occasionally exceeded expectations. Most aspects of the service were above average.
- **Excellent**: The service consistently exceeded expectations. All aspects of the service were outstanding and could be considered a benchmark for others to follow.

4.2.1. KPI specific remarks on the evaluation

KPI specific remarks provide more details on the KPI evaluation. These details may define the scope of the KPI in more detail, e.g., what is included or excluded in the evaluation. KPIs related to pilots may need to average the metric over all pilots and all targets that are being evaluated in the context of the KPI. As pilots are very diverse, it is of interest to visualize the distribution of values whose average is provided as the KPI value. Table 3 below provides the evaluation instructions together with parties responsible for the evaluation.

[5] See https://www.prioritysystem.com/reasons4d.html Figure 16 and text below figure.

Evaluation instructions	Responsible
KPI1: Ratio of available flexibility at target and amount covered by GLocalFlex solutions[6] Flexibility of energy consumption means ability to change time and/or amount of energy consumed. Consider all devices and targets that can be flexible and estimate the amount of flexibility. What share of that flexibility is covered by GLocalFlex solutions (all flexibility solutions, not only tradable flexibility). Compute the ratio in terms of energy (kWh) ratio. KPI is the average over different pilot targets, but illustration of the ratio distribution can be of interest.	pilots
KPI2: Tradable full flexibility potential of each pilot Compute the amount of flexibility that can be made tradable in each pilot. This is some share of flexibility that is covered by GLocalFlex solutions (see KPI1). Pilot participants may be conservative in trading, so this estimate will focus on potentially tradeable flexibility.	pilots
KPI3: Total number of services provided by pilots through flexible appliances or devices "Provided by pilots" refers to services that are demonstrated in pilots. If pilots demonstrate consultation type services, those are counted as well.	pilots
KPI4: Expected cost for a consumer to participate in EFM (excluding asset investment)[7] While assuming flexible assets and internet connection, estimate the costs of additional devices and services to participate in EFM. A cost estimate may rely on costs of equivalent existing devices and services. Remark: costs are restricted to device/service costs, costs like, e.g., increase of supplier bill due to shift of consumption are not included here.	pilots
KPI5: Lowest possible flexibility amount that can be traded on EFM Lowest flexibility amount so that marketplace operations (like aggregation, auction solving) are not time consuming in auctioning and verification of flexibility is still meaningful. Assume that most consumer flexibilities are in the range of the lowest flexibility amount.	WP4 leader
KPI6: Share of consumers keen on EFM after the pilots Gather pilot feedback and design questions for evaluating this KPI. Pilot feedback needs to be homogeneous enough so that the obtained data can be used to evaluate this KPI.	pilots
KPI7: Total volume of flexibility offers by each pilot on EFMs It takes time to find balance in pricing of sell and buy orders. Hence, at piloting phase all sell and buy orders are counted in total volume without requiring that marketplace has matched orders.	WP4

[6] Although it might be difficult to obtain exact numbers for this KPI, rough estimations are probably possible. The key idea is to demonstrate that the pilots focus on relevant flexibilities (to those that have impact). It may happen that some pilots have access to only limited assets, but they should focus on where the impact lies.

[7] This KPI may also be difficult to compute, but, again, rough estimates could be provided by pilots. The aim of this KPI is to enable a cost and benefit comparison.

Evaluation instructions	Responsible
KPI8: Latency of flexibility marketplace platform operations An indicator for an average total processing latency for the submitted trade orders experienced at the marketplace, excluding network and other transmission latencies, but including processing delays for trade orders coming in and associated confirmations heading out of the order book while assuming that the orders can be closed immediately after arriving.	WP4
KPI9: Accuracy of delivered flexibility Average accuracy of delivered flexibility during late piloting periods (piloting starts early and accuracy is expected to improve during the project). The accuracy of flexibility delivery is the ratio of verified flexibility over promised flexibility.	WP4
KPI10: Total number of replicable components, models, algorithms, and services from one pilot site to another Identify which components, models, algorithms and services could be replicated from one pilot site to one or more other GLocalFlex pilot sites.	WP6, pilots
KPI11: Replicability of replicated components, models, algorithms, and services Consider those elements whose replication is demonstrated in GLocalFlex. Evaluate replicability of each element with unsatisfactory – excellent scale together with a short explanation. Resulting 5-level scale is converted to numerical value in [0, 0.25, 0.5, 0.75, 1]. The final KPI value is the average of replicability values.	WP6, pilots
KPI12: Performance of marketplace identity interoperability demonstration (participant's ability to switch from one EFM to another) The outcome of the demonstration is evaluated at unsatisfactory – excellent scale together with a short explanation. This KPI is kept at qualitative level.	WP4
KPI13: Assessment of how the platform reaches different groups (commercial, communities, different socio-economic groups etc.) KPI13 is evaluated by pilots, with the support of VTT (service design). KPI has value unsatisfactory/fair/satisfactory/good/excellent and a short explanation text. The KPI value is a summary of reaching different groups. The group description can be fine-tuned during the project. Initial suggestion of groups comes from Service Design work that has identified "personas" and potential users with their characterizations on, e.g., opportunities and willingness to participate.	pilots + VTT
KPI14: How effectively were the KPIs for dissemination and communication met in "one-way communication activities targeting the general public"? Evaluation of this KPI is only an arithmetic computation based on selected communication and dissemination KPIs given in Table 4. Each channel in the table has its KPI value and objective. KPI 14 is computed as an average of these KPI/objective ratios.	WP7
KPI15: Outcome of the privacy and cybersecurity assessment report D4.3 Authors of D4.3 evaluate jointly this KPI based on findings on privacy, cybersecurity and grid security. Grid security may require consulting relevant project partners.	Authors of D4.3

Evaluation instructions	Responsible
KPI16a: Total number of BMs identified. Total number of BMs provided by pilots.	Task5.4
KPI16b: Total number of BMs demonstrated. Counting the BMs that are demonstrated in pilots. A BM can be considered as demonstrated if key elements of it are demonstrated. The full BM may contain actors that are not involved in the GLocalFlex project and hence out of the scope of BM demonstration.	pilots
KPI17: Assessment of economic feasibility of the demonstrated BMs. Authors of D5.2 evaluate this KPI as a summary outcome of the BM study. This KPI is qualitative with scale unsatisfactory – excellent and a short explanation. The feasibility assessment may be at more general level than the demonstrated BMs and similar demonstrated BMs may be grouped together. The explanation may indicate if there is variation in the economic feasibility among different types of BMs and more details.	authors of D5.2

Table 3: Instructions and responsible party of KPI evaluation

	Channels	KPIs	Objective
One-way communication activities	Public website	Nº of visits (with a minimum stay of 2.5 min.)	5000
	Press releases	Nº of press releases	6
	Video graphics	Nº of videos per year Nº of visits per video	2 300
	Infographics	Nº of infographics	2
	Twitter	Nº of times hashtag is used	1000
	LinkedIn	Nº of followers	300
	Facebook	Nº of followers	100
	Meetings with energy consumer groups	Nº of meetings per year Nº of attendees per meeting	20 20
Outreach activity	Public events	Nº of events attended	8

Table 4: Selected communication and dissemination KPIs to evaluate the project KPI14.

5. Conclusions

This document provides the overarching framework for the definition of the business use cases and the key performance indicators to be used for the evaluation of the GLocalFlex project performance.

Starting from the 23 business use cases identified by the demonstrators in D2.1 [3] and D3.1 [4], 8 overarching business use cases have been defined by using a common terminology and representation, which cover the different activities proposed by the pilots, and ensuring the complementarity and consistency among the different demonstrators. These overarching business use cases are expected to support the demonstrators in the process of fine-tuning the definition of their specific business use cases. Likewise, they are also an important input for the creation of the service catalogue, as well as for the definition of the business models to be considered within the project.

In addition to the key performance indicators defined by the pilots for the evaluation of their individual performance, additional key performance indicators to measure the implementation of the project have been presented. The evaluation of the project can be made according to its expected outcomes, which relate to the 9 main objectives of GLocalFlex. Therefore, in order to demonstrate that GLocalFlex meets its expected outcomes, 17 key performance indicators have been defined to evaluate the degree of completion of those 9 GLocalFlex project objectives. Project key performance indicators cover all aspects of the project and, thus, evaluate these aspects from technical, societal, and economic points of view. A type (technical, societal or economic) is assigned to each KPI, but, depending on the point of view, some KPIs can be technical, societal, and/or economic. Both quantitative (numerical) and qualitative KPIs will be used.

Therefore, this report proves that the third milestone of the project (business use cases and additional KPIs are defined for pilots) has been completed.

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6. Annex: First BUC questionnaire

The purpose of this questionnaire is to understand the realities of your pilot site in terms of sources of flexibility, as well as in terms of enabling feasible business use cases. Before answering, please read each question carefully.

[Tip: In the *pre-filled answers*, delete what does not match your answer and, if necessary, add what you want.]

GENERAL INFORMATION

Partner Name	
Corresponding person	*Your name or email*
Pilot Site	*Spain, Switzerland, France, Finland, Czechia, Germany*

QUESTIONS

Q1. What types of consumers or prosumers are involved in your pilot site?

Households, small businesses, SMEs, large businesses, offices/public sector, sports facilities, educational or cultural facilities, industry, etc.

Q2. Which of the following sources of energy flexibility do you have in your pilot site?
Can you collect individualized data by categories of flexibility sources that allow you to identify generation or consumption patterns?

Source of Energy Flexibility	I have it *(Y/N and specify)*	I can collect data *(Y/N and specify)*

Renewable energy generation equipment:		
a. without storage	*solar, wind, mini-hydraulic, cogeneration, etc.*	
b. with storage	*solar, wind, mini-hydraulic, cogeneration, etc.*	
Storage equipment without generation		
Road electric vehicles:		
a. Number and type of electric vehicles	*car, motorcycle, professional transport, passenger transport*	
b. Standard electric vehicle charging points		
c. Fast electric vehicle charging points		
Flexibility sources on the demand side:		
a. White goods appliances without battery (cleaning, cooking, refrigeration and ventilation)	*heat pumps, heating with electric storage heaters, residential HVAC, dishwasher, washing machine, dryer, dehumidifier, humidifier, electric boiler (domestic hot water), programmable pot, etc.*	
b. White goods appliances with battery	*cordless vacuum, cordless iron, etc.*	
c. Brown goods appliances with battery (image and sound)	*wireless headphones, portable speakers, video cameras, cameras, audio and video players, etc.*	
d. Gray goods appliances without battery (computing and telecommunications)	*paper printers, 3D printers, CPU for high computational demanding tasks, etc.*	
e. Gray goods appliances with battery (computing and telecommunications)	*laptop, mobile phone, tablet, mouse, keyboard, remote control, watch, etc.*	
f. Mobility equipment with battery (excluding road vehicles)	*bicycle, scooter, wheelchair, etc.*	
g. Other appliances with battery	*personal care and hygiene appliances (dental hygiene, shavers, epilators, etc.), portable batteries (power banks), toys, heated technical clothing, etc.*	
h. Other appliances without battery	*other deferred operation appliances*	
i. Professional equipment without battery	*professional oven (ceramic, dental ceramic, bakery, hospitality), industrial refrigeration and HVAC, commercial and industrial lighting, etc.*	
j. Professional equipment with battery	*surveying station, DIY tools, gardening tools, etc.*	

Q3. Is there any of the equipment that offers flexibility on the demand side for collective use?
(for example, hot water tanks for district heating systems or common equipment owned by a residents' association)
If so, is it possible to individualize consumption records?

For collective use, there is the…. *It is possible to individualize…*

Q4. Do you have any other source of energy flexibility? (please specify)
Do you find irrelevant to the project any element in the flexibility sources above (Q1)?

I have… *I find relevant…*

Q5. Are there any vacation patterns that release available energy on non-working days?
(weekends, holidays, or cessation of activity due to vacations for the entire workforce)

Vacation patterns are related to…

Q6. Will you be able to collect data associated with the use of the distribution grid that allows you to model and predict situations of congestion or technical restrictions? (due to weather impact on peak demand, seasonal tourism, major sports and cultural events, etc.)

I will be able to collect data…

Q7. Can you identify any of the following barriers to entry into local flexibility markets in your pilot site?

Barriers	Hinders access
Financial cost of acquiring generation or storage equipment	*Y/N*
Financial risk of the necessary investment	*Y/N*
Risk associated with penalties for non-compliance with flexibility commitments	*Y/N*
Insufficient size of the estimated potential flexibility	*Y/N*
Age of main appliances (not programmable even through electric current timers)	*Y/N*
Difficulty in collecting generation, storage, or consumption data	*Y/N*
Difficulty in analyzing available data (generation prediction models, consumption needs, weather predictions, etc.)	*Y/N*
Difficulty in automating consumption in response to grid signals (digitization)	*Y/N*
Difficulty participating in local auction platforms	*Y/N*
Difficulty participating in digital payment platforms	*Y/N*
Insufficient number of participants	*Y/N*
Antiquity or insufficient size of the power grid	*Y/N*
Regulatory or legal restrictions	*Y/N*
Lack of interest from the local distribution company	*Y/N*

Please, comment more about the barriers that you identified above. For example, which specific regulations may affect your case and to what extent.

Q8. Which flexibility services and market segments will your pilot site target?

Services	Segments
Optimization of energy procurement/trade in energy markets (day-ahead, intraday)	*None, local, national, supranational, European*
Optimization of production, storage and consumption within an energy community	*None, local, national, supranational, European*
Provision of balancing services: FCR	*None, local, national, supranational, European*
Provision of balancing services: aFRR	*None, local, national, supranational, European*
Provision of balancing services: mFRR	*None, local, national, supranational, European*
Provision of balancing services: RR	*None, local, national, supranational, European*
Provision of balancing services: other	*None, local, national, supranational, European*
Provision of congestion management services (capacity or energy based)	*None, local, national, supranational, European*
Provision of voltage control services	*None, local, national, supranational, European*
Provision of other flexibility services for power system operation (emulated inertia, black start, etc.)	*None, local, national, supranational, European*
Other (please specify here:_____)	*None, local, national, supranational, European*

Q9. Which of the following business opportunities do you identify in your pilot site?

Services	Please explain
Development of software for analysis of generation and consumption patterns to identify sources of flexibility	
Development of software for management/automation of generation, consumption, storage and excess energy output to the grid patterns	
Development/manufacturing/commercialization of appliances that respond to price signals or technical constraints	
Development/manufacturing/commercialization of devices to manage consumption or the load of non-programmable appliances	
Financing and risk-sharing	
Consulting services to facilitate participation in the local electricity market platform (auction)	
Global consulting services, equipment and management of participation in flexibility markets (energy-as-a-service)	
Digital communication infrastructure (internet)	
Cable infrastructure (power grid)	
Design, construction and remodeling of smart homes and commercial and industrial buildings	
Others … (specify others that you detect and are not listed above)	