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DELIVERABLE D3.1
PARITY Business use cases & Requirements

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Executive Summary

This document, deliverable of task 3.1 "Elicitation and analysis of business/use cases and requirements for the PARITY tool suite", shows the results of a comprehensive study on identifying the needs of targeted end-users and their main requirements and functionalities for the PARITY solutions. The main components of the aforementioned PARITY tool suite (both hardware and software tools) are:

- Smart Contract Enabled Local Flexibility Market Framework.
- Smart Contract Enabled IoT Gateway.
- Building-As-A-Battery management algorithms.
- PARITY Smart Grid Monitoring and Control algorithms and STATCOM.
- EV Profiling & Geo-Charging Services algorithms.

To identify user needs and tools requirements a 3-step approach has been implemented: (i) information extracted previous projects and partners' experience, (ii) Participatory process with targeted end users: building users surveys and tool users interviews, and (iii) internal (Project consortium partners) and external stakeholders' discussion groups

The first information source for the PARITY main requirement elicitation focused on the previous project partners' experiences. For this purpose, demo leaders and the main technical partners have contributed with their knowhow and experiences acquired in previous projects related to demand response management and the main objectives of the PARITY project.

In a second step, after analysing partners' roles and demonstrator users, an adequate participatory process was proposed with the aim to engage and gather feedback from different internal and external PARITY stakeholders. Surveys have been designed to extract information from flexibility providers involved in the project such as residential customers, tertiary building users and building managers. Besides, a number of interviews were conducted with flexibility users and traders such as aggregators and DSOs both involved with the pilot sites and external to the project. These interviews and surveys have been the main information source to set users' needs, requirements and functionalities for the PARITY tool suite. Participating stakeholders have expressed a high acceptance level towards the new technologies and their participation in Local Flexibility Markets. At the same time, they pointed out possible concerns about remuneration from new flexibility markets, data privacy issues and willingness to leave part of their device control to other entities.

To complete the information extracted from the project main stakeholders' interviews and surveys, several discussions on Use Cases (UCs) with PARITY partners have been carried out. These discussions have provided a new set of requirements and functionalities for the project tool suite and has allowed partners to evolve the initial use case list to the state described in section 6.2 of this document.

All the work carried out along task 3.1 has revealed important points:

- The main flexibility providers in the project (residential consumers, tertiary building users and facility managers) are interested in participating in local flexibility markets and demand response schemas, preferably through aggregators, but have concerns about economic incomes or legislation.
- Project flexibility users and traders (DSOs and aggregators) are interested in using distributed flexibility resources to improve the operation of their facilities and assets to reduce or delay grid investments or as a new revenue stream. On the other side DSOs and aggregators are worried about economic, technological and legal barriers.
- Residential and tertiary demo site buildings have enough flexibility sources (home appliances, DHW, HVAC, local PV generation) to develop and test the PARITY tools but an important effort to properly monitor and control these systems must be done.
- Residential consumers and tertiary buildings users would allow external entities, aggregators in this framework, to manage their consumption devices but would like to maintain the possibility of limiting or cancelling external operation set-points.

In general, stakeholders' attitude towards new Local Flexibility Markets is positive although there is uncertainty about market configurations and rules that PARITY should contribute to dissipate and test to a certain extend.

Table of Contents

List of Figures

List of Tables

List of Acronyms and Abbreviations

Terms	Description
AS	Ancillary Services
BAB	Building As Battery
BC	Business Case
BRP	Balancing Responsible Party
CHP	Combined Heat and Power (generation)
DER	Distributed Energy Resources
DGs	Distribution Grids
DHW	Domestic Hot Water
DSO	Distribution System Operator
EV	Electric Vehicle
ESCO	Energy Service Company
HVAC	Heating, Ventilation and Air Conditioning
IoT	Internet of Things
LFM	Local Flexibility Market
LV	Low Voltage
MV	Medium Voltage
P2H	Power to Heat
PV	Photovoltaic
RES	Renewable Energy Sources
SoC	State of Charge
UC	Use Case
P2P	Peer to peer
VPP	Virtual Power Plant
WP	Work Package
FM	Facility manager
A	Aggregator

1. INTRODUCTION

The PARITY project addresses the "structural inertia" of Distribution Grids (DGs) by delivering a transactive flexibility framework that will increase durability and efficiency of the electrical grid, while simultaneously enabling the adoption of more Renewable Energy Sources (RES), through enhanced real time control of Distributed Energy Resources (DER) flexibility combined with novel Active Network Management functionalities. PARITY will go beyond the traditional "top-down" grid management practices by delivering a unique local flexibility management platform through the seamless integration of Internet of Things (IoT) and Blockchain technologies. By delivering a smart-contract enabled market platform based on blockchain technology, PARITY will facilitate the efficient deployment of local micro-transactions and reward flexibility in a cost-reflective and symmetric manner, through price signals of higher spatio-temporal granularity based on real-time grid operational conditions. Finally, by deploying advanced IoT technology, PARITY will offer distributed intelligence (DER profiling) and self-learning/self-organization capabilities (automated real-time distributed control), orchestrated by cost reflective flexibility market signals generated by the blockchain Local Flexibility Market platform (LFM platform). Within PARITY, DER will form dynamic clusters that essentially comprise self-organized networks of active DER nodes, engaging in real-time aggregated & P2P energy/flexibility transactions.

More in detail, the PARITY project aims to enable the set-up and operation of local flexibility markets at the distribution network level via a holistic offering encompassing:

- A smart contract enabled, blockchain based LFM platform which will facilitate both peer-to-peer energy/flexibility transactions as well as the sell/purchase of flexibility to Smart Grid actors.
- IoT enabled DER Flexibility management tools - both in a peer-to-peer distributed fashion, but also through a centralized aggregator
- Smart Grid monitoring and management tools to enable the Distribution System Operator (DSO) to optimally manage the low voltage distribution network in the presence of increasing intermittent RES penetration and with the aim to contain the problems they create to grid stability

In parallel to the aforementioned technology solutions that will be created and demonstrated in the project, PARITY will also deliver all the necessary additional elements that are critical for the effective deployment, replication and proliferation of the PARITY solution. These include:

- The investigation of market coupling mechanisms that will enable to bundle and trade local flexibility potential in the national energy and ancillary service markets when it exceeds the needs of the local market and it can be monetized at higher levels of the grid,
- The definition of LFM actors and the associate business models that will ensure seamless LFM operation,
- The innovative retail energy commercial arrangements and contracts which will enable the automated provision and trading of flexibility in the LFM that will ensure grid stability
- The policy reform recommendations to shape the regulatory frameworks that will enable LFM creation in a financially sustainable manner.

PARITY will demonstrate all its results in four demonstration sites with varying characteristics in terms of climatic zones, proliferation of RES and demand device types, regulatory frameworks and market codes as well as culture and environmental consciousness. The sites are located in Granada, Spain; Athens, Greece; Malmo, Sweden, and Massagno, Switzerland.

1.1 Scope and objectives of the deliverable

This document involves a comprehensive study on identifying the needs of targeted end-users of the PARITY solutions. A three-step approach has been implemented:

- Internal (Project consortium) and external stakeholders' groups have been assembled to create a balanced cluster of electricity market stakeholders and flexibility providers (prosumers), based on selected criteria, such as age, gender, technology literacy.
- Questionnaires have been performed through surveys, discussion working groups and personal- and group- interviews to define the main user requirements. The key areas of interest have been identification of major challenges that affect their willingness in accepting the new technologies (e.g. cost, technology understanding, regulations); preferred business cases per user group and what is their view on them (e.g. aggregators could fear a peer-to-peer market structure, or see it as an opportunity for establishing more profitable business models); desired automation and control levels; expectations towards comfort vs efficiency and ownership of infrastructure; aptitude towards privacy, trust and security issues.
- Information extracted from T3.2, Ex-ante surveys of pilot infrastructure & equipment installation planning, has been used to establish the first set of business cases and use cases relevant to the PARITY technology and the defined end-users' requirements.

As shown in following sections of the deliverable, after analysing partners roles and demonstrators users, a proper selection of the ways to gather information adapted to objective population (quantity, energy sector knowledge, availability to answer questionnaires, easy access, etc.) has been made. Different surveys and interviews were designed to extract information from residential customers, tertiary building users, aggregators, DSOs, building manager and general experts from demo countries (Spain; Greece, Sweden and Switzerland) and partners countries. To complement information gathered with interviews and surveys, several discussions on Use Cases (UCs) and Business Cases (BCs) have been carried out among PARITY partners.

The main components of the PARITY tool suite (both hardware and software tools), which main requirements are set in this document, are:

- Smart Contract Enabled Local Flexibility Market Framework.
- Smart Contract Enabled IoT Gateway.
- Building-As-A-Battery management algorithms.
- PARITY Smart Grid Monitoring and Control algorithms and STATCOM.
- EV Profiling & Geo-Charging Services algorithms.

1.2 Structure of the deliverable

This document, structured into 6 main sections and three annexes, has been designed to accompany the reader from the previous experiences of project partners to the initial set of requirements for the PARITY tool suite.

After the introduction, section 2 is dedicated to the previous experiences of PARITY partners that could be useful for the current project. In this section, the experiences are grouped per demo countries and the requirements from other projects that could be interesting to be applied in PARITY are listed.

Section 3 of this document is crucial, as it describes the methodology followed to gather information among different stakeholders.

Section 4 and 5 show the main results and conclusions extracted from surveys and interviews. As it can be seen, the stakeholders have been grouped two groups: (i) flexibility providers (residential consumers, tertiary building users and facility mangers), those that will use some PARITY tools that will to manage its consumption demand to reduce energy bills or provide services to support grid operators, and (ii) flexibility users and managers (DSOs and aggregators, in section 5), those that will manage or use flexibility to act in LFM or for a better grid operation and management.

In section 6 a brief description of UCs and BCs, in its current state, is shown. It is said "current state" because the initial lists of UCs and BCs provided in the DoA of the Project is under discussion among the partners when this deliverable was being written. This source of information, BCs and UCs discussion, is a source of information, complementary to surveys and interviews, as their descriptions will be used to gather additional requirements and functionalities for the PARITY tool suite. Future tasks, mainly T3.5 - PARITY System Specifications & Architecture definition, will we used to finish the definition of the use cases and other ones in WP4 - Local Flexibility Business & Market Models will be used to end the business cases descriptions.

The Conclusions section summarizes the requirements of PARITY tool suite extracted from interviews, surveys, previous experience and UCs/BCs discussions. These requirements will be very useful in future work packages (WP) and tasks of the project as they will determine many functionalities of the tools to be developed and tested.

In the annexes sections a complete analysis of interviews and surveys is shown, Annex A, and the links to the different surveys and interviews (in their English version) carried out are listed, Annex B. Finally, Annex C shows JIRA is being used as the platform to host user and system requirements and allow their management, convenient tracking and prioritization.

1.3 Relation to other tasks and deliverables

Task 3.1 and its associated deliverable 3.1 are part of the initial work of the project as it is crucial to set the main characteristics and functionalities of the PARITY tool suite. This deliverable and its main conclusions will be useful for many tasks and WPs:

- Initial work tasks and WPs:
    a. T3.2, Ex-ante surveys of pilot infrastructure & equipment installation planning.
    b. T3.5, PARITY System Specifications & Architecture definition.
    c. WP4, Local Flexibility Business & Market Models.
- Tools developing tasks and WPs:
    a. WP5, Local Flexibility Market Platform.
    b. WP6, Smart Grid Optimization & Management.
    c. WP7, DER Flexibility Management & Storage-as-a-Service
- Tests and performance analysis tasks and WPs:
    a. T3.3, PMV methodology definition.
    b. WP8, System Integration, Demonstration and Impact Assessment.

2. PREVIOUS EXPERIENCES

This section shows a short list of partners' experiences in related projects that can be used to set part of the requirements and functionalities of the PARITY tool suite.

2.1 Spain

CUERVA previous experiences in research and development projects:

- CUERVA is a key partner in the **SYNERGY project (H2020)** "Big Energy Data Value Creation within SYNergetic enERGY-as-a-service Applications through trusted multi-party data sharing over an AI big data analytics marketplace". Call: H2020-DT-2018-2020 (Topic: DT-ICT-11-2019). Cuerva is participating in SYNERGY as a demo partner with special contribution towards the definition of grid level analytics addressing its role as DSO operator and for the roll-out and assessment of Synergy project in the Spanish pilot.
- CUERVA is participating in the **INTERPRETER project (H2020)**: "Interoperable tools for an efficient management and effective planning of the electricity grid". Call: H2020-LC-SC3-2018-2019-2020 (Topic: LC-SC3-ES-6-2019). Cuerva will participate by giving necessary inputs for the correct development of INTERPRETER tools. In addition, CUERVA will – through its Link Third Party Turning Tables – develop a tool for DSO ancillary services focused on phase balancing of the DN. Finally, CUERVA will lead WP7 where the different technologies developed during the project will be tested and validated in the selected Use Cases, using its living lab and information coming from its grid.

URBENER previous experiences in research and development projects:

- URBENER participated in the **ATANER Project**, which analysed the renewable generation and how it can satisfy consumption by mixing different generation technologies.
- URBENER in collaboration with FUNDACIÓN CIRCE developed **EV-OPTI MANAGER** (EV charging manager optimization demand) so that any electrical consumer and more those who offer electric vehicle recharging services can optimize their electrical demand and reduce their expenses in acquiring electrical energy. This will result in improving the competitiveness of these companies and reducing their impact on the Spanish electricity system.
- URBENER participated in the **SIRVE Project** (Integrated Systems for Recharging Electric Vehicles) together with FUNDACIÓN CIRCE. Electric vehicle chargers were designed where part of the power supply was carried out using renewable energy.

CIRCE previous experiences in research and development projects:

- CIRCE participated in the **DISCERN Project** (Distributed Intelligence for Cost-Effective and Reliable Distribution Network Operation, FP7 framework) in which different functionalities were analysed. One of the most important functionalities was to provide flexibility in the operation of the network in case of faults situations.
- **FLEXCOOP Project** (Democratizing energy markets through the introduction of innovative flexibility-based demand response tools and novel business and market models for energy cooperatives, H2020). This project introduces an end-to-end Automated Demand Response Optimization Framework. It enables the realization of novel business models, allowing energy cooperatives to introduce themselves in energy markets under the role of an aggregator. It equips cooperatives with innovative and highly effective tools for the establishment of robust business practices to exploit their microgrids and dynamic VPPs as balancing and ancillary assets toward grid stability and alleviation of network constraints.
- **FLEXICIENCY Project** (energy services demonstrations of demand response, FLEXibility and energy effICIENCY based on metering data, H2020). Four major Distribution System Operators (in Italy, France, Spain and Sweden) with smart metering infrastructure in place, associated with electricity retailers, aggregators, software providers, research organizations and one large consumer, propose five large-scale demonstrations to show that the deployment of novel services in the electricity retail markets (ranging from advanced monitoring to local energy control, and flexibility services) can be accelerated thanks to an open European Market

Place for standardized interactions among all the electricity stakeholders, opening up the energy market also to new players at EU level. The proposed virtual environment will empower real customers with higher quality and quantity of information on their energy consumptions (and generation in case of prosumers), addressing more efficient energy behaviours and usage as through advanced energy monitoring and control services. Accessibility of metering data, close to real time, made available by DSOs in a standardized and non-discriminatory way to all the players of electricity retail markets (e.g. electricity retailers, aggregators, ESCOs and end consumers), will facilitate the emergence of new markets for energy services, enhancing competitiveness and encouraging the entry of new players, benefitting the customers. Economic models of these new services will be proposed and assessed. Based on the five demonstrations, while connecting with parallel projects funded at EU or national levels on novel services provision, the dissemination activities will support the preparation of the Market Place exploitation strategies, as well as the promotion of the use cases tested during the demonstration activities.

2.1.1 Proposed requirement using previous experiences in Spanish partners projects

According to previous experiences, Spanish partners propose these requirements to be applied in PARITY tool suite development.

- Customer demand forecasting based on prediction models using historical data of consumption as well as including real time forecasting when possible technically.
- Electrical energy generation forecasting based on weather predictions to be corrected in real time.
- Optimized algorithms based on historical and real time data of battery storage, energy demand and electrical energy market prices.
- Management tools should have a local algorithms platform to adapt external signal to the real state of the local systems.
- A proper monitoring is essential: secure, accurate and fast enough.
- Tools should be automatic, human-centric, flexibility calculating, flexibility set-points in customers facilities and parallelizable depending on the role of the stakeholder in the market, for example aggregator focused due to the main role that will play in the market as a main flexibility trader aggregating the demand of their customers to achieve flexibility requirements following legislation. Tools should provide then with the programming unit management required to manage flexibility.

2.2 Greece

HYPERTECH previous experiences in research and development projects:

- **MERLON - Integrated Modular Energy Systems and Local Flexibility Trading for Neutral Energy Islands** (2020 – GA Number: 824386 , part of the BRIDGE initiative)

  MERLON introduces an integrated modular local energy management framework for the holistic optimization of local energy systems in presence of high shares of RES. Optimization in MERLON applies to multiple levels. It spans local generation output, demand and storage flexibility, as well as the flexibility offered by EVs and interconnection with heterogeneous energy vectors (CHP) to facilitate maximum RES integration into the grid, avoidance of curtailment and satisfaction of balancing and ancillary grid needs.

  HYPERTECH is the project coordinator and delivers advanced solutions for context-aware demand flexibility profiling appropriately combined with Power-to-Heat (P2H) technologies as part of the MERLON integrated optimization strategies.

- **PLANET - Planning and operational tools for optimising energy flows and synergies between energy networks (H2020 – GA Number: 773839, part of the BRIDGE initiative)**

  PLANET aims to deliver a holistic Decision Support System for grid operational planning in order to explore, identify, evaluate and quantitatively assess optimal strategies to deploy, integrate and operate conversion/storage systems on the distribution grid of several energy carriers within boundary constraints of real deployments outlined in the future energy system scenarios. Such tools are crucial for network operators and policy makers who need support in decision making process.

HYPERTECH is the technical coordinator of the project, leading the development of the integrated DSS (decision support system) while its main contributions focus on the design and development of an innovative Virtual Energy Storage framework (models and services).

- **WiseGRID - Wide scale demonstration of Integrated Solutions and business models for European smartGRID** (H2020 – GA Number: 731205, part of the BRIDGE initiative)

  WiseGRID provides services for the actors of the distribution network (with a special emphasis on energy communities) under different scenarios, in order to promote more sustainable energy grids, empower prosumers and enable the establishment of a near real-time pan-European energy balancing market. To this end, WiseGRID has created nine innovative products designed to increase the smartness, stability and security of a consumer-centric energy grid, including a fast charging station for electric cars, technology enabling homes to generate, store and trade their own energy, and advanced smart meters.

  HYPERTECH involvement is focused on the development, configuration and demonstration of innovative ICT solutions for residential demand side management addressing the needs of home users and aggregators.

- **NOBEL GRID - New Cost Efficient Business Models for Flexible Smart Grids** (H2020 – GA Number: 646184, part of the BRIDGE initiative)

  NOBEL GRID dealt with the development, deployment and evaluation of advanced tools and ICT services for DSOs and electric cooperatives, enabling active consumers' involvement – i.e. DR schemas – and flexibility markets, through dual-use of telecommunication networks and efficient integration of DERs and DR systems.

  Within NOBEL GRID, HYPERTECH was responsible for the development, configuration, demonstration, evaluation, maintenance and hosting of an innovative toolset for demand flexibility profiling and Demand Response strategies optimization over multiple demand loads i.e. lighting, heating, ventilation, and air conditioning (HVAC), along with powerful demand analytics, aggregation and forecasting services to aggregators.

CERTH previous experiences in research and development projects:

- **INERTIA – Integrating Active, Flexible and Responsive Tertiary Prosumers into a Smart Distribution Grid** (FP7-ICT – GA Number: 318216)

  The objective of INERTIA project was to introduce the Internet of Things principles to the Distribution Grid Control and DSM Operations. It provided an overlay network for coordination and active grid control, running on top of the existing grid and consisting of distributed and autonomous intelligent Commercial Prosumer Hubs. INERTIA offered fine-grained control while protecting privacy and autonomy on the local level, fully respecting prosumer preferences and needs.

  CERTH was the project coordinator of INERTIA, leading the pilot realisation of a multi-sensorial installation allowing real-time monitoring and control of a variety of building's assets. CERTH further leaded occupancy estimation, modelling and prediction development with monitored environments, along with development of the control platform at building level.

- **InteGRIDy - integrated Smart GRID Cross-Functional Solutions for Optimized Synergetic Energy Distribution, Utilization & Storage Technologies** (H2020 – GA Number: 731268)

  InteGRIDy aims to integrate cutting-edge technologies, solutions and mechanisms in a scalable Cross-Functional Platform connecting energy networks with diverse stakeholders, facilitating optimal and dynamic operation of the Distribution Grid, fostering the stability and coordination of distributed energy resources and enabling collaborative storage schemes within an increasing share of renewables. InteGRIDy approach is deployed and validated in 6 large-scale and 4 small-scale real-life demonstration sites covering different climatic zones and markets with different maturity.

Within inteGRIDy, CERTH developed an operation analysis framework in a modular way, which deals with the forecasting, DR prediction analysis along with the DR and BESS optimization mechanisms, and the respective visualization platform addressing the needs of consumers, facility manager and aggregator. Moreover, CERTH was responsible for the small scale pilot use cases provided in the inteGRIDy project.

- **GREENSOUL - Eco-aware Persuasive Networked Data Devices for User Engagement in Energy Efficiency** (H2020 – GA Number: 696129)

  GreenSoul pursues higher energy efficiency in public buildings by altering the way people use energy consuming shared devices (lights, printers) and personal devices (personal pluggable appliances). For that, it applies a twofold strategy: 1) persuades users to increase their energy-awareness and change their energy consumption habits and 2) embeds intelligence in the devices to let them autonomously decide about their operation mode for energy efficiency purposes.

  CERTH lead the activities related to design and implementation of the behavioural aspects and socio-economic models of the GreenSoul platform. Moreover, CERTH contributed to the development of the Analytics engine and assisted to pilot installation and execution.

- **DELTA - Future tamper-proof Demand rEsponse framework through self-configured, sels-opTimized and collAborative virtual distributed energy nodes** (H2020 – GA Number: 773960)

  DELTA is an ongoing project, which proposes a DR management platform that distributes parts of the Aggregator's intelligence into lower layers of a novel architecture, based on VPP principles, in order to establish a more easily manageable & computationally efficient DR solution. The DELTA engine will be able to adopt & integrate multiple strategies & policies provided from its energy market stakeholders, making it authentically modular & future-proof.

  CERTH is the project coordinator of DELTA, contributing, among others, to the development of blockchain technologies and services.

- **MEISTER – Mobility Environmentally-friendly, Integrated and economically Sustainable Through innovative Electromobility Recharging infrastructure and new business models (**H2020 – GA Number: 769052)

  MEISTER is an ongoing project, which aims at creating the conditions for smart e-mobility market take up in cities, by means of developing integrated approaches, smart solutions and innovative, sustainable business models, which will be tested and validated in three European urban areas. The project will deliver a set of tools to foster e-mobility large scale adoption by (1) demonstrating innovative, sustainable business models to lower installation and operation costs of charging infrastructure, (2) optimizing usage of infrastructure by the smart combination of charging and parking services, (3) integrating EV within urban SUMPs, including the establishment of EV sharing, (4) providing interoperable platforms and services to users for an easy access to charging, billing and smart grid services.

  Within MEISTER, CERTH contributes with leading role in activities related to the forecasting and trend analysis techniques. Moreover, CERTH contributes to the development of optimization methods for generation of schedules, applied within the smart charging platform.

HEDNO previous experiences in research and development projects:

- **WiseGRID - Wide scale demonstration of Integrated Solutions and business models for European smartGRID** (H2020 – GA Number: 731205, part of the BRIDGE initiative)

The main objective of the project was to provide a set of solutions and technologies to increase the smartness, stability and security of an open, consumer-centric European energy grid. With different technologies such as smart metering, smart home appliances, batteries, EVs, etc., Tools and services developed within the scope of the project allowed active participation of the European consumers and prosumers.

HEDNO was responsible for the implementation and testing of the wisegrid tools in the Greek pilot site, in the Mesogia area as end user, DSO, and owner of the electrical network of the Greek pilot site. Furthermore, HEDNO was the leader of sub-project 1 "Project Foundations" consisted of three work packages, "Smart Grids and energy market regulation, business models and social aspects", "WiseGRID Use cases, requirements and KPIs definition" and "Open, secure and flexible architecture, data privacy and standards".

- **CROSSBOW - CROSS BOrder management of variable renewable energies and storage units enabling a transnational Wholesale market** (H2020 – GA Number: 773430, part of the BRIDGE initiative)

  Crossbow project proposed the shared use of resources to foster cross-border management of variable renewable energies and storage units, enabling a higher penetration of clean energies whilst reducing network operational costs and improving economic benefits of RES and storage units.

  HEDNO participated in the pilot site activities with NTUA and IPTO with the main purpose to develop upgraded TSO-DSO cooperation for the adoption of new flexibility models.

- **GRIDSOL - SMART RENEWABLE HUBS FOR FLEXIBLE GENERATION: SOLAR GRID STABILITY** (H2020 – GA Number: 727362, part of the BRIDGE initiative)

  GRIDSOL presented a new concept to increase renewable energy penetration in a grid-friendly manner: Smart Renewable Hub. A flexible hybrid power plant that combines primary Renewable Energy Sources (RES) and storage technologies under a Dynamic Output Manager of Energy (DOME) that dispatches the electricity on a single output according to the availability and cost-effectiveness of each technology.

  HEDNO participated in the "Feasibility and adequacy of GRIDSOL in the electric power system of European Islands" aiming to study the strategies in order to choose the best combination of technologies from 3 different points of view: minimum cost production, maximum benefit and minimum environmental cost focusing on Non-Interconnected systems (islands). The analysis required the construction and validation of a large number of scenarios.

- **iDistributedPV - Solar PV on the Distribution Grid: Smart Integrated Solutions of Distributed Generation based on Solar PV, Energy Storage Devices and Active Demand Management** (H2020 – GA Number: 764452)

  IDistributedPV project objective was to develop affordable integrated solutions to enhance the penetration of distributed solar PV based on the effective integration of solar PV equipment, energy storage, monitoring and controlling strategies and procedures, active demand management, smart technologies and the integration of procedures in the power distribution system.

  HEDNO participated in the development of solutions for Smart Management of Distributed generation based on solar PV and energy storage devices and in the analysis, comparison and identification of most promising integrated solutions based on the assessment methodology and the selected KPIs (economics, environmental, and reliability and security of the grid).

- **SHAR-Q - Storage capacity sharing over virtual neighbourhoods of energy ecosystems** (H2020 – GA Number: 731285)

  The main objective of the SHAR-Q project was to optimize the storage capacities deployed in the grid with the help of a peer-to-peer interoperability network that connects neighbourhooding RESa+Storage ecosystems into a collaboration framework.

HEDNO was the pilot site leader for the Greek demo and responsible for the EVs charging stations' installation required within the scope of the project. Moreover, HEDNO contributed to the review of the regulatory frameworks and recommendations of progress in regulations supporting the collaboration of energy actors.

2.2.1 Proposed requirement using previous experiences in Greek partners projects

According to previous experiences, Greek partners propose these requirements to be applied in PARITY tool suite development.

- Availability of sufficient amount of historical data is important for proper training of machine learning algorithms, for example in order to generate EV usage profiles. Therefore, a data collection phase should be planned carefully.
- User Interfaces of the tools have to be designed by taking into account that may be used by senior citizens or people with limited technical experience, especially in the residential pilots of the project.
- Privacy is an important issue, therefore data exchange should be encrypted and users must be able to set and change their login passwords. Moreover, role-based data access has to be implemented.
- All applications must implement authentication mechanisms to prevent access and/or use by unauthorized users.
- All systems and tools must conform to GDPR.
- Common Application Programming Interfaces (APIs) used for communication among different tools must be well-defined to handle various cases. Definition of data schemas that describe the structure of data formats is proposed.
- The tools developed should be aligned and easy adaptable to the regulatory framework.

2.3 Sweden

EON previous experiences in research and development projects:

- **INTERFLEX**, Interactions between automated energy systems and Flexibilities brought by energy market players (H2020, part of the BRIDGE initiative BRIDGE), EON implemented a stand-alone grid solution in a small village to supply its 140 households with onto 100 percent renewable energy, supported by a battery system – SIMRIS. One of the project's aims is that customers in SIMRIS who are connected to the local energy system will not experience a difference in the quality of power supplied. By having steerable load assets – i.e. heat pumps – the system is able to cut power peaks and make generation more efficient. To ensure security of supply during the project phase, SIMRIS can be seamlessly re-connected to the regional grid at any time.
- **COORDINET** (H2020, part of the BRIDGE initiative BRIDGE), EON is currently introducing a common digital trading platform/market place named SWITCH to enable small energy retailers to enter the market and trade flexibilities. Aiming at optimizing the power grid and avoiding capacity shortages, a wide range of stakeholders is being addressed. The project is ongoing, however first experiences could be summarized and provided.
- EON was involved in a city quarter solution called **Hållbarheten (The Sustainability)**, a pilot project for future energy homes. Putting prosumers, living in multifamily housing, in the centre of development, the main energy infrastructures on the market – gas, power and district heating – were targeted for innovative solutions on the consumer level. A wind turbine and individual solar panels provided each apartment with its own locally produced renewable electricity. Inhabitants had the possibility of controlling their energy consumption with smart home devices, scheduling and actively adapting their consumption (i.e. heat-pumps, electric vehicles, LED-lighting) and generation with feedback from metering equipment.

2.3.1 Proposed requirement using previous experiences in Swedish partners projects

During the demonstration period, SIMRIS as a local energy system, provided insights on the implementation and adoption of balancing mechanisms. Some aspects can be considered when setting up requirements for the Parity project:

- Promoting attraction by including an end-user platform: by for example displaying household energy balances and a real-time simulated P2P-market where citizens could trade privately produced energy with their neighbours.
- Revenue streams: flexibility products should be designed to have sales potential on different market places and value streams.
- Determination of the flexibility value/pricing is essential, especially at the early stage of market development to cope with sporadic activations by the DSO and a lack of liquidity on the market.
- Flexibility potential can be successfully utilized in areas with grid constraints, for example in regions with a high share of variable RES.

Focusing on residential buildings and smart homes, the following requirements for technical implementations can be extracted:

- Ease of use/plug & play: intuitive and mature technology should be provided to the user. Users loose interest quickly when a solution is too complex or does simply not work as expected.
- Feedback to the user is needed: historic values and current status as well as benefits gained.
- New technology needs experienced and innovative installers and technology providers.

In terms of non-technical requirements it was found, that for multi-family houses the economic incentives were very low and the idea of sustainability prevailed as a benefit.

- Stable energy prices omitted the logic of adjusting loads depending on these prices. More volatility defines the potential in saving money.
- Residents of smart homes should show a high interest and high willingness to work with new technologies.
- Different incentives could be necessary depending on the sector that is approached.

When introducing the common digital trading platform “SWITCH” to enable small participants to enter the market, the following experience can be reported:

- Business cases and incentives focusing on small potential prosumers - it is comparatively easy to reach bigger actors within the energy business, thus economic benefits need to be identified and addressed adequately.
- Secure reimbursement scheme: additionally to variable payments depending on flexibility activations, flexibility providers demand a fixed reimbursement for their services.
- Cultural awareness and mindset: a supporting development among flex-providers is required on order to create awareness and a fruitful mindset, highlighting opportunities for potential customers.

From a technical perspective, flexibility providers requested a fully automated bidding and activation process as well as the availability of forecasting mechanisms.

2.4 Switzerland

AEM, SUPSI and HIVE previous experiences in research and development projects:

- **enCOMPASS** (H2020, part of the BRIDGE initiative BRIDGE). This project developed an integrated socio-technical approach to behavioural change for energy saving based on user-friendly digital tools for making energy data consumption available and understandable for the different users and stakeholders (residents, employees, pupils, building managers, utilities, ICT providers) empowering them to collaborate to achieve energy savings and manage their energy needs in energy efficient, cost-effective and comfort-preserving ways.
- **BFE** (Swiss Federal Office of Energy) project to develop management of self-consumption communities. Users’ participation in the process was managed in order to allow the control of

flexibility. The aim was to optimise the load profile of the neighbourhood and increasing the self-consumption.

- SUPSI with OPTIMATIK and AEM developed **OPTIFLEX**, a LV/MV network management algorithm that allows for an optimised management of the flexibility generated within a given distribution area (in this case both the entire AEM distribution area and its subareas). This solution is built on a data communication infrastructure based on a commercial big data platform (KiBiD, by Kisters AG) that integrates smart meter readings for household flexibilities such as heat pumps and boilers, and SCADA systems for larger flexibilities such as batteries and small scale hydropower plants. The project was developed with the support of the Swiss Innovation Agency Innosuisse.
- **GRIDSENSE project**. In this project a software algorithm, able to sense the current state of the distribution network using voltage as a proxy, optimised the load distribution according to a model predictive control scheme, taking into account various performance criteria, ranging from cost, network stability, to self-sufficiency and self-consumption. The algorithm was deployed on hardware "gridsense-units" which could be attached to the major flexibilities in a household and they could cooperate in the energy management optimisation task.
- **TICINO** (Switzerland, Scenario 2035). Aim of this project was to effectively know the flexibility available in the market and to categorize it by user ratio.

2.4.1 Proposed requirement using previous experiences in Swiss partners projects

According to previous experiences, Swiss partners propose these requirements to be applied in PARITY tool suite development.

- Dimensions and interconnectivity of any hardware component have to be considered carefully, because of the lack of space in the building entry cabinets.
- Standard interface protocols shall be applied to guarantee the interoperability and the connection to the communication channel.
- Communication standards have to comply with the local conditions (for example availability of a dedicated broadband) and to be carefully defined with the pilot site owner.
- Data cleaning should be performed as much as possible at the point of data collection and measurement.
- Algorithms to detect data measurement and data transmission anomalies should be deployed on all the nodes.
- During installation, procedures to get data as accurate as possible on the installed equipment should be put in place.
- Every device must comply with the CE labels and in particular with 2014/35/EU "Low Voltage (LVD)", 2014/30/EU "Electromagnetic compatibility (EMC)" and 2011/65/EC "RoHS".
- Feedback to the users is needed: historic values and current status as well as benefits gained.
- The prosumers should be able to double check the data stored by the other entities that pertain to them. Each prosumer should have access to a database where his/her data are stored and be able to verify and amend any imprecision, bit administrative and/or technical.
- All actors in the tool suite, from Prosumers to TSO should be able to access data in an easy and transparent manner.
- New technology needs a detailed manual for avoiding mistakes during the installation and a wasting of time and trust.
- Important devices shall comply with fire police requirements and with the available capacity of the grid connection in the building where they will be installed (for avoiding upgrade costs).

In general terms:

- Historical data shall be provided for each "end user" or prosumers based on a 15-minute timing (standard consumption, peak and voltage).
- Grid tariffs have to be set considering the max peak registered every month, in order to protect the users who are unable to provide flexibility from paying inefficiencies caused by market's operations and to define a neutral limit for assessing the economic feasibility of any market transaction (income have to be bigger than the grid cost caused by the max peak generated).

3.METHODOLOGY

This section describes the methodology carried out to extract the user requirements of the PARITY tool suite. In a first step, end-users have been identified and classified by role. Then the appropriate participatory processes have been defined to address each type of end-user. The two participatory processes chosen are surveys and interviews. For either of them, target sample, type of information to be collected, topics and questions of every questionnaire, and dissemination tools to be used were selected.

There are two types of end users, demand flexibility providers (DER owners, residential energy consumers and prosumers, building residents and users) and flexibility users according to the use they make of the extracted demand flexibility: aggregators, facility managers, retailers, DSOs, LFM coordinators, and DER network operators). These users are classified according to the default PARITY's business cases as reflected in Table 1. Thanks to that, main actors to be considered in the questionnaires regarding PARITY's goals have been listed out.

Table 1. Beneficiaries of PARITY's business cases.

BC	Description	Beneficiary	Markets
BC1	Aggregator as an active player in the LFM and national energy/AS markets (including optimal trading of flexibility under control across available markets for revenue maximization and adequate liquidity safeguard)	Aggregators, Facility managers	LFM Wholesale market; Ancillary services
BC2	Energy Retailer as a P2P flexibility trading facilitator to (including flexibility, day-ahead, intraday, balancing & ancillary market trading optimisation)	Retailers and Aggregators	LFM Wholesale market; Ancillary services
BC3	DSO as a market coordinator (the trusted party capable to operate a LFM to ensure independence and fairness to all involved market actors)	DSO as LFM coordinator	LFM
BC4	DSO as a DER enhanced network operator (including the use of novel smart grid management tools and infrastructure that enable more cost-efficient ways to ensure power quality and grid stability in the distribution grid and consideration of flexibility	DSO as DER network operator	Grid services: Balancing, congestion management

End user requirements deal with the PARITY's basic functionality set. The starting point for tool functionality definition is the PARITY's initial use case list, as presented in the Project DoA. The next step dealt about analysing and understanding the initial use case list proposal and relating them with their respective beneficiaries and business cases (Table 2). In addition, PARITY's pilot-sites related with each use case have been identified. Therefore, the information expected from each pilot-site is clearly delimited.

Table 2. Beneficiaries and business cases related to preliminary PARITY's use cases.

UC	Use Case title	Pilots	Beneficiary	BC
UC1	Building-level P2H/BAB flexibility estimation & automated provision to aggregator for LFM participation	All	Aggregators	BC1
UC2	Aggregated P2H flexibility estimation and provisioning for market participation pre-qualification	All	Aggregators	BC1, BC2

UC3	Aggregated V2G flexibility estimation and provisioning for market participation pre-qualification	PS1 PS5	Aggregators	BC1, BC2
UC4	Human-centric and contract-safeguarding participation in LFM, on the basis of context-aware flexibility profiles.	PS3 - PS6	Aggregators	BC1, BC2, BC3
UC5	Forecasting, scheduling and dispatch of DER flexibility for coordinated management of the LFM grid	PS3 - PS6	Aggregators	All
UC6	Flexibility exchange triggered by smart contracts for automated grid balancing	PS4 PS6	DSOs, BRP	BC3, BC4
UC7	Smart grid management using enhanced PQ services for grid instability limitation	PS3	DSOs, BRP	BC4
UC8	Ancillary services provision by STATCOM to TSO for overlay network stability	PS3	TSO, DSOs	BC4
UC9	Congestion management by DSO through operation of LFM to increase DER penetration	PS3	DSOs, BRP	BC4
UC10	Operation of local flexibility market in a grid constrained area	PS4 PS6	Aggregators	BC3
UC11	Provision of ancillary services to overlay ancillary service market operated by TSO	PS6	TSO, DSOs, BRP	BC3
UC12	Participation of LFM-enabled flexibility to national wholesale energy market	PS4 PS6	Traders, Aggregators	BC1, BC2, BC3
UC13	Red light (emergency) grid management using automated control of distributed DER (through smart contracts)	PS3 PS6	DSOs, BRP	BC4
UC14	UC4 Energy/flexibility credit exchange in the LFM jurisdiction	PS4 - PS6	Traders, Aggregators	BC1, BC2, BC3
UC15	Flexibility enhancement through synergies with neighbour distribution networks and/or LFMs.	PS4 PS6	DSOs, BRP	BC3

The previous explained classification has been useful to define the involved roles in the PARITY project, as well as their relationship with the business cases and the best approach in which participation has been required. Table 3 summarises this classification effort.

Table 3. Roles description in PARITY project.

Roles	Role description	PARTNERS	BC	Participatory process
1	Residential prosumers	CERTH, URBENER, AEM, CWATT	BC1, BC2, BC4	online survey - Big population
2	Office building users	HYPERTECH, CERTH, BFS, EON	BC1, BC2, BC4	online survey - Big population
3	Facility managers / ESCOS	CERTH, HYPERTECH, CWATT, AEM, URBENER, BFS	BC1	interview – Small population

4	DSO	CUERVA, HEDNO, AEM	BC3, BC4	Interview – Small population
5	Aggregators	URBENER, CWATT, EON, AEM	BC1, BC2	Interview – Small population
6	Tech developers	CERTH, HYPERTECH, CIRCE, CWATT, SUPSI, HIVE, QUE, UDEUSTO	N/A	N/A

The type of participatory process depends on the nature of information to be elicited and the characteristics of the addressed target respondents. Flexibility providers are residential prosumers and tertiary building users. They are a large target population with generic needs and concerns. For them, specially tailored surveys have been designed, playing two roles: residential dwellers and tertiary building users. Generic multi-choice questions were compiled, grouped in section, and massive-reaching surveying tools deemed necessary.

On the other hand, the flexibility users are made up by existing actors in the electricity markets that need the demand response flexibility for different purposes. These companies are fewer, but the information requested was more detailed and precise explanations are necessary to understand their needs and requirements. For this purpose, specially designed interviews for each type of actor were performed with a selection of companies among partner companies and external companies.

- Surveys: tertiary building users and residential consumers.
    - Carried out on-line using the tool Survey Monkey [1]
- Interviews: Aggregators, DSOs, and facilities managers.
    - Carried out by teleconference.

As a result, first drafts of both surveys and interviews were elaborated. After the definition of interviews and surveys, the expected outcomes to be obtained from each questionnaire were defined and were used to set the appropriate questions for every issue. The topics covered in each questionnaire are listed in the next table and the interviews and surveys can be seen in Annex B of this document.

Table 4. Topics covered in each questionnaire.

Participatory process	Topic
SURVEY - Residential consumers	Sample characterization questions: age, gender, position, location…
	Dwelling Type and size
	DER availability
	Generation system
	Electricity contract
	Annual Consumption
	LFM Participation involvement
	Willingness for flexibility participation
	Automated, semiautomated participation
	Type of aggregation contract
	Intrusiveness and data security preferences
	Contractual preferences and consumer rights protection

	Information sharing and interface
	Comfort preferences
	Barriers identified
	Other topics raised by participant
SURVEY - Office building users	Building type
	DER availability
	LFM Participation involvement
	Willingness for flexibility participation
	Information sharing and interface
	Barriers identified
	Comfort preferences
	Other topics raised by participant
INTERVIEW – Facility managers	Building Type
	DER availability
	Generation system
	Electricity contract
	Annual Consumption
	LFM Participation involvement
	Willingness for flexibility participation
	Automated, semiautomated participation
	Type of aggregation contract
	Intrusiveness and data security preferences
	Information sharing and interface
	Contractual preferences and consumer rights protection
	Barriers identified
	Other topics raised by participant
INTERVIEW – Aggregators	Characterization and company profile
	Type and number of flexibility providers
	Current relationship with them and liabilities
	Interest for flexibility market participation
	Interest for Retail market participation
	Interest for AS market participation
	Current IT system architecture
	Type of integration of new aggregation tools with current systems
	Current availability of data from flexibility providers
	Barriers identified

	Other topics raised by participant
INTERVIEW – DSOs	Characterization and company profile
	Size and type of grid assets.
	Type of grid management
	Interest of DR for RES generation matching
	Interest of DR for grid balancing
	Interest of DR for grid stability and congestion management
	Interest of becoming a LFM operator
	Interest of becoming a DER network operator
	Current IT system architecture
	Current availability of data from flexibility providers
	Type of integration of new flexibility tools with current systems
	Barriers identified
	Other topics raised by participant

Surveys are oriented to multiple-choice questions, to make it easier for the user and homogenise and narrow down the possible feedback, while interviews were oriented to be open questions to be able to obtain details from experts (internal and external to the project) of the sector. The time duration of the questionnaires was also considered to avoid fatigue from the responding users. After that, an iteration process was followed in which the questionnaires were revised and tested by all the consortium partners and then, translated into the addresses' languages for which the questionnaires were intended.

4. FLEXIBILITY PROVIDERS REQUIREMENTS

This section shows the main results and conclusions derived from questionnaires made to the flexibility providers involved in the project (residential consumers, tertiary building users and facility managers) and the main requirements extracted from them.

4.1 Residential consumer requirements

This section shows the main conclusions and requirements extracted from the surveys answered by residential consumers, from demo sites (Pilot site 3 – Lachar -Escúzar Area-Spain, Pilot site 4 – Luggagia Innovation Community – Switzerland, Pilot site 5 – Athens – Greece, Pilot site 6 – Malmö - Sweden) and no demo ones (PARITY project partners' workers answering about their own homes and impressions or feelings). A wider analysis of the surveys can be seen in the annexe "Residential consumers survey". The final amount of surveys received is shown in Table 5:

Table 5. Surveys received from residential consumers.

Surveyed population	Answers received
Pilot site 3 – Lachar -Escúzar Area-Spain	39
Pilot site 4 – Luggagia Innovation Community – Switzerland	15
Pilot site 5 – Athens – Greece	35
Pilot site 6 – Malmö - Sweden	22
Non-pilot sites	100

Related to thermal demands:

- In general, the main energy source for heating and DHW is fuel (gas, diesel or biomass) limiting electric demand management possibilities. In view of the EU strategy for decarbonization and increased electrification of heating and cooling, PARITY candidate site selection focused more on demo sites that cover these criteria [2].
- Related to cooling systems, the main technology is air conditioning, and manual ventilation is the main ventilation technique among pilots' and non-pilots' answers. Cooling use is rather uncommon in Northern countries but very used in Southern states as Spain or Greece, being an important flexibility resource. Only in the Swedish demonstration site forced ventilation is predominant. As a consequence, ventilation can be a flexibility source only in the Nordic demo.

Smart and DER devices and their manageability:

- Dimmable lighting is not very used among pilot and non-pilot users, as it is shown in Figure 1. Only the Swedish demo shows a majority of users with dimmable lighting in some rooms of the house.

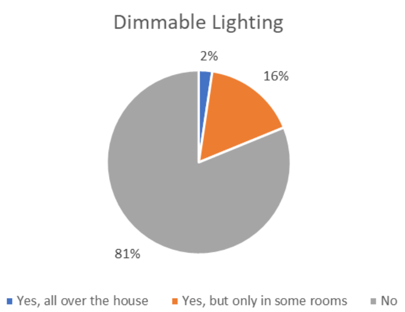


Figure 1. Residential consumers dimmable lighting use.

- Most of residential consumers surveyed have no electric vehicles.
- Few houses feature any sensors and they are mainly temperature and humidity sensors. Monitoring is not common among residential users (see Figure 2).

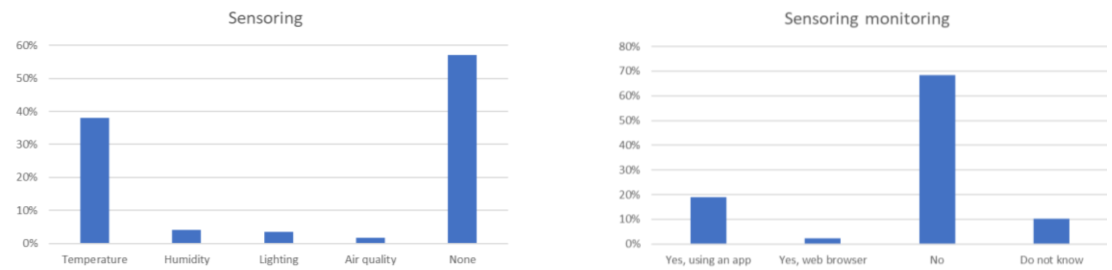


Figure 2. Residential consumers sensoring and sensoring monitoring in residential spaces.

- A small amount of answers show that residential consumers have smart meters among pilot and non-pilot users.
- The smart TV is the most common smart device and not all the consumers manage their smart devices remotely (see Figure 3).

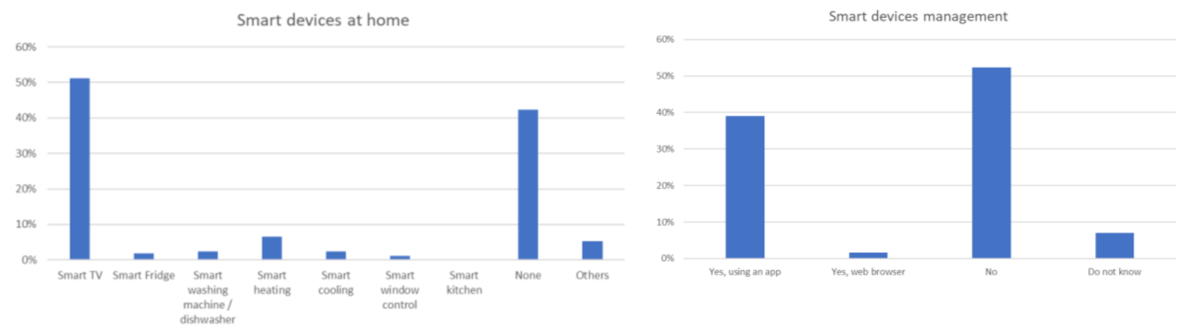


Figure 3. Residential consumers smart devices use and its management.

- The main distributed resource is solar PV facilities (see Figure 4). These devices are controllable, but not all remotely.

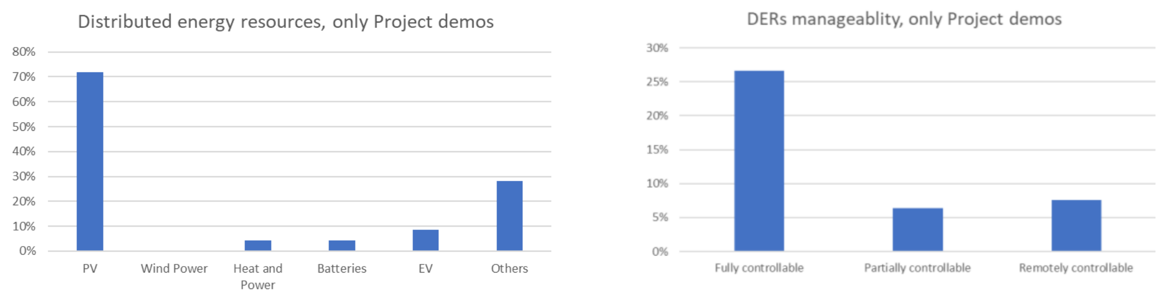


Figure 4. Residential consumers distributed generation and its management by residential consumers.

- Some of these generation facilities are shared among different consumers in the same building and other, a double quantity, are not shared.
- The vast majority of the users (about 80%) are interested in automatizing their DERs (Figure 5).

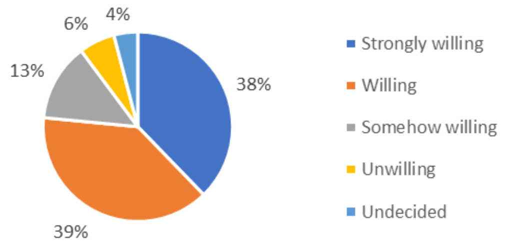


Figure 5. Residential consumers DERs automatizing willingness.

Information from the systems:

- Most of the surveyed population is interested in knowing more info about its energy demand, a larger amount by using mobile apps in the demo sites.
- Surveyed people prefer mainly to be informed on demand.

External management:

- Surveyed population prefer explicit demand response (active automatic management of devices without owner intervention as a result of externally triggered events) than implicit demand response (owner managing devices as a result of price or market signals) (Figure 6).
- Interviewed consumers would allow a full control of their storage systems rather than other systems, as dimmable lighting for example, as the later has a direct impact on users' preferences and comfort level (Figure 6).

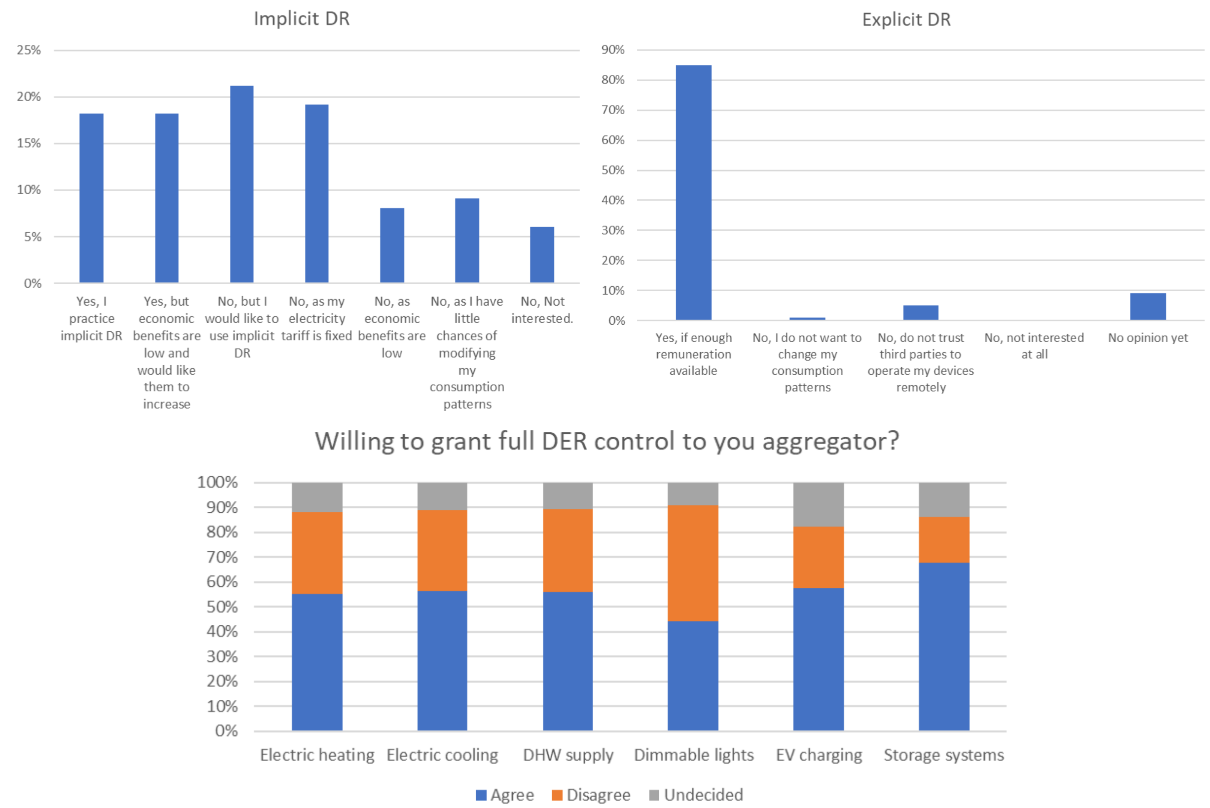


Figure 6. Residential consumers demand response acceptation level.

- Residential consumers would be willing to participate in explicit demand response schemes with external control of their resources but with the possibility of limiting it if desired, not a full external control.

Below is the list of requirements for the PARITY tool suite derived from the foregoing conclusions:

- Customer demand and generation forecast capabilities to optimise consumption and reduce energy bills.

- Customer flexibility potential calculation, aggregation with other customers' flexibility, trading in LFM markets and automatically application of flexibility set-points in customers facilities.
- Customers would like to limit flexibility events if desired.
- Use of digital / smart contracts.
- PARITY tool suite should provide adapted info to residential customers.
- Safe communications and data protection management.

As a summary it can be highlighted that surveyed residential consumers, pilot and non-pilot ones, are interested in automatizing its distributed resources to participate in explicit demand response programs and in LFM to have new incomes. It also must be highlighted that to use their appliances (DHW, cooling, ventilation, HVAC, solar PV, storage, lighting, etc…) a high effort to monitor and control them has to be made. It is also important that although consumers in general want to participate in DR programs, they want to have the possibility to limit or cancel these set points.

4.2 Tertiary building user requirements

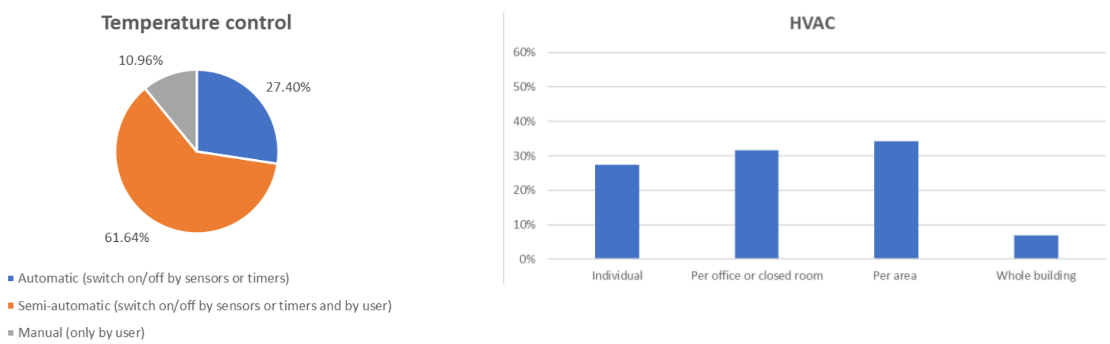
As the previous one, this section only shows the main conclusions and requirements extracted from the surveys answered by tertiary building users, demo and non-demo partners. A wider analysis of the surveys can be seen in the annexe "Tertiary building users surveys". The final amount of surveys received is shown in Table 6:

Table 6. Surveys received from tertiary building users.

Surveyed population	Answers received
Pilot site 5 – Athens – Greece	27
Non-pilot sites	58 Spain: 49 Greece:2 Austria: 1 Others: 6

Building devices and their manageability:

- Most tertiary building users prefer a semi-automatic management (switch on/off by sensors or timers and by user) of climate and lighting systems (Figure 7).
- Most tertiary building users prefer an individual, per office or per area system management rather than whole building management (Figure 7).
- Tertiary building users think that EV batteries could be a flexibility source with some limits.



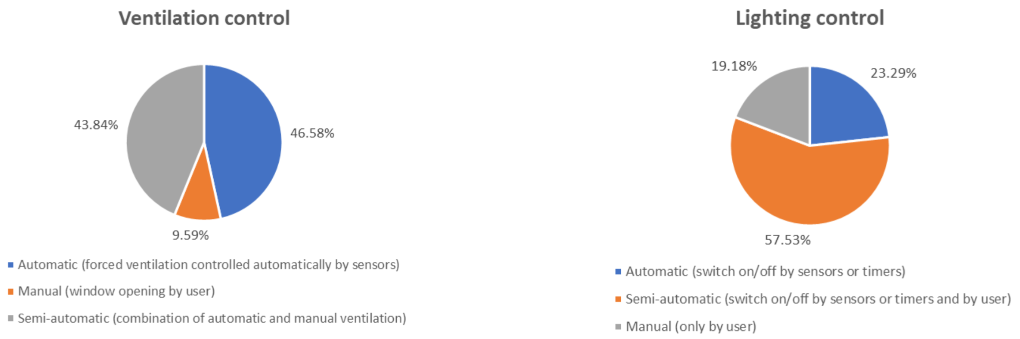


Figure 7. Main flexibility sources in tertiary buildings desired management techniques.

Information provided by the systems:

- Tertiary building users are interested in receiving information about the energy consumption of the building where they work.
- Users want to have access to this information through a website, mobile apps or through an email.

Flexibility market participation:

- Interviewed users think that the building where they work can participate in demand management markets or programs (Figure 8).
- Small investments or changes are needed to participate in these markets (Figure 9).
- Tertiary building users would accept an external management of building devices but with the possibility to adapt climate and lighting set-points manually to their needs.

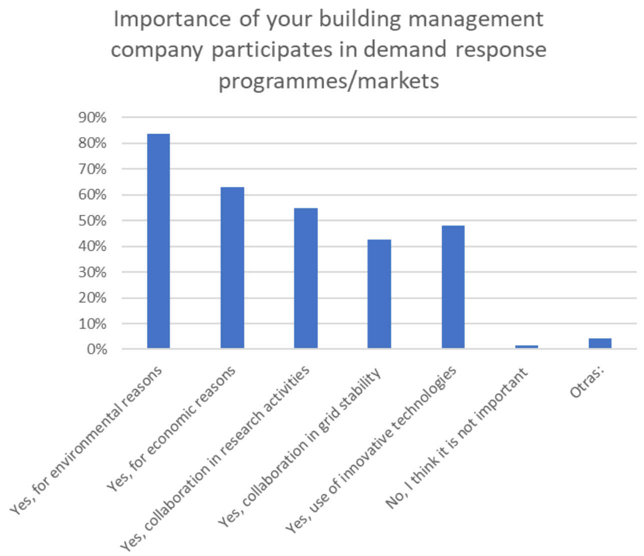


Figure 8. Participation in DR programs perception by tertiary building users (I).

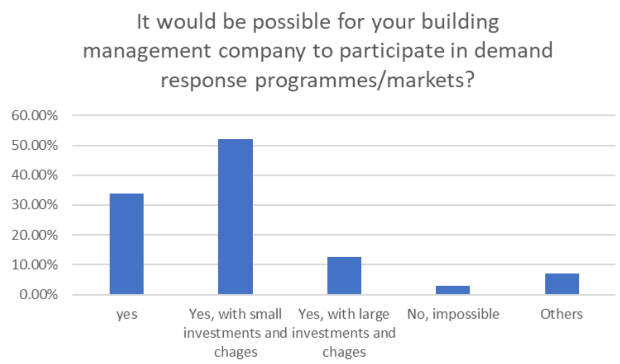


Figure 9. Participation in DR programs perception by tertiary building users (II).

Below is the list of requirements for the PARITY tool suite derived from the foregoing conclusions:

- Tertiary buildings demand and generation forecast to optimise consumption to reduce energy bills.
- Building flexibility possibilities calculation, aggregation with other customers flexibility, trading in LFM markets and automatically application of flexibility set-points in customers facilities.
- Building users would like to limit flexibility orders if desired.
- PARITY tool suite should provide info to building users.
- Safe communications and data protection management.

It must be highlighted that most of the surveyed tertiary building users considers that the buildings where they work could be used as flexibility source in LFM with low investments or changes in their use. Although they would accept external control of building systems (cooling, ventilation, etc.) they would like to have the possibility to limit or cancel these set points.

4.3 Facility manager requirements

As detailed in "Annex A – Facility manager interviews", five companies owning and/or managing tertiary buildings and their energy consumptions have been interviewed about their opinion and interest in demand response schemes. These companies are four PARITY Project members, although in two cases the interviewed person was not directly related to the consortium, and one external company. For two of the interviewed companies, building management is not their main activity. The next points highlight the main conclusions from the interviews:

- Buildings characteristics and available flexibility sources:
  - The interviewed companies manage different type of buildings, mainly office buildings. Some interviewed companies use these buildings as R&D facilities.
  - Most of the interviewed companies have solar PV generation facilities in the same building, which can be an interesting flexibility source if properly monitored, managed and used. One company owns a PV facility for direct grid feeding instead of self-consumption.
  - HVAC equipment is based on fuel and gas for the large buildings, and heat pumps and fan coils for the smaller, with limited flexibility potential.
  - DHW is based on electric low-power heaters. This is easy to use as flexibility source but with low effect due to low power.
  - Almost all FM own EV charging points in their buildings, but there are few users up to now.
  - Lighting and DHW are the most usual manageable demands but they have low potential due to its reduced power or usage limits. HVAC can be manageable only for heat pumps.
- Monitoring, controllability and data availability:
  - Regarding monitoring and data availability, all FM have deployed sensors and other monitoring systems, mainly temperature, presence, generic HVAC sensing and PV generation but few are centrally controlled.
- Energy Market, LFM and DR schemas participation:
  - In general, interviewed facility managers are no interested in operating directly in LFM due to expected low incomes. They could be open to operate in LFM through aggregators, this idea is more powerful in real FM (their only activity is management of buildings).
    - Some companies are interested in LFM as part of their R&D activities.

  - FM are interested in demand management as a way to improve efficiency and comfort of their users, to gain controllability overloads and to optimise solar PV generation and consumption.
    - DR schemes would be more useful if EV charging points and large PV and storage facilities were available.
  - FM are interested in participating in demand flexibility schemes through aggregators. The operation should be automated, following external operation set-points
- PARITY tool suite interesting requirements and functionalities:
  - PARITY involved partners have highlighted the next use cases:
    - Building level P2H/BAB flexibility estimation & automated provision to aggregator for LFM participation (UC1).
    - Aggregated P2H flexibility estimation & automated provision for market participation pre-qualification (UC2).
    - Human-centric and contract-safeguarding participation in LFM, on the basis of context-aware flexibility profiles (UC4).
    - Forecasting, scheduling and dispatch of DER flexibility for coordinated management of the LFM grid (UC5).
    - Flexibility exchange triggered by smart contracts for automated grid balancing (UC6).
    - Energy/flexibility credit exchange in the LFM jurisdiction (UC14).
  - Interviewed FM not directly related to the project have stated the next functionalities as interesting or important: Demand forecast, Flexibility aggregation, Interface with the customer. With low importance, some also want demand management tools and a DER registry.
- The most important barriers for demand response participation for facility managers are:
  - Current restrictive regulations that presently do not explicitly allow the participation of demand response in most electricity markets
  - The complexity of the systems and contracts is also a perceived drawback, not only because they are not fully understood but because it might be the source of additional technical issues and failures.
  - The lack of previous experience in DR management is a problem by most of the FM interviewed.
  - Some FM point out the issue of the self-control override in favour of automated systems under control of a third party.
  - The low incomes expected is another important perceived barrier, also due to the uncertainty of those incomes.
- Related to incentives perceived by the interviewed FM.:
  - Increase control and automation of systems in facilities,
  - Expected improvements in energy efficiency and energy savings (mainly using PV systems)
  - Improvements in comfort derived from sensoring, monitoring and automated control of DER.

These are the requirements for the PARITY tool suite derived from the facility manager interviews:

- Customer demand and generation forecast.
- Customer flexibility calculation, aggregation and management, and automatically application of flexibility set-points in customers facilities.
- Use of smart contracts.
- Safe and robust communication among different actors.
- Eventual participation in LFM through aggregated and automated demand flexibility schemes
- Interface with customers to provide information about their facilities.
  - Data protection full respect
  - Sensoring, monitoring and automation systems.
  - DER registry.

As conclusions, the interviewed partners are interested in research about how to develop and test suitable tools to enable DR participation in new LFM. Their buildings are specially catered for testing. Other FM focus their interest in gaining higher control over DERs and use this control to improve comfort and obtain energy savings. PV-self consumption optimization is also viewed as a positive outcome. They all perceive economics as low incentive and express their concerns about the current regulatory frame. End-user data protection is of paramount importance. In their mind, large PV facilities and storage systems like an increase of PV availability would increase their potential demand flexibility potential.

5. FLEXIBILITY USERS & MANAGERS REQUIREMENTS

This section shows the main results and conclusions derived from interviews made to the flexibility users and managers involved in the project (DSOs and Aggregators) and the main requirements extracted from them.

5.1 DSO requirements

Four DSOs have been interviewed. Three of them are PARITY project members who are either DSOs or play this role in the demos they are involved. In one case the interviewee was not directly related to the consortium. A summary of the relevant conclusions is presented below. To see all the results of the surveys, please consult the "Annex A - DSO interviews".

- DSOs' grid and systems:
    - All DSOs have distributed solar PV generation facilities for their customers in the distribution network that can be used to provide flexibility. In addition, three of the four DSOs interviewed have hydraulic generation to provide flexibility to the grid.
    - Related to network operation, two of the distributors are managed by themselves considering the technical requirements of the network, whereas one DSO is managed by a third party.
    - Congestion issues are not a problem as of today, but it may become serious with increasing participation of non-manageable sources in the grid. They perceive DR management as an economic and straight-forward method to avoid future costly grid expansions.
- Monitoring, controllability and data availability:
    - As for the granularity of the monitoring, data reading frequency goes from 15 minutes to 1 hour.
    - Most of the DSOs interviewed have smart metering installed in 90% to 100% of their consumers. Only one DSO has a smart meter network below 90% (40% of its consumers). This DSO can obtain separately consumption and generation profiles unlike the rest of the DSOs.
    - All DSOs interviewed have a minimum of 3 years of historical data.
- PARITY tool suite interesting requirements and functionalities:
    - PARITY involved partners have highlighted the next use cases:
        - Building level P2H/BAB flexibility estimation & automated provision to aggregator for LFM participation (UC1).
        - Aggregated P2H flexibility estimation & automated provision for market participation pre-qualification (UC2).
        - Aggregated V2G flexibility estimation & automated provision for market participation pre-qualification (UC3).
        - Human-centric and contract-safeguarding participation in LFM, on the basis of context-aware flexibility profiles (UC4).
        - Forecasting, scheduling and dispatch of DER flexibility for coordinated management of the LFM grid (UC5).
        - Flexibility exchange triggered by smart contracts for automated grid balancing (UC6).
        - Smart grid management using enhanced PQ services for grid instability limitation (UC7).
        - Ancillary services provision by STATCOM to TSO for overlay network stability (UC8).
        - Operation of local flexibility market in a grid constrained area (UC10).
        - Red light (emergency) grid management using automated control of distributed DER (through smart contracts) (UC13).
        - Energy/flexibility credit exchange in LFM jurisdiction (UC14).
    - Interviewed DSOs not directly related to the project have stated the next functionalities as interesting or important: Demand and generation forecast, flexibility provision,

aggregation of flexibility, DERs registry, contractual data repository, local and global demand manager, interface for users.

- LFM and DR schemas participation:
    - The interest of the interviewed DSOs in demand response management is based on grid optimal operation (grid balancing, grid stability and congestion management) capabilities and on the optimal management of other energy resources as renewables, storage (batteries or water reservoirs in hydro plants) or CHP facilities.
    - Interviewed DSOs are interested in becoming LFM operators for different reasons: economics (a cheap tool for balancing LV and MV grids), operative (an interesting tool to support grid operation) and “educative” (explaining to consumers that DR is interesting also for them).
    - DSOs are interesting in becoming DER network operators as the owners of the LFM, granting restricted access to qualified participants. It can be a way to improve grid management efficiency.
    - Interviewed DSOs would incorporate the tools to be developed or similar ones in their current IT systems. User aggregation and centralized data management seem to be interesting for them.
- Related incentives for the development of LFM or to participate in these markets:
    - Fair remuneration (for all stakeholders, from providers to aggregators and managers)
    - Contribution to grid balancing
    - Avoid or delay costly grid investments by using DR for congestion management.
- Related barriers for the development of LFM or to participate in these markets:
    - Lack of legislation technical and economical in most countries.
    - Lack of previous experiences.
    - Possible penalties or low economic incomes with high initial investments.
    - Learning curve or possible personal data protection problems.

The following requirements are extracted from the interviews made to DSOs:

- Customer demand and generation forecast.
- Customer flexibility calculation, aggregation, management in LFM markets and automatically application of flexibility set-points in customers facilities.
- Use of smart contracts and block chain to safely monitor transactions and security.
- Local and global demand management.
- DERs (STATCOM and other distributed resources) management to solve grid issues.
- Operation of LFM even in grid constrained areas.
- Interaction platform between neighbour LFM and grids.
- Interface with customers to provide information about their facilities.
    - DER registry.

As summary, the interviewed partners are very interested in research of tools (hardware and software) to enable LFM and use it to improve technically the grid operation, the schedule or resources (hydro, storage or CHP) and to reduce costs or delay investments. Interviewed DSOs are interested in incorporating new tools to operate in LFM and to improve its grid operation capabilities. A fair remuneration, lack of proper legislation and lack of previous experience in LFM are their main concerns about DR for DSOs.

5.2 Aggregators requirements

As detailed in “Annex A - Aggregators interviews”, four companies have been interviewed. These companies are PARITY Project members although in one case, the interviewed person was not directly related to the consortium. For one of the companies interviewed, demand aggregation and representation in the wholesale electric energy market is its main activity but for the others aggregation is one among many activities in a bigger portfolio. The next points highlight the main conclusions from the interviews to potential aggregators:

- Monitoring, controllability and data availability:
    - Related to IT systems architecture, all the interviewed aggregators have access to their customers' meters and data, run their own software and think that their systems are safe although safety can be improved.
        - Interviewed potential aggregators have information from customers demand and generation and other meteorological data. One of them has more precise data of some clients: voltage, current, reactive power and power factor.
        - Two of them are interested in integrating the PARITY tool with their current IT system and one prefers to run the PARITY software as a standalone application for the time being.
        - They would like to have automatic reporting systems but customizable.
- Energy market, LFM and DR schemas participation:
    - Companies are not interested in the retail electricity market except for one of them, already playing in this market.
    - All the interviewed companies are interested in participating in LFM, mainly for economic reasons and some of them also for sustainability, research interests and other reasons.
    - Related to the ancillary service market participation only one company shows interest, mainly for the economic returns, although this company is worried about the initial investment and the related risk.
    - Different types of customers could be involved in flexibility markets such as prosumers offering flexibility through aggregators. One of the interviewed companies only rely on large consumers (industrial, big tertiary buildings, agriculture, etc.). The other interviewees include smaller consumers as residential or commercial customers.
- PARITY tool suite interesting requirements and functionalities:
        - Building level P2H/BAB flexibility estimation & automated provision to aggregator for LFM participation (UC1).
        - Aggregated P2H flexibility estimation & automated provision for market participation pre-qualification (UC2).
        - Aggregated V2G flexibility estimation & automated provision for market participation pre-qualification (UC3).
        - Human-centric and contract-safeguarding participation in LFM, on the basis of context-aware flexibility profiles (UC4).
        - Forecasting, scheduling and dispatch of DER flexibility for coordinated management of the LFM grid (UC5).
        - Flexibility exchange triggered by smart contracts for automated grid balancing (UC6).
        - Participation of LFM-enabled flexibility to national wholesale energy market.
- The main incentives these companies perceive for their participation in DR are:
    - Fair remuneration is the main incentive.
    - Environmental improvement
    - Enhanced grid operation
    - New technology development
    - New services or business opportunities
- The main barriers pointed out by potential aggregators are:
    - Possible low remuneration in activities that need high initial investments
    - Standardization
    - New developments with their inherent risks
    - Business and legal concerns
    - Limited access to residential customers

Below is the list of requirements for the PARITY tool suite derived from the foregoing conclusions:

- Customer demand and generation forecast.
- Customer flexibility potential calculation, aggregation with other customers' flexibility, trading in LFM markets and automatically application of flexibility set-points in customers' facilities.
    - Operate even in constrained areas.
- Use of smart contracts and block chain to monitor transactions and ensure traceability and security.
- Trade with flexibility also in national markets.
    - Provide services not only to DSOs, but also to TSOs.
    - The tools could be useful also to operate in wholesale markets, not only in flexibility markets.
- Safe and robust communications among different actors.
- Aggregators need much information from their customers (energy demand, solar PV generation, etc.) and from other sources (weather, market prices, etc.) and the PARITY tools must be able to provide it.
    - In this line, the tools must provide automatic and parameterizable reports about customers, markets, system development, etc.

As summary, the interviewed aggregators are interested in the research and use, at different levels, of DR/flexibility tools to operate in LFM, aligned the objective of PARITY project. They differ in the most suitable flexibility providers: one aggregator would focus on bigger consumers, but the others would extend to small residential consumers, aggregating them. This is an issue covered by PARITY demo sites, which include residential and tertiary consumers. Economic reasons are crucial to participate in LFM and DR schemes, but they see a risk of low incomes and high investments for participation.

6. INITIAL BUSINESS CASES AND USE CASES

The last information source to set the main requirements of the PARITY tool suite, after surveys, interviews and previous experience, is the analysis of Business Cases and Use Cases. Discussions among partners in online meetings took place in order to define in detail and elaborate on the initial business cases and use cases. Those discussions resulted in the refined BCs and UCs that are described in this section.

6.1 Business Cases (BCs)

This section provides a short description [3] of the four BCs[1] to be tested in the PARITY Project.

6.1.1 Business Case 1: Aggregator

Aggregator as an active player in the LFM and national energy/ancillary services markets (including optimal trading of flexibility under control across available markets for revenue maximization and adequate liquidity safeguard)

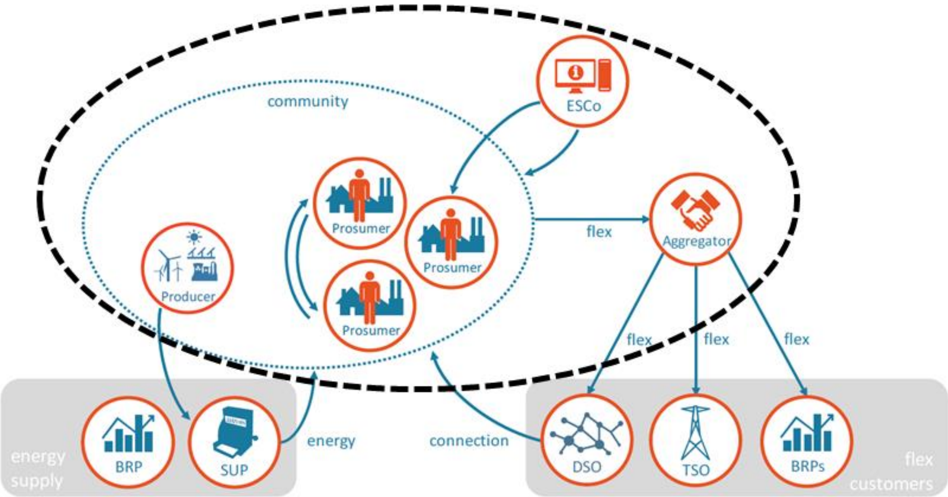


Figure 10. PARITY BC 1 (from [3], note: the players in this figure represent roles, not the actual market participants).

Roles assumed by the independent aggregator:

- Controls devices at the prosumers' premises and represents them in flexibility markets
- Active participant and trader of aggregated demand flexibility in LFM.

The starting point for the first BC is the **typical business model of an independent DR aggregator**. Here, the aggregator controls devices at the prosumers' premises that have a relevant potential for load shifting. Then, the aggregator offers the aggregated load flexibility at various flexibility markets to flexibility requesting parties such as TSO, DSO or BRPs. In return, the prosumers will get a financial remuneration from the aggregator for providing their flexibility. By applying this explicit DR model,

[1] A business case presents and supports, with detailed reasoning, expected net benefits for the business an action

the aggregator acts as an active player by linking the LFM to wholesale and ancillary services markets, or straight away to DSOs for grid management.

The value proposition of such an aggregator towards the prosumers in this BC comprises both facilitating direct trade with other local prosumers and participating in various wholesale and ancillary services markets.

6.1.2 Business Case 2: Supplier

Energy retailer or supplier as a P2P flexibility trading facilitator (including flexibility, day-ahead, intraday, balancing & ancillary market trading optimisation)

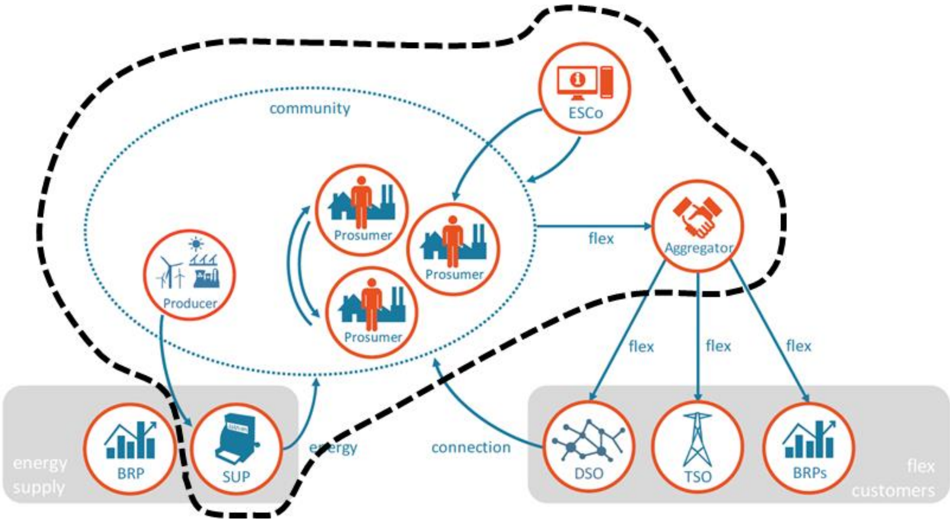


Figure 11. PARITY BC 2 (from [3], note: the players in this figure represent roles, not the actual market participants).

Roles assumed by the supplier:

- Supplier (if prosumers do not switch to new models)
- P2P trading facilitator
- Retail supplier platform manager
- DER/Prosumer clustering services
- RES Aggregator for wholesale energy markets

In the second BC, an **energy supplier (market retailer) should mainly act as an intermediary to facilitate the P2P transactions**. Therefore, in this BC the supplier primarily facilitates peer-to-peer trading within the LFM. Here, the actual business of electricity supply is a supplementary element that can be offered by the supplier to the prosumers in the LFM as well. This BC is mainly about how retailers – especially small ones - can utilize P2P transactions of self-organized prosumers enhancing their typical energy supply model. This BC analyses how retailers incorporate P2P transactions into their typical activities as retailers and how they can offer matchmaking, hedging/arbitrage and personalized energy provision services on-top of P2P transactive platforms. The term “facilitate” ideally refer to this type of services : DER/prosumer clustering based on complementarity and other attributes most favourable for P2P LFM transactions. Streamlining prosumer individual preferences into energy market transactions.

In competitive retail markets, P2P energy-trading platforms are a value-added service suppliers can offer to differentiate themselves. Allowing prosumers to obtain more value from their DERs should help suppliers retain them as customers. Suppliers can also benefit by gaining better awareness of their customers through their actions in the P2P platform, allowing them to contract more effectively with generators.

As an example, P2P platforms could be used to facilitate RES energy trading, through advanced forms of traditional types of ‘green tariffs’. Also including temporal and locational attributes of DER (generation, storage and demand), through trusted and transparent transaction mechanisms that include a full trace of the energy path flow (from generation to demand).

Finally, this BC could also include the connection between LFM and wholesale markets facilitated by the energy retailers and how retailers can setup upstream service contracts and prosumer clustering utilizing P2P transactions. P2P energy transactions will allow prosumers to dynamically form trading groups with the correct synthesis of DERs to fulfil capacity and controllability specifications. RES aggregation for specific trading intervals of wholesale energy markets, while storage utilization to meet ramp-rate requirements.

6.1.3 Business Case 3: DSO as Market Coordinator

DSO as a market coordinator (the trusted party capable to operate an LFM to ensure independence and fairness to all involved market actors)

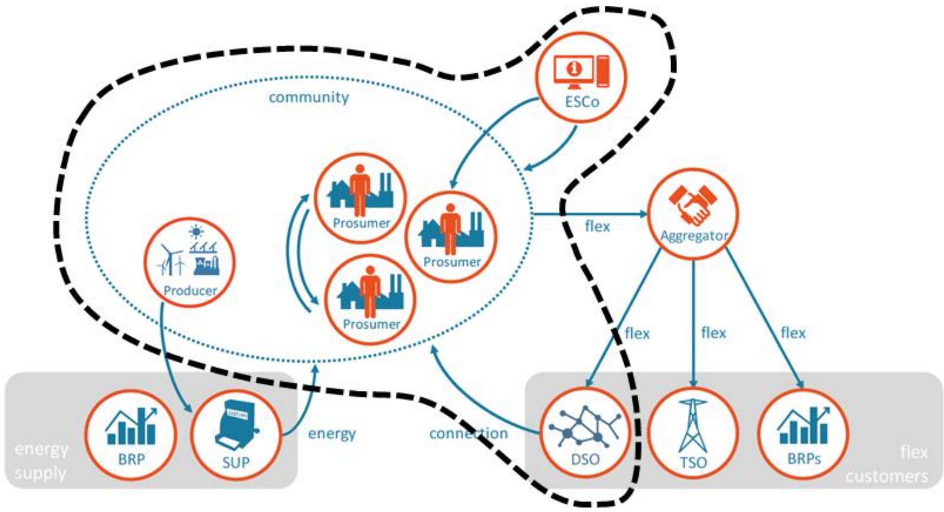


Figure 12. PARITY BC 3 (from [3], note: the players in this figure represent roles, not the actual market participants).

Roles assumed by the DSO:

- Management and operation of the distribution system, as usual.
- DSO as LFM operator.

The core competence of the DSO in this Business Case is the **passive coordination of the LFM** with the aim to ensure fairness among all market participants. In this concept, the DSO acts as a neutral authority controlling the compliance with market rules and therefore avoiding conflicts of interest between the actors involved in the LFM.

This BC should ideally be focus on the preventive grid management to which the DSO can perform by contributing to the LFM configuration.

- **Green state->** under green state this configuration should allow P2P transactions to be executed within previously defined limits/constraints, where multiple actors can actively participate.
- **Orange State->** When the grid condition turns ORANGE, then the DSO becomes the only buyer of flexibility.
- **Red state ->** this is related to BC4, where the DSO assumes control.

6.1.4 Business Case 4: DSO as DER enhanced network operator

DSO as a DER enhanced network operator (including the use of novel smart grid management tools and infrastructure that enable more cost-efficient ways to ensure power quality and grid stability in the distribution grid and consideration of flexibility as an alternative to network upgrades).

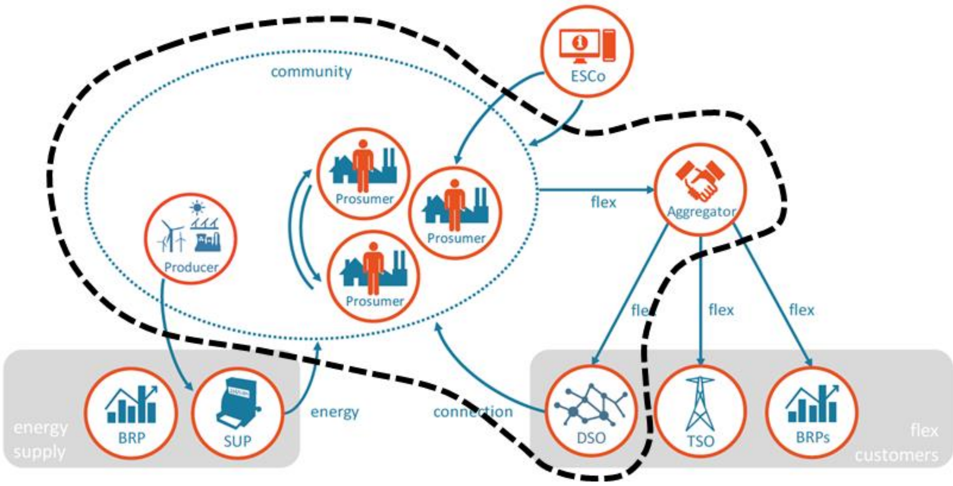


Figure 13. PARITY BC 4 (from [3], note: the players in this figure represent roles, not the actual market participants).

Roles assumed by the DSO:

- Management and operation of the distribution system, as usual.
- DSO as LFM operator.
- Aggregator for providing ancillary services for the DSO

In BC-4, the DSO is **actively controlling the loads at prosumers' premises in order to gain flexibility for the distribution grid**. This BC enhances the role of a DSO using the LFM to act in cases of red-light state such as congestion issues or grid instability problems. In this case, the DSO takes control of the associated DERs extracting the necessary flexibility to ensure grid stability, as an alternative to network upgrades. The DSO remains the only buyer of flexibility but this flexibility is somehow imposed to the prosumers and aggregators in the LFM. This means, in addition to the DSO's core competency, it is acting as an aggregator solely meeting the flexibility needs of the distribution grid. In this case, a fair compensation towards the prosumers providing the flexibility needs to be ensured, reflecting actual market prices. Similarly to BC-3, this additional business activity performed by the DSO may be critical and should be contemplated in the regulatory framework. This direct intervention by the DSO is only applied in times of critical grid constraints and therefore does not hamper an open and competitive local flexibility market. Expected compensations to prosumers should also be higher.

6.2 Use Cases (UCs)

This section provides a short description of the UCs to be tested in the PARITY Project, based on the discussions among partners. A description table, a schema, and general requirements derived, are provided per each UC (Table 7).

Table 7. Post partners discussions UC list.

UC (initial)	UC (after initial discussions)	Use Case title
UC1	UC1	Building-level P2H/BAB flexibility estimation & automated provision to aggregator for LFM participation
UC2	UC2	Aggregated P2H flexibility estimation and provisioning for market participation pre-qualification
UC3	UC3	Aggregated V2G flexibility estimation and provisioning for market participation pre-qualification
UC4+UC6+UC14 (union of these 3 UCs)	UC4	Human-centric and contract-safeguarding energy and flexibility transactions in LFM, on the basis of context-aware flexibility profiles
UC5	UC5	Forecasting, scheduling and dispatch of DER flexibility for coordinated management of the LFM grid
UC7	UC6	Smart grid management using enhanced PQ services for grid instability limitation
UC8	UC7	Ancillary services provision by STATCOM to TSO for overlay network stability
UC9	UC8	Congestion management by DSO through operation of LFM to increase DER penetration
UC10		REMOVED
UC11	UC9	Provision of ancillary services to overlay ancillary service market operated by TSO
UC12	UC10	Participation of LFM-enabled flexibility to national wholesale energy market
UC13	UC11	Red light (emergency) grid management using automated control of distributed DER (through smart contracts)
UC15	UC12	Flexibility enhancement through synergies with neighbour distribution networks and/or LFMs.

6.2.1 Use Case 1

Use Case #	**UC-1**
Use Case Name	Building-level P2H/BAB flexibility estimation and automated provision to aggregator for LFM participation
Intent	Use Case main purpose is to describe the process of generating different flexibility product profiles of different spatio-temporal granularity, upon the request of the Aggregator. These Flexibility product profiles (human centric and context aware) will allow for the robust estimation of mid-term (day ahead), short term (intraday/intr-hour) and near-real time flexibility forecasting. This should be ideally performed for relevant controllable assets (HVAC, DHW and local actual and virtual energy storage) in a generic manner that will address the need of different flexibility products and respective services. *Explicit and Implicit DR could be examined, however always through automation*.
Author	HYPERTECH
Last Update	27/4/2020
Actors Involved	Prosumer, Aggregator/ESCO, Building Occupant
Assumptions	• The current UC focuses on the individual prosumer. • Aggregated portfolio flexibility is addressed in UC 2. • EV Flexibility is addressed in UC3. • ESCOs managing individual buildings are assumed to be interacting with an aggregator for receiving such services however hypothetically they could receive such services directly for their own purposes.
Pre-conditions	• Gateway, WSN and submetering infrastructure installed, commissioned and fully operational • Contractual arrangement between Prosumer, Aggregator/ESCOs established • Prosumer profiling has run for an appropriate period and profile models have been learned and calibrated successfully
Trigger	• Aggregator system requests flexibility profile for a specific time horizon • Profile information could also be forwarded on a periodic basis (to accommodate specific transaction flows especially during the operational phase where flexibility is dispatched)
Brief Description	Main objective is to facilitate the seamlessly integration of heterogeneous DER within a unified flexibility management framework. Moreover, in order to enhance prosumer participation in this framework without violating user comfort parameters, appropriate metering, monitoring and sensor infrastructure is installed (Smart Home system and devices). The data collected by this equipment is fed through established communication streams to the profiling mechanisms that provide information on the building’s energy specifications as

	well as on the occupants' energy-related preferences. This information is utilised for the estimation of optimised demand flexibility profiles considering comfort-related constraints. More specifically: • Occupants use their spaces and interact with the relevant building assets as before. • PARITY Flexibility profiling engine automatically generates different profiles (occupancy, visual and thermal comfort, device usage, building thermal inertia and respective virtual energy storage, local energy storage capacity, HVAC profiles, DHW profiles) through non-intrusive analysis of building occupancy/operational data and without the need for explicit user feedback • Asset Flexibility profiles are combined into predefined flexibility products with specific characteristics addressing the needs of the PARITY market scenarios. • Aggregator/ESCO requests Flexibility forecast for a specific time horizon (next day, next hour(s), next minute(s), near-real time. • PARITY System (Flexibility engine) provides the requested information in the required granularity. *Portfolio level aggregated flexibility is performed within UC2, where based on the prosumer-level flexibility profiles, the aggregators estimate the flexibility of their portfolio through appropriate clustering of prosumer flexibility within the scope of different flexibility products, in order to reach market-size requirements under different business cases.*
Successful End Condition	Estimation of the aggregated flexibility potential by the Aggregator for all individual prosumers, flexibility products and respective assets
Post-conditions	Flexibility product profiles estimated for a predefined time horizon and spatio-temporal granularity. (e.g. volume, availability period and duration, up or down response times, minimum baseline period between consecutive activations, Frequency / number of activations possible time / seasonal limitations (depending on type of load) etc
Related Use Cases	UC-2, 4, 8-12
Related Business case	BC-1, BC-2 and BC-4

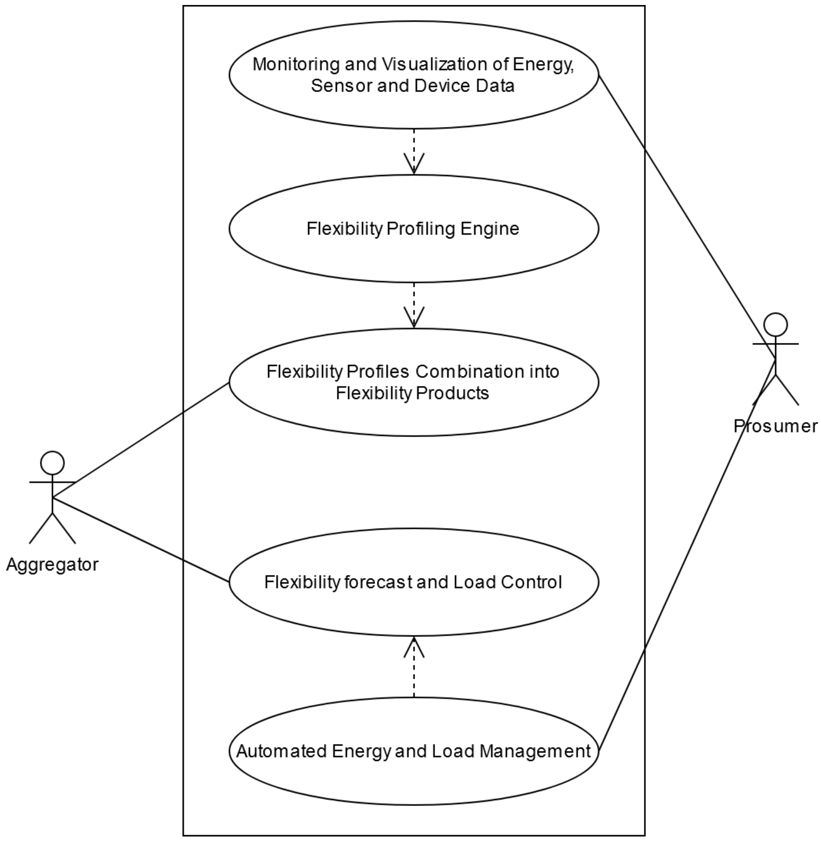


Figure 14. UC 1 schema.

General requirements derived from the UC:

- Non-intrusive building monitoring and prosumer profiling
- Demand and prosumer flexibility profiling without requiring explicit feedback
- User friendly graphical visualization of data analytics and details provided to the prosumer
- Provide intuitive ambient intelligence services to prosumers
- High levels of security and privacy in line with GDPR
- Advanced analytics services on prosumer profile data
- Day ahead, intra – day or near real - time flexibility estimation of individual prosumers considering the prosumer’s comfort preferences

6.2.2 Use Case 2

Use Case #	UC-2
Use Case Name	Aggregated Building-as-a-Battery flexibility estimation and provisioning for market participation pre-qualification
Intent	To provide information about aggregated Building-as-Battery (BAB) flexibility to interested actors (Aggregator, Energy retailer or DSO) for a requested area, in order to ease Aggregator or DSO tasks, and increase benefit of individual prosumers from participating in the market. BAB includes Power-to-Heat storage and actual storage (stationary batteries).
Author	CERTH
Last Update	27/04/2020
Actors Involved	Prosumer, Aggregator, Energy retailer, DSO
Assumptions	• There are multiple prosumers with BAB capacity that are interested to participate in LFM. • BAB flexibility of each individual prosumer is limited.
Pre-conditions	• Each prosumer has been registered to the PARITY platform along with its devices (HVACs, water heater etc.) and installed sensors (e.g. energy meters). • IoT Gateway device has been installed at each individual prosumer's site for monitoring consumption and extracting a flexibility schedule. • BAB flexibility forecasting per building/prosumer can be extracted for different time frames: Prosumers broadcast their flexibility schedules, which are validated through the smart contracts. Regarding the time frame, short-term (intra-hour) and mid-term (intra-day) flexibility forecasting are expected to be supported. Also, long-term flexibility forecasting may be considered, based on the requirements. • Groups of prosumers can be formed by the platform, based on their location and their forecasted flexibility schedules.
Trigger	Aggregator / Energy retailer or DSO requests estimated flexibility for a selected area and time frame.
Brief Description	1. Aggregator / Energy retailer or DSO (based on the BS applied) requests estimated flexibility for a selected area and time frame. 2. The corresponding PARITY service is engaged and calculates the aggregated flexibility using individual flexibility forecasting (short-term intra-hour or mid-term intra-day) already collected. 3. The corresponding PARITY service returns the aggregated flexibility. Furthermore, additional analysis information about the groups of prosumers will be available to the request initiator.

Successful End Condition	Aggregated energy collectives have been formulated and aggregated flexibility information is available to Aggregator or Energy retailer or DSO.
Post-conditions	BAB flexibility resources can be dispatched if needed in market transactions or for improving network condition (e.g. to ease congestion), based on the business case applied.
Related Use Cases	UC-1, UC-12
Related Business case	BC-1, BC-2, BC-4

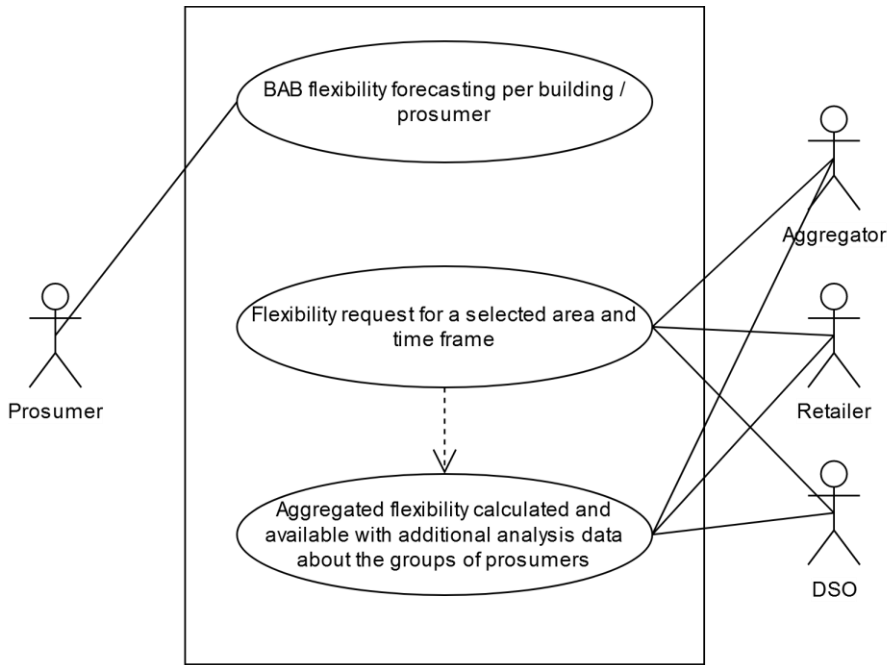


Figure 15. UC 2 schema.

General requirements derived from the UC:

- The system must be able to provide aggregated flexibility, as a service, of a requested area.
- Information about flexibility of individual prosumers should not be able to be extracted by the Aggregator/market operator, for privacy reasons.
- Both short-term and mid-term flexibility aggregation will be supported.
- Based on the applied market model and business case, appropriate presentation of the aggregated flexibility information to the involved stakeholders has to be provided.

6.2.3 Use Case 3

Use Case #	UC-3
Use Case Name	EV profiling and aggregated EV flexibility estimation for market participation
Intent	The purpose of this use case is to make use of services related to EVs, which are regarded as flexible loads. In particular, EV profiling and V2G services will allow prosumers to perform direct P2P transactions through the LFM, minimizing the charging costs. Moreover, aggregated EV flexibility can be provided to Aggregator, Energy retailer or DSO in order to be taken into account in market transactions.
Author	CERTH
Last Update	27/04/2020
Actors Involved	Prosumer / Facility manager, Aggregator, Energy retailer, DSO
Assumptions	• V2G EV chargers are available and EVs can be used as flexible load. • Charging needs of EV users and data from past charging sessions are available.
Pre-conditions	• EV charging stations and EVs have been registered to the platform. • EV user profiles (routine patterns of EV storage availability/usage) have been created based on user charging needs, past charging sessions, types of trips (work days, weekends), etc. • EV profiling service has produced a charging schedule and estimated the flexibility per each EV station, using various data as input: user profile, dynamic electricity pricing, EV characteristics, etc. In case an individual prosumer (home-owner) is also an EV charger owner, the generated charging schedule will allow to deliver profit from arbitraging and maximise self-consumption.
Trigger	Two different scenarios can be triggered within this use case. A. An EV user makes a request (to a specific or multiple charger owners) to utilize a charging station. B. Aggregator / Energy retailer or DSO requests estimated V2G flexibility for a selected area and time frame (short-term, mid-term).
Brief Description	The steps for scenario A are the following: 1. An EV user makes a request (to a specific or multiple charger owners) to utilize a charging station. 2. Information such as pricing, charging duration, time slots, location, etc. is returned to the EV user (from one or multiple charging stations). 3. In case of multiple candidate charging stations, an optimal charging station is proposed automatically, or selected manually by the user.

	4. Upon acceptance, payment is processed through smart contracts. The steps for scenario B are the following: 1. Aggregator / Energy retailer or DSO (based on the BS applied) requests estimated flexibility for a selected area and time frame. 2. The corresponding PARITY service is engaged and calculates the aggregated flexibility. 3. **The corresponding PARITY service returns the aggregated EV flexibility.**
Successful End Condition	A. In case a charging transaction has been completed, the reward for the charging service provided has been given. B. Aggregated EV flexibility is available to the Aggregator or Energy retailer or DSO.
Post-conditions	EV flexibility resources can be dispatched if needed in market transactions or for improving network condition.
Related Use Cases	UC-10
Related Business case	BC-1, BC-2, BC-4

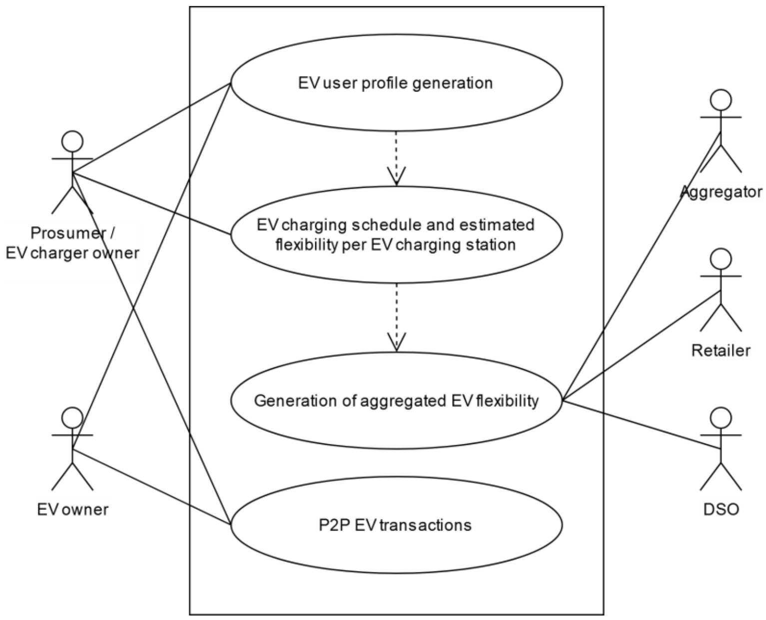


Figure 16. UC 3 schema.

General requirements derived from the UC

- EV usage patterns of specific prosumer should not be available to Aggregator, Market operator, and DSO, for privacy reasons.
- The system must be able to provide recommendations to the users or automatically modify EV schedule accordingly (if allowed by the users), in order to use the requested flexibility.

- Appropriate user interfaces must be available in order to ensure that prosumers or facility managers have complete control over the charging service and are aware of the EV charger status.

6.2.4 Use Case 4 (former UC4, UC6 and UC14)

Use Case #	**UC-4**
Use Case Name	Human-centric and contract-safeguarding energy and flexibility transactions in LFM, on the basis of context-aware flexibility profiles
Intent	PARITY will establish multiple geographically-distributed LFMs managed by local MOs as a complement to the current wholesale markets. This UC focuses primarily on the participation of prosumers in P2P energy and flexibility transactions. Prosumers will be able to engage in transactions directly (as peers) or indirectly (communities or certified third-party market participant, such as an aggregator). PARITY LFMs should promote local flexibility trading and demand response to available resources in local areas, towards increasing the efficiency, flexibility and responsiveness of local resources, aiming at local self-balancing while complying to DSO (network) constraints, but also allow for further interaction with wholesale markets through surplus energy/flexibility. Prosumers will be able to automatically participate in multi-bilateral P2P transactions facilitated by the market operations and also receive credit for their flexibility. Aggregators will be able to offer flexibility services to customers (DSO, TSO, BRP/Supplier, or facilitating P2P exchanges) by delivering flexibility products that utilize controllable assets of the prosumer portfolio (i.e. HVAC, DHW, EVs, batteries). The Aggregator will define the optimal cluster of portfolio assets that best meet the size and timing constraints of specific flexibility products. The goal of the PARITY platform is to provide tools that will allow Aggregators to offer multiple flexibility products within the same portfolio and maximize their value on different market opportunities. DSOs will be able to deploy novel active network management practices by proactively introducing their constraints into the LFM market configuration but also becoming active participants Finally, ESCOs will be able to utilize flexible assets behind the meter to increase prosumer benefits and reduce costs. Flexibility products can support ESCOs to offer advanced energy optimization services combined with implicit DR frameworks (e.g. ToU optimization, kWmax control: automated curtailments, Self-balancing or even controlled islanding) The PARITY toolset will aim at high levels of automation on all relevant phases, from planning, market bidding, real time operations and automated control as well as appropriate settlements, according to previous market commitments. The additional offering and activation of such flex products to the TSO ancillary services market is addressed inUC11. Furthermore, other types of flexibility services relevant to the wholesale market or DSO needs (congestion, voltage control) are part of UC9 and UC12 respectively.
Author	HYPERTECH

Last Update	27/4/2020
Actors Involved	In automated transactions all relevant actors are also represented by respective software agents, which in a more elaborate analysis of the UC could potentially be depicted as UC actors as well. • Prosumer (and prosumer communities) • Aggregator • Market Operator (depending on our implementation approach the market could be based on automated transactions, in which case the LF P2P platform will act as the market operator) • BRP/Supplier • ESCOs (Optional)
Assumptions	• Flexibility services for Congestion Management addressed in UC9 • Flexibility services for Ancillary services (balancing markets) addressed in UC11 • Flexibility services for Wholesale Market participation (spot, intraday) addressed in UC12
Pre-conditions	• Gateway, WSN and submetering infrastructure installed and operational • Aggregator, Prosumer, BRP/Supplier, agreements established within the context of the PARITY market models • UC1, 2 and 3 have run successfully and a forecast for individual prosumer and aggregated portfolio flexibility has been estimated at the necessary spatio-temporal granularity • Prosumer portfolio for different flexibility products established and successfully pre-qualified
Trigger	Market operations are assumed to be continuous and market clears in predefined time steps (aligned with central market operations).
Brief Description	Market participation is performed in continuous loops (typically D-1 as well as intraday). Specific periods to be defined based on finally adopted PARITY LFM model. Basic steps of the process are provided hereafter: • Prosumers pre-define their explicit energy/flexibility related preferences (e.g. local/regional sources of energy purchases, type of energy, fixed schedules, other) • DSOs pre-define grid relevant constraints (e.g. asset sensitivity factors in relation to their effect in relieving congestion, grid constraints etc) • Prosumer and/or Portfolio Energy and Flexibility Schedule Forecasted (based on the outputs of UC1-3) • Peers (individual prosumers, communities, aggregators) provide their flexibility products bids to the Market • DSO validates flexibility product schedules against grid constraints (optional step in case this is performed based on a combination of DSO pre-defined asset sensitivity + grid constraints information incorporated into the market clearing operations) • DSOs, BRPS, ESCOs provide their flexibility requests

	• MO clears the market – (Based on the traffic light approach) Under normal operations, multi-bilateral trading is performed prioritizing grid local self-balancing, always complying to grid constraints. Only the residual production is forwarded to external transactions (other LFMs or regions or wholesale markets). Under yellow conditions, DSO is the only market buyer. Under red conditions market operations are paused. Ideally, each region will have its own LFM market, its own constraints and therefore its own price incentives to produce or consume. • MO generates a dispatch schedule • Prosumer assets operational status are continuously monitored during the ISP (in the form of continuous nominations) to the MO • MO detects an imbalance and triggers/invokes the appropriate flexibility products from the pool previously cleared into the market • MO to perform the Settlement process –
Successful End Condition	• Flexibility bids cleared • Flexibility offers invoked fully (or to a large extend) successfully completed • Relevant stakeholders (Prosumers, Aggregators, ESCOs and depending on the market model also BRPs/Suppliers) remunerated • Prosumer energy optimization performed
Post-conditions	• Transaction logs stored in the LFM registry
Related Use Cases	preceding -> UC1, UC2, UC3, parallel/interdependent-> UC5, UC 8, UC 9, UC 10
Related Business case	BC-1, BC-2, BC-4

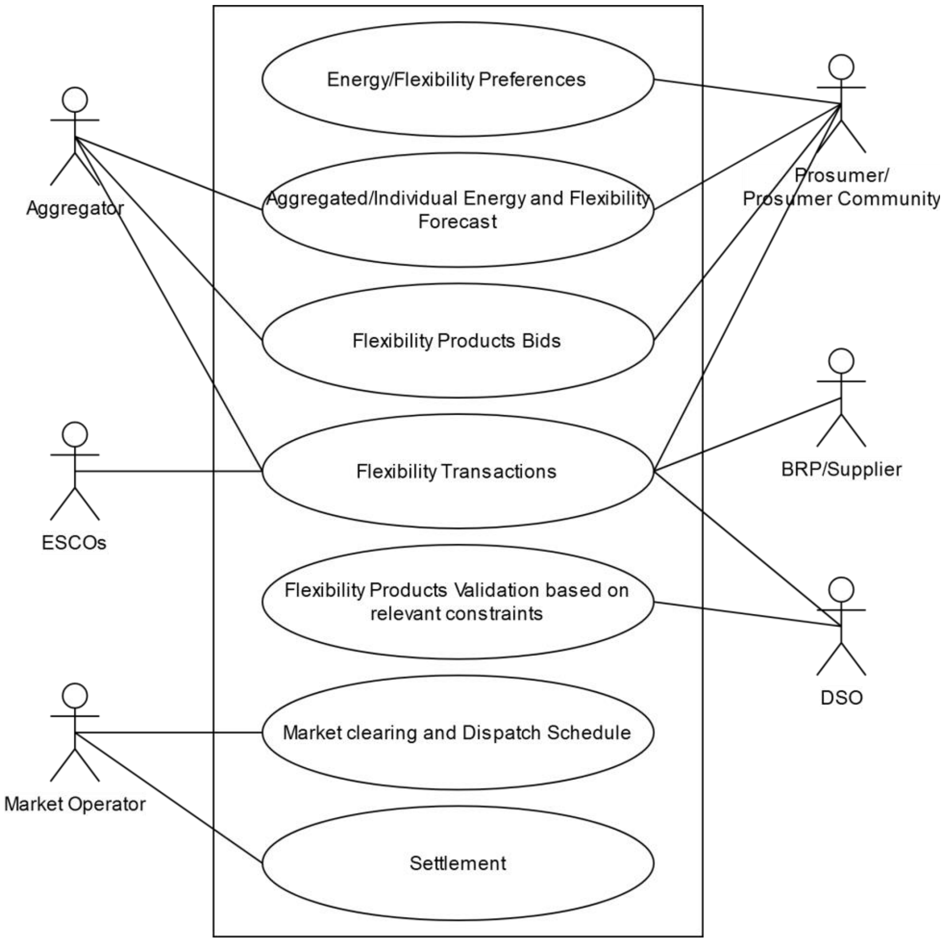


Figure 17. UC 4 schema.

General requirements derived from the UC:

- Support of secure and continuous automated transactions
- Flexible contracts covering different needs of transactive energy framework peers
- Increased utilization of local flexibility assets
- High levels of distribution grids self – organization
- Increased capability for preventive grid management
- High levels of trust and security

6.2.5 Use Case 5

Use Case #	UC-5
Use Case Name	Forecasting, scheduling and dispatch of DER flexibility for coordinated management of the LFM grid
Intent	The intent of this use case is to describe the operational real-world scenario in which a grid operator needs to utilize resources available through the LFM platform.
Author	CheckWatt
Last Update	02/04/2020
Actors Involved	Prosumers, Aggregator, BRP/Supplier, DSO, LFM Operator
Assumptions	• LFM platform in operation • Known availability of DER
Pre-conditions	• Operator knowledge about LFM grid restrictions, requirements and needs • (Help by DSOs to fill in what data is typically needed to analyse grid weak points • Network Green State. For Orange state, where the operator is the single buyer of flexibility and dispatches DERs to resolve grid issues refer to UC-8
Trigger	System needs identified by grid operator.
Brief Description	The LFM operator needs tools to determine the use of resources available through the LFM platform. The nature of these resources is of high importance, as they should be used according to their limitations and best abilities. However, the limitations of each DER has to be translated into a standard format by the aggregator (UC-2, UC-3) and should be presented to the LFM operator in this way. This use case involves the LFM operator to have extensive information about the grid to make a meaningful forecast and prepare the DER. DER benefit from earlier information, thus being able to prepare for example a chemical or thermal battery for probable discharge. In Green State, LFM transactions happen automatically and continuously in near-real time. For this to happen local grid constraints should be proactively provided on a continuous bases so that the LFM can clear only bids that comply to these constraints (Preventive Grid Management).
Successful End Condition	DER flexibility is continuously dispatched through the LFM platform in accordance with LFM grid needs. Available DER are utilized efficiently and do come back to the platform for further participation (an indicator for DER owner satisfaction).

Post-conditions	● Stable grid conditions (could be specified with the help of DSO) ● LFM flexibility providers coming back to the platform
Related Use Cases	UC-2, UC-3, UC-4 UC-8, UC-11
Related Business case	BC-3

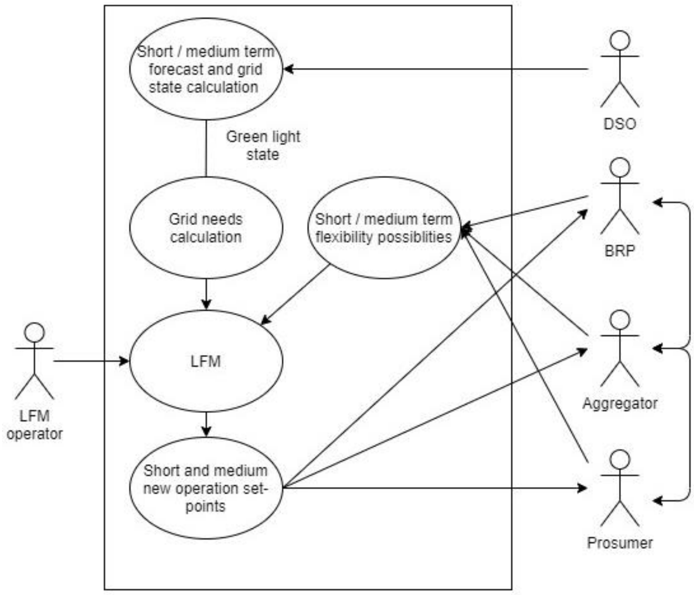


Figure 18. UC5 schema.

General requirements derived from the UC:

- LFM platform technology available
- Proactive and high-level DSO engagement and forecasting abilities
- Attractive price model to secure availability of DER from prosumers
- Secure communication and comprehensive agreements safeguarding resource availability

6.2.6 Use Case 6 (former UC7)

Use Case #	**UC-6**
Use Case Name	Smart grid management using enhanced PQ services to improve grid operation
Intent	Generate setpoints for DERs to maintain grid stability (In normal state no setpoints will be generated and the STATCOM will work balancing demand among the three phases)
Author	CIRCE
Last Update	30/03/2020
Actors Involved	DSO, Prosumers, Aggregators, LFM Operator
Assumptions	Grid and DERs monitored and managed remotely Prosumers and Aggregator have signed a contract to provide services to the grid
Pre-conditions	(UC will work constantly and calculate set-points only if grid issues (voltage deviations and overloading) are forecasted) DERs are available.
Trigger	Grid issues state forecasted
Brief Description	0.0.- DSO and prosumers DERs are monitored by devices in real time. 0.1.- Forecast of the next step generation and demand of prosumers 0.2.- Power flow calculation in the grid to detect possible problems in the grid (voltage deviations and overloading) 1.1.- If no problems are detected no set-points would be calculated. 1.2.- If any problems are detected, new set-points for the DERS would be calculated. 2.- Grid needs and DERs operation set-points are calculated. 3.- Operation set-points are calculated, systems and LFM limitations are followed 4.- Operation set-points are sent to the monitoring and control devices and applied to the DERs
Successful End Condition	Operation setpoints for DERs
Post-conditions	Instability avoided
Related Use Cases	Grid stability operation: UC-7, UC-11 General: UC-1, UC-4.

Related Business case	BC-4, BC-1

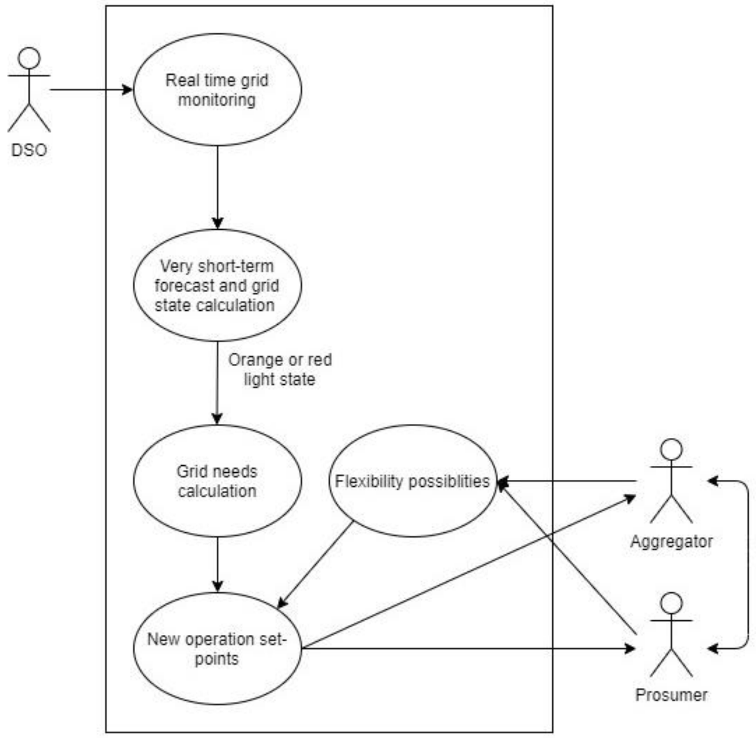


Figure 19. UC 6 schema.

General requirements derived from the UC:

- Secure communications, monitoring and management of distributed assets.
    - Automatic application of operation set-points for DERs
- Short term, demand and generation, forecasts.
- Power flow calculations to detect instabilities and grid needs
- Calculation of DERs set-points, to avoid or limit instabilities

6.2.7 Use Case 7 (former UC8)

Use Case #	UC-7
Use Case Name	Ancillary services provision by STATCOM to TSO for overlay network stability
Intent	Provide support to the TSO using STATCOM capabilities.
Author	CIRCE
Last Update	30/03/2020
Actors Involved	TSO, DSO, Prosumers, Aggregators
Assumptions	Grid and STATCOM monitored and managed remotely Direct communications between TSO and DSO
Pre-conditions	DERs is available.
Trigger	TSO sends a support request to the DSO
Brief Description	0.- TSO detects a problem in the transport system. 1.- TSO demand that DSO to provide flexibility services, in terms of P/Q. 2.- The DSO forecast of the next step state of the grid including the TSO request 3.1.- If the TSO request generates instabilities in the DSO grid no set-points for the STATCOM are calculated 3.2.- If the TSO request doesn't generate instabilities in the DSO grid set-points for the STATCOM are calculated 4.- Operation set-points are sent to the STATCOM monitoring and control devices
Successful End Condition	Operation setpoints for DERs
Post-conditions	Support provided to the TSO
Related Use Cases	Grid stability operation: UC-11 General: UC-1, UC-4.
Related Business case	BC-1

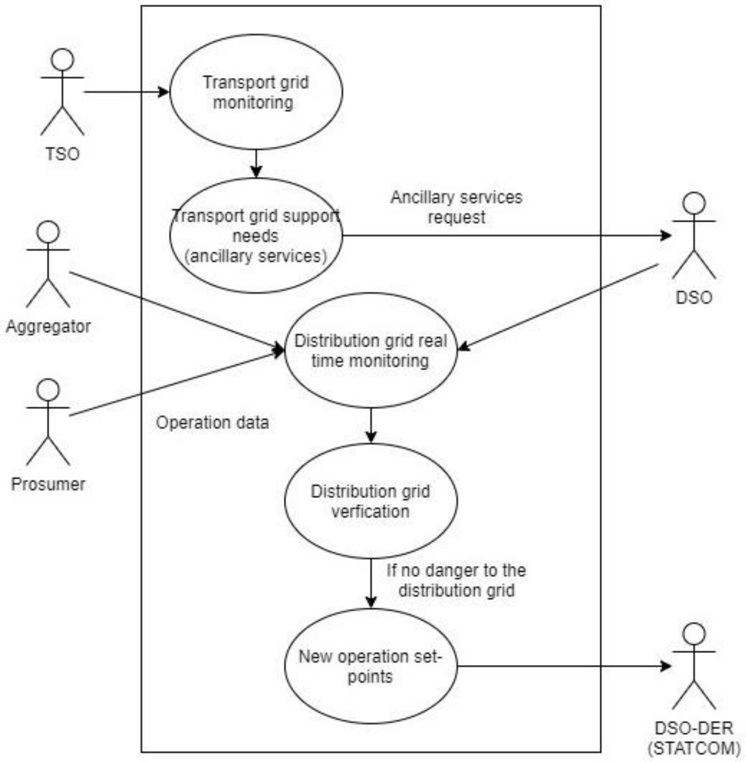


Figure 20. UC 7 schema.

General requirements derived from the UC

- TSO-DSO secure communications.
- Secure communications, monitoring and management of distributed assets.
    - Automatic application of operation set-points for the STATCOM
- Short term, demand and generation, forecasts.
- Power flow calculations to detect grid issues in the grid
- Calculation of STATCOM set-points.

6.2.8 Use Case 8 (former UC9)

Use Case #	**UC-8**
Use Case Name	Congestion management by DSO through operation of LFM to increase DER penetration
Intent	The intent of this use case is to describe the process in which the DSO acting as a single buyer of flexibility when grid is in Orange state sets up and manages the LFM to attract the necessary resources to the LFM platform enabling congestion management.
Author	CheckWatt
Last Update	02/04/2020
Actors Involved	DSO
Assumptions	● There are sufficient DER available for a reasonable cost located in the congested area ● Congestion management is a main driver for the setup of an LFM ● DER integration and aggregation is cost efficient compared to large scale solutions
Pre-conditions	● Existing LFM platform architecture deployed ● Grid Orange State. There are potential congestion issues that the DSO need to address using the flexibility available in the LFM.
Trigger	A DSO is looking at ways to evolve into a smart grid operator and has immediate or long-term congestion issues.
Brief Description	1. Grid modelling and identification of congestion management needs. Ideally the DSO should act as a single buyer in the LFM where necessary DER flexibility is purchased through automated LF market transactions. 2. DER mapping and recruitment through aggregator 3. On-point remuneration model (tilt towards market-based rather than fixed rate) to assure attraction in the right spots in the grid.
Successful End Condition	1. Availability of DER on LFM, and 2. Dynamic activation of flexibility by DSO in real time to reduce or eliminate congestion.
Post-conditions	● Stable grid conditions (could be specified with the help of DSO) ● DER availability sufficient for dispatch according to forecast (UC-5)
Related Use Cases	UC-5, UC-12
Related Business case	BC-4

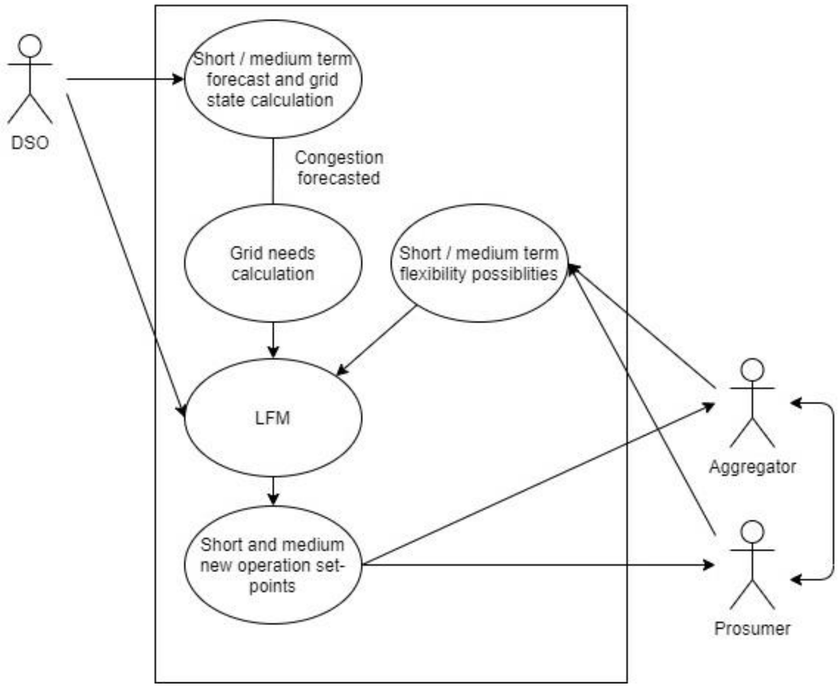


Figure 21. UC 8 schema.

General requirements derived from the UC:

- LFM platform technology available
- Proactive and high-level DSO engagement and forecasting abilities
- Attractive price model to secure availability of DER from prosumers
- Secure communication and comprehensive agreements safeguarding capacity availability during orange and red light state.

6.2.9 Use Case 9 (former UC11)

Use Case #	UC-9
Use Case Name	Provision of ancillary services to overlay ancillary service market operated by TSO
Intent	Participate in ancillary service markets for TSO by providing flexibility
Author	e7
Last Update	22/04/2020
Actors Involved	TSO/ ancillary service market operator, Aggregator (independent aggregator in BC-1 or retailer in BC-2), Prosumers, DSO
Assumptions	Prosumers under contract with the aggregator (independent aggregator in BC-1 or retailer in BC-2) and therefore participants in the LFM
Pre-conditions	Remotely switchable DERs available at prosumers' premises Flexibility provision to TSO does not lead to congestions in the distribution grid → DSO's permission required Flexibility needs of DSO already met (hierarchical approach)
Trigger	Call for flexibility tenders by TSO/ancillary service market operator
Brief Description	1.- Prosumers provide their flexibility products bids to the LFM. 2.- DSO validates flexibility product schedules against grid constraints 3.- TSO/ancillary service market operator starts procurement process by publishing a call for tenders 4.- LFM operator clears the market – (*Based on the traffic light approach*) Under normal operations, multi-lateral trading is performed prioritizing grid local self-balancing, always complying to grid constraints. Only the residual production is forwarded to external transactions (ancillary services market). 5.- the entity that assumes the aggregator role in the LFM (independent aggregator in BC-1 or retailer in BC-2) offers a tender for flexibility via its BRP 6.- TSO/ancillary service market operator accepts the tender 7.- Event occurs that requires ancillary service for the transmission grid. 8.- TSO sends order for flexibility provision to aggregator of LFM (independent or retailer) 9.- Aggregator of LFM dispatches loads at prosumers via aggregation platform, executed by the prosumers' oracles.

Successful End Condition	Loads in LFM dispatched according to TSO request
Post-conditions	Ancillary service provided to TSO
Related Use Cases	UC-1, UC-2, UC-3,
Related Business case	BC-1, BC-2

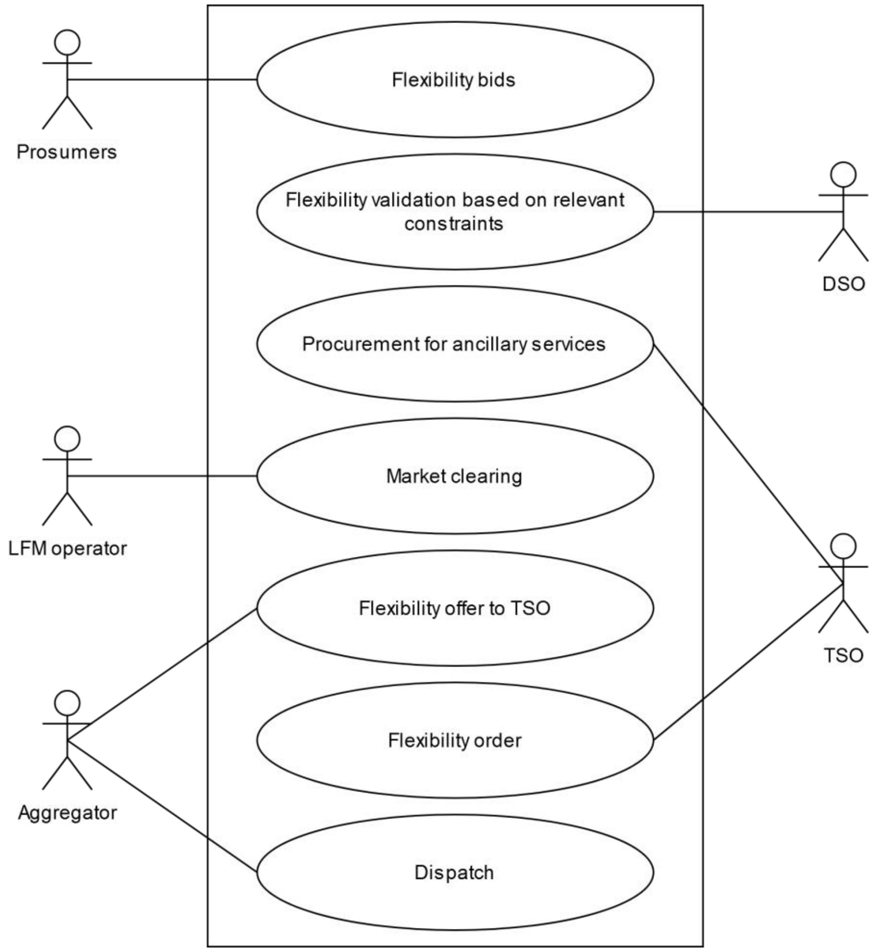


Figure 22. UC 9 schema.

General requirements derived from the UC

- Concerning aggregation, the PARITY solution needs to meet the prequalification criteria for ancillary services markets (e.g. requirements for the quality of technical connection of prosumers to the aggregator)

6.2.10 Use Case 10 (former UC12)

Use Case #	UC-10
Use Case Name	Participation of LFM-enabled flexibility to national wholesale energy market
Intent	The LFM operators can provide flexibility services toward the wholesale energy market. The flexibility's availability is communicated to energy retailers/aggregators. Energy retailers/aggregators access the wholesale market and buy flexibility from LFM operators
Author	HIVE
Last Update	27/04/2020
Actors Involved	Wholesale energy market operator, Aggregator (independent aggregator in BC-1 or retailer in BC-2), Prosumers, DSO
Assumptions	Prosumers under contract with the aggregator (independent aggregator in BC-1 or retailer in BC-2) and therefore participants in the LFM Minimum aggregated capacity (e.g. 5MW Switzerland)
Pre-conditions	Remotely switchable DERs available at prosumers' premises Flexibility provision to wholesale energy market does not lead to congestions in the distribution grid → DSO's permission required Flexibility needs of DSO already met (hierarchical approach or traffic signal method, status=green light)
Trigger	Call for flexibility tenders by wholesale energy market operator
Brief Description	1. The prosumers sends their flexibility estimation to the aggregator/retailer. 2. The aggregator/retailer can utilize the flexibility for: • Pooling of Local Energy/Flexibility • Transfer of Surplus or shortage to the central market • Automated resolution of imbalances to the central market 3. The aggregator sells the flexibility to the wholesale market (day-ahead, intraday) 4. Aggregator of LFM dispatches loads at prosumers via aggregation platform, operation setpoints are sent to DER and prosumers, executed by the prosumers' oracles.
Successful End Condition	Operation setpoints are sent to DER and prosumers.
Post-conditions	Flexibility provided to the wholesale energy market
Related Use Cases	UC-1, UC-2, UC-4

Related Business case	BS-2, BS-1

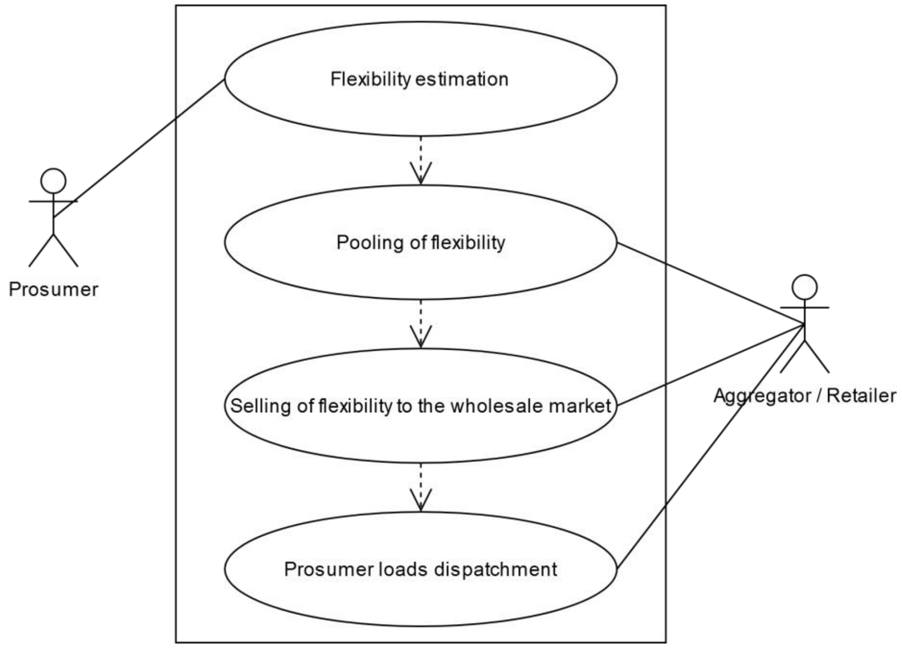


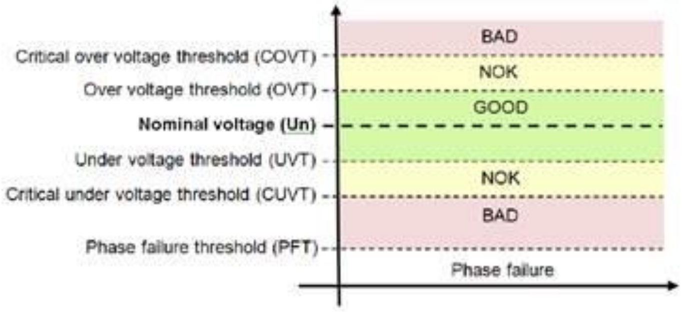
Figure 23. UC 10 schema.

General requirements derived from the UC

- Flexibility provision to wholesale energy market does not lead to congestions in the distribution grid → DSO's permission required
- Flexibility needs of DSO already met (hierarchical approach or traffic signal method, status=green light)

6.2.11 Use Case 11 (former UC13)

Use Case #	**UC-11**
Use Case Name	Red light (emergency) grid management using automated control of distributed DER (through smart contracts)
Intent	Define the main DSOs standards to ensure a safe and reliable grid management, avoiding troubles which may endanger the security of the end users' power supply. To pursue this goal, we suggest overlooking the rules and limits for a safe: 1) MV/LV grid's management 2) the devices' standards for being connected to the grid
Author	AEM
Last Update	08/04/2020
Actors Involved	Prosumers, Aggregator, DSO
Assumptions	The standards we refer for maintaining the grid stability are: 1. Standard EN 50160, which sets the parameters to be maintained to ensure a good power supply (voltage level, frequency, harmonics, flicker, etc.). 2. Maximum load of each line: on the MV grid (1 to 36 kV) the load on the various connections is monitored, and usually it is not a critical issue, in case of maintenance, redundancies allow to shift the loads and keep the flow above the limits; on the LV grid (<1 kV) the lines are normally protected from overloads by fuses in the cabinets. 3. Maximum transformer load: a regularly survey of transformers' loads is carried (currently manually, in the future by an online tracking); transformers are dimensioned abundantly, taking into account security level n-1; n-2.
Pre-conditions	The distribution grid (MV and LV) is dimensioned for "top down" loads, characterized by a well know (based on the historical experience) and relatively low contemporary power factors.
Trigger	The DER boosting is changing those standards, determining negative loads (production flows) and high contemporaneity power factor (for PV practically 1), which may lead, where high PV concentration occurs, to an increase in local voltage and a potential overload of lines and/or transformers.
Brief Description	To control these issues (mainly the first one mentioned) the voltage level is monitored by the smart meters (+/- 10% according to EN 50160). If those thresholds are reached (under/over-voltage), the flexibility (loads) available in the area on the same LV line will be used (increasing or decreasing consumption/production). In the future the same will be done for the cos fi (Power Factor). In the following table we are listing the values (voltage and cos fi, red lights) that we will monitor:

	16.2.2.1 Level Monitoring and Classification For quality assessment purposes there is also a possibility to monitor the voltage level more in detail. The voltage of every phase is monitored according to the levels given in the figure below:  These actions allow to monitor each low voltage line, which will be considered as a single system (although interconnected). Therefore, the DSO may act selectively line by line where troubles are detected, avoiding, as it was used to be in the past, to set commands valid for the whole distribution territory.
Successful End Condition	When the voltage level and the power factor will be stabilized under the EN 50160 threshold.
Post-conditions	Usually the DSO is following a prudent attitude for preventing as long as possible the Red-light zone to be reached. Historically it was done by ripper control (nowadays, through the "time of use" command if smart meters are used), switching loads during the most critical hours (indirect peak shaving). PARITY has to deal with this prevention's attitude, defining a way of working with the DSO for getting common benefits.
Related Use Cases	UC-7 and 8. DSO may use the services provided by those UCs for pursuing its goals. Following this strategy we shall consider that a DSO serves a variety of customers (the larger part of them without any tool for influencing flexibility, like the one renting flats), and it need (by law) to optimise/reduce in the most efficient way the grid tariffs. This goal, which is protecting a public interest, could conflict with the market's rules. PARITY shall therefore take into account this (apparent or real) issue.
Related Business case	BC-4

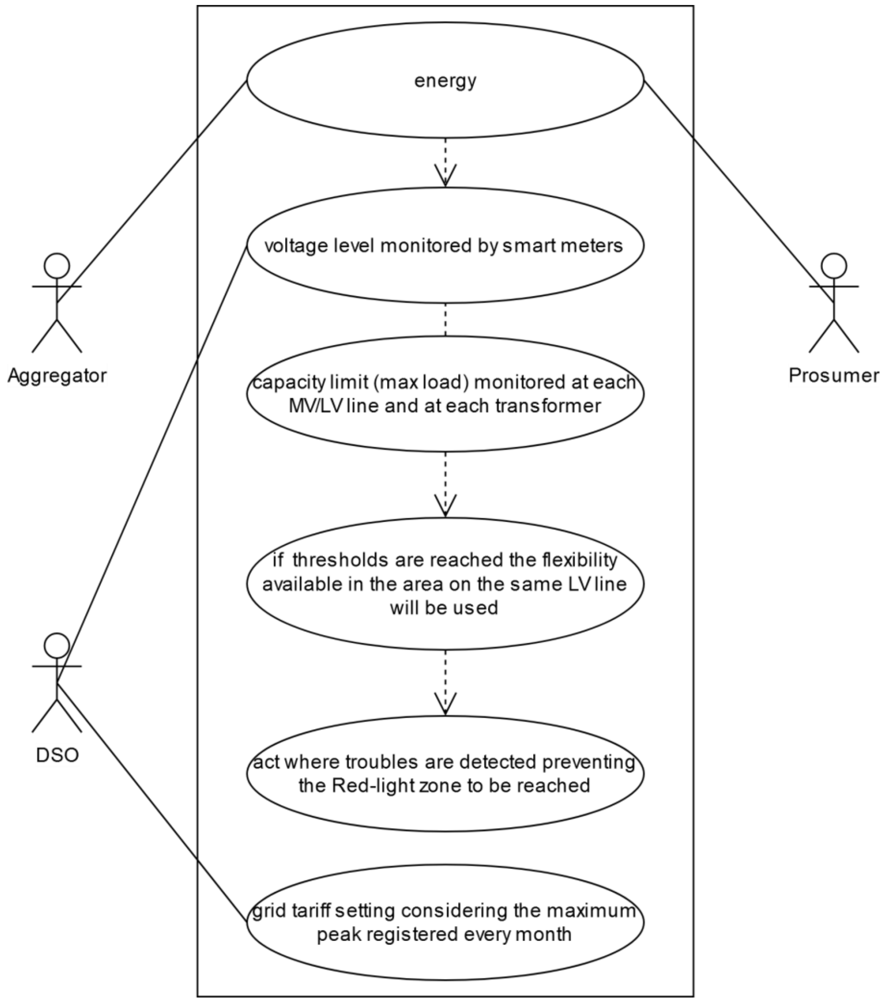


Figure 24. UC 11 schema.

General requirements derived from the UC:

- EN50160 norm monitored at transformer stations (HV/MV and MV/LV) and by smart meters (LV).
- Capacity limit (max load) at each MV/LV line and at each transformer is monitored by remote.
- Grid tariff has to be set considering the maximum peak registered every month (measurements every 15 minutes), in order to protect the user unable to provide flexibility from paying inefficiencies caused by market's operations and to define a neutral limit for assessing the economic feasibility of any market transaction (income have to be bigger than the grid cost caused by the max peak generated).

6.2.12 Use Case 12 (former UC15)

Use Case #	**UC-12**
Use Case Name	Flexibility enhancement through synergies with neighbour LFMs
Intent	Provide flexibility for DSO and neighbouring LFMs, gain flexibility from neighbouring LFM
Author	e7
Last Update	03/04/2020
Actors Involved	DSO, Prosumers
Assumptions	Under the regulatory framework, the DSO is allowed to take prosumers (of an LFM) under contract for the provision of flexibility; Prosumers of the neighbouring LFMs are under such a contract with the DSO
Pre-conditions	Remotely switchable DERs available at prosumers' premises
Trigger	Critical grid status in the distribution grid OR need for flexibility in one of the neighbouring LFMs (in order to solve supply/demand imbalances within the LFM)
Brief Description	1.- DSO detects congestion or voltage problem in the Distribution grid OR DSO (as operator of LFMs) detects imbalance in an LFM that can't be solved within the LFM 2.- DSO assesses the available flexibility in the different neighbouring LFMs 3.- DSO decides on which loads to be dispatched 4.- DSO sends control signal via the prosumers' oracles to devices that should be dispatched
Successful End Condition	Loads at prosumers' premises are dispatched
Post-conditions	Local grid constraints OR imbalances in specific LFM are solved
Related Use Cases	**UC-1, UC-2, UC-3, UC-6, UC-8, UC-11**
Related Business case	BC-4, BC-3, BC-4

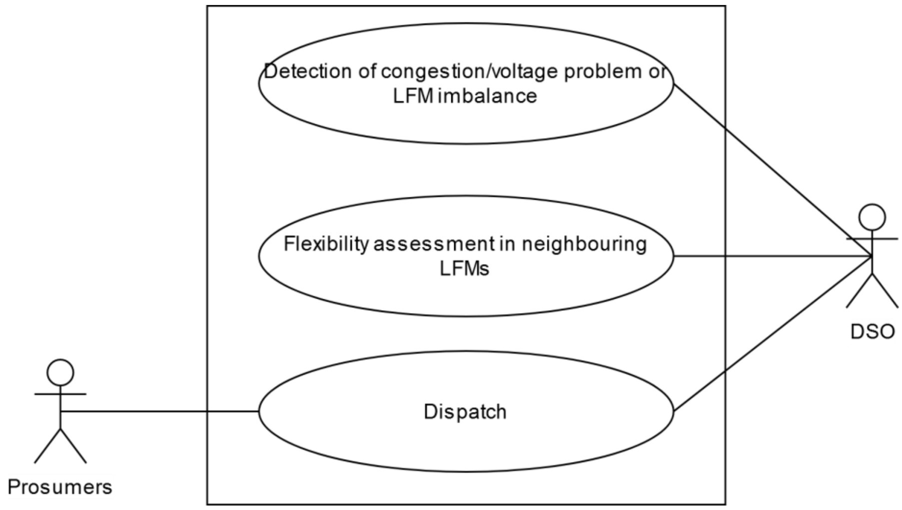


Figure 25. UC 12 schema.

General requirements derived from the UC

- DSO needs to take care of balancing between different LFMs and therefore of flexibility trading between different LFMs

7. CONCLUSIONS

This document shows the results of the study carried out to identify the needs of targeted end-users of the PARITY solutions. After analysing partners' roles and demonstrators' building users, a proper selection of information gathering processes have been made for targeted population samples (number, energy sector knowledge, representativity, availability to answer questionnaires, gender, easy-to-access, etc) and different surveys and interviews have been designed to extract information from residential customers, tertiary building users, aggregators, DSOs, building manager and general experts from demo countries (Spain; Greece, Sweden and Switzerland) and project partners countries. Demo and project partner stakeholder list was completed with external contacts and relevant sectoral actors. To complete this information several discussions on Use Cases (UCs) and Business Cases (BCs) have been carried out among PARITY partners with the aim of finding connections, overlaps and common functionalities, and describing more precisely each UC's scope.

In addition to the requirements, the surveys and the interviews have revealed the level of preparation of the pilots (Spain; Greece, Sweden and Switzerland) and their users (residential building consumers, tertiary buildings users, facility managers, DSOs and aggregators) for the development of the project. The main highlights for each end user type are:

- Residential consumers:

Residential consumers would accept, in general, to participate in LFM through an aggregator. They are not against carrying out this participation by means of an external entity, an aggregator for example, allowing it to manage their home devices to provide flexibility for LFM participation but would like to have the possibility to limit or cancel external set points as they fear losing control over their comfort preferences. Special communication care should be paid to this regard.

In general, surveyed residential consumers show interest in automatising their home devices (from HVAC, ventilation or lighting to solar PV generation systems, batteries or electric vehicles) and participating in local flexibility markets and demand response schemes.

Concerning the project pilot sites, there seems to be enough flexibility resources at the surveyed residential consumers homes for the PARITY project objectives. Although some resources are actually monitored remotely, a special effort must be done to use these devices as flexibility sources within the PARITY project framework: extra sensoring and monitoring network deployment and possible adaptation of local devices to follow external set-points.

Residential consumers, in general would like to receive information about the way energy is used at home, and also about their participation in LFM.

- Tertiary buildings users:

Most of the surveyed tertiary building user work in office buildings. In general terms, they consider that the buildings where they work have enough resources to participate in LFM and the buildings could be used as flexibility sources in these markets with low investments or changes in their use.

Tertiary building users would accept external control of building systems (cooling, ventilation, etc…) but they would like to have the possibility to limit or cancel these set points. They are mainly interested in knowing information about the energy performance of their buildings and online energy consumption data.

- Facility managers:

External facility managers consulted have the impression that Office buildings have limited resources to be used as flexibility resources currently. Large PV facilities and storage systems would enhance their demand flexibility potential.

Facility managers within the project consortium are interested in researching about how to develop and test suitable tools to enable DR participation in new LFM. Their buildings are specially well catered for testing as they are fitted with a good deal of sensoring and metering equipment. Other FM focus their interest in gaining higher control over DER and use this control to improve comfort and obtain energy savings.

- DSOs:

The interviewed DSOs are very interested in research of tools (hardware and software) to enable LFM and use these markets to trade the necessary DR to improve technically the grid operation capabilities, the schedule of resources (hydro, storage or CHP) as well as to reduce costs or delay investments on network assets.

Congestion issues are not a problem as of today, but it may become serious with increasing participation of non-manageable sources in the grid. They perceive DR management as an economic and straight-forward method to avoid future costly grid expansions.

- Aggregators:

Interviewed aggregators are interested in research for the use, at different levels, of DR/flexibility tools to operate in LFM. This is aligned with the objective of the PARITY project.

They differ in the most suitable flexibility providers: some aggregators would focus only on large consumers, but most would reach out towards the aggregation of small residential consumers' flexibility.

Economics is the main reason to participate in LFM and DR schemes for the interviewed aggregators, but they see a risk of low incomes for participation.

An important information extracted from project stakeholders are the perceived incentives and barriers to the development of DR schemas and LFM. Residential building consumers, tertiary buildings users, facility managers, DSOs, aggregators and general experts have showed similar results. The list of the main incentives and barriers for agents to take part in newly set up LFM are:

- Incentives
    - New source of incomes and fair remuneration for all stakeholders, from providers to aggregators and managers.
    - Contribution to grid balancing and stability.
    - Avoid or delay costly grid investments by using DR for congestion management.
    - Increase control and automation of energy systems.
    - Expected improvements in energy efficiency and energy savings (mainly PV consumption optimization).
    - Improvements in comfort derived from sensoring, monitoring and automated control of DER.
- Barriers
    - Low economic revenue expectancy with high initial investments.
    - Lack of technical and economical specific regulations in most countries.
    - Lack of previous experiences.
    - The complexity of the systems and contracts is also a perceived drawback, not only because they are not fully understood by all agents but because it might be the source of additional technical issues and failures.
    - Personal data concerns.

The components of the PARITY tool suite (both hardware and software tools), whose main requirements are set in this document, are:

- Smart Contract Enabled Local Flexibility Market Framework.
- Smart Contract Enabled IoT Gateway.
- Building-As-A-Battery management algorithms.
- PARITY Smart Grid Monitoring and Control algorithms and STATCOM.
- EV Profiling & Geo-Charging Services algorithms.

The main requirements for the PARITY tool suite are extracted from surveys and interviews, but also from partners' previous experiences in related projects and use cases debates. This is the list of functional and non-functional requirements for the PARITY tool suite:

- Functional requirements
    - Data gathering and consumer profiling.
        - Gathering and collection capabilities for all the necessary data to forecast and assess demand flexibility.
        - Non-intrusive building monitoring and prosumer profiling.
        - Advanced analytic services on prosumer profile data.
        - Proper monitoring is essential: secure, accurate and fast enough.
        - Algorithms to detect data measurement and data transmission anomalies should be deployed on all the nodes.
        - Data cleaning should be performed as much as possible at the point of data collection and measurement.
    - Short and medium term forecasting:
        - Customer demand management and generation forecast capabilities to optimise consumption and reduce energy bills.
        - Customer flexibility potential calculation, aggregation with other customers' flexibility, trading in LFM markets and automatically application of flexibility set-points in customers facilities.
    - Flexibility calculation aggregation and dispatch:
        - Local and global demand management with demand management capabilities at local level and at aggregated level.
        - Demand and prosumer flexibility profiling without requiring explicit feedback.
        - Flexibility events cancelation or limitation capacities by consumers if desired.
        - Day ahead, intra – day or near real - time flexibility estimation of individual prosumers considering the prosumer's comfort preferences.
    - DER interoperability and controllability:
        - Management tools should have a local algorithms platform to adapt external signals to the real state of the local systems.
        - DER registry enabling to list, dimension, characterise, communicate and control all relevant DERs involved in a flexibility contract with every prosumer.
        - Secure communications, monitoring and management of distributed assets.
        - Automatic application of operation set-points for the DERs, including the STATCOM.
        - Automatic system but with overriding capabilities by prosumer.
    - DSO business-specific requirements:
        - High levels of distribution grid self – organization.
        - Power flow calculations to detect grid issues.
        - Increased capability for preventive grid management.
        - TSO-DSO secure communications.
        - DERs (STATCOM and other distributed resources) management to solve grid issues.
    - Aggregator business-specific requirements
        - Meet the prequalification criteria for ancillary services markets.
        - The system must be able to automatically modify EV schedule (if allowed by the users), in order to extract the requested flexibility.
    - General Market and business level requirements:
        - Enable eventual participation in LFM through aggregated and automated demand flexibility schemes.
        - Operation of LFM even in grid constrained areas.
        - Interaction platform between neighbour LFM and grids.
        - Provide services not only to DSOs, also to TSOs.

        - Possibility to operate in wholesale markets, besides flexibility markets.
        - Capacity to collect market related information such as bid information, energy prices, energy traded volumes, ...
        - Capacity to collect external sources information such as weather parameters, temperature, radiation, humidity locally.
        - Meet requirements for the quality of technical connection of prosumers to the aggregator Flexible contracts covering different needs of transactive energy framework peers.
        - The tools developed should be aligned with and easily adaptable to the regulatory framework.
- Non-functional requirements
    - User friendliness
        - Consumer comfort preferences cannot be altered by the non-intrusive system.
        - Management tools should have a local algorithms platform to adapt external signals to the real state of the local systems.
        - Interface with customers to provide information about their facilities and equipment.
        - Provide automatic and customizable reports about customers, markets, system development, etc…
        - User friendly graphical visualization of data analytics and details provided to the prosumer.
        - Provide intuitive ambient intelligence services to prosumers.
        - User Interfaces of the tools have to be designed by taking into account that they may be used by senior citizens or people with limited technical experience.
        - Common Application Programming Interfaces (APIs) used for communication among different tools must be well-defined to handle various cases. Definition of data schemas that describe the structure of data formats is proposed.
        - Ease of use/plug & play: intuitive and mature technology should be provided to the user. (Users loose interest quickly when a solution is too complex or does simply not work as expected).
    - Data security / privacy
        - Use of digital / smart contracts and block chain to monitor transactions and security.
        - Safe communications and data protection management.
        - EV usage patterns of specific prosumer should not be available to Aggregator, Market operator, and DSO, for privacy reasons.
        - Support of secure and continuous automated transactions.
        - All applications must implement authentication mechanisms to prevent access and/or use by unauthorized users.

8. REFERENCES

[1] "SurveyMonkey tool web page." [Online]. Available: https://www.surveymonkey.com/.

[2] "DIRECTIVE (EU) 2018/844 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency." 2018.

[3] M. Klaassen, E., van der Laan, *USEF White Paper Energy and Flexibility Services for Citizens Energy Communities*. Arnhem: USEF Foundation, 2019.

ANNEX A: SURVEYS AND INTERVIEWS, MAIN RESULTS AND GRAPHS

This Annex shows a wide view of the results and graphs provided by the surveys and interviews made to the main stakeholders related to the project: residential consumers, tertiary building users, facility manager, DSOs and aggregators. Specific conclusions and requirements are listed and analysed in previous sections of this document.

Residential consumers surveys

As explained in the METHODOLOGY, section, 3, a unique survey was designed for the residential consumers living in the pilot sites. This unique survey was translated and adapted into every demo users' language (GR, IT, ES, SE) to facilitate the fill-in process. An extra survey has been made targeting the PARITY partners' workers. This section shows the results and graphs derived from the surveys filled-in by residential consumers. The main conclusions are highlighted in section 4.1.

The final amount of surveys received is shown in Table 8:

Table 8. Amount of residential consumers surveys.

Surveyed population	Answers received
Pilot site 3 – Lachar -Escúzar Area-Spain	39
Pilot site 4 – Luggagia Innovation Community – Switzerland	15
Pilot site 5 – Athens – Greece	35
Pilot site 6 – Malmö - Sweden	22
Non-pilot sites	100

In general (demo and non-demo users' responses), the main energy source for heating purposes is fuel (gas, diesel or biomass) limiting electric demand management possibilities (Figure 26). Fortunately, in the demo sites, the main energy source for HVAC is electricity, enabling the development and testing of demand management and flexibility-related techniques.

Related to domestic hot water, DHW, the same tendency is seen (Figure 27): higher use of fuels in general but an important use of electricity-based equipment in the demos thus enabling the subsequent PARITY project development and testing as it can be used as flexibility sources.

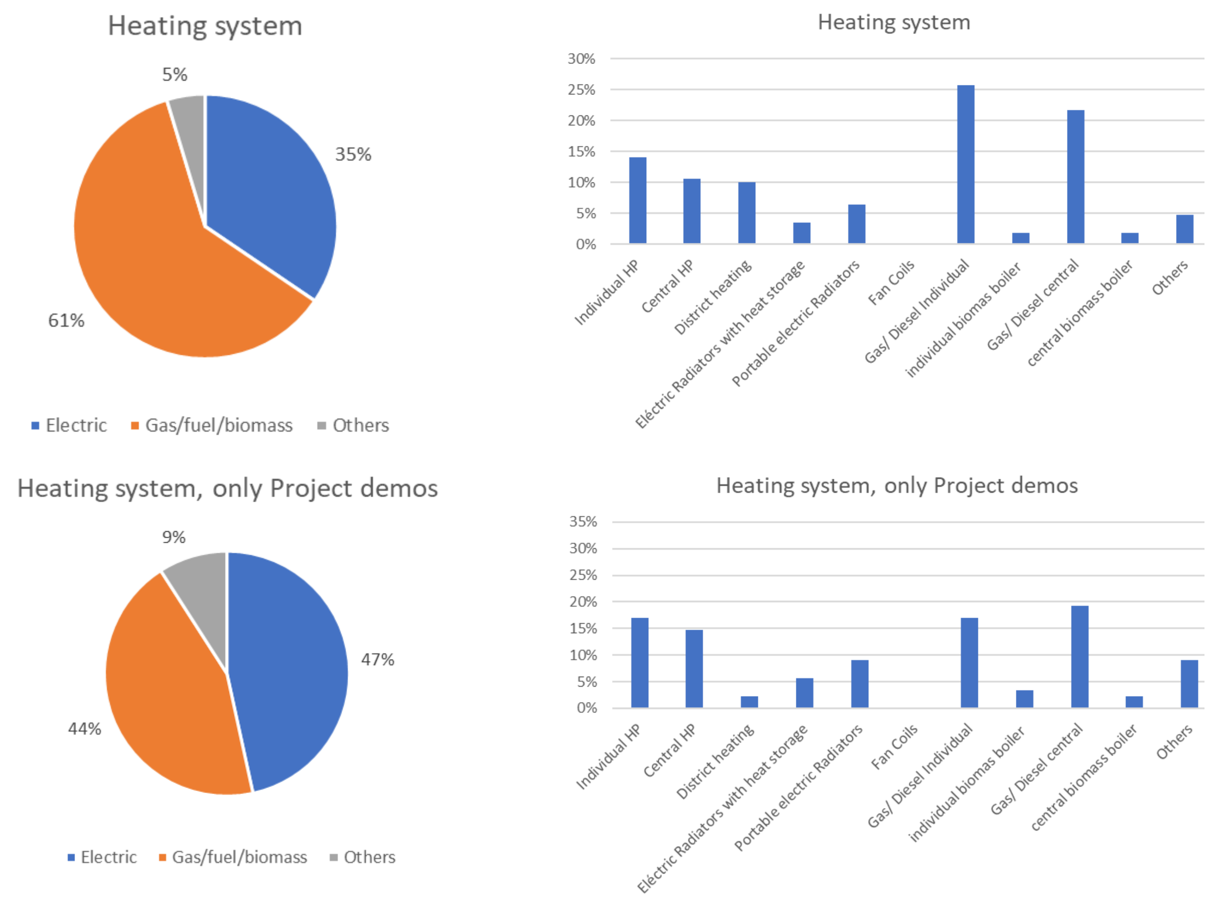


Figure 26. Residential survey heating systems results.

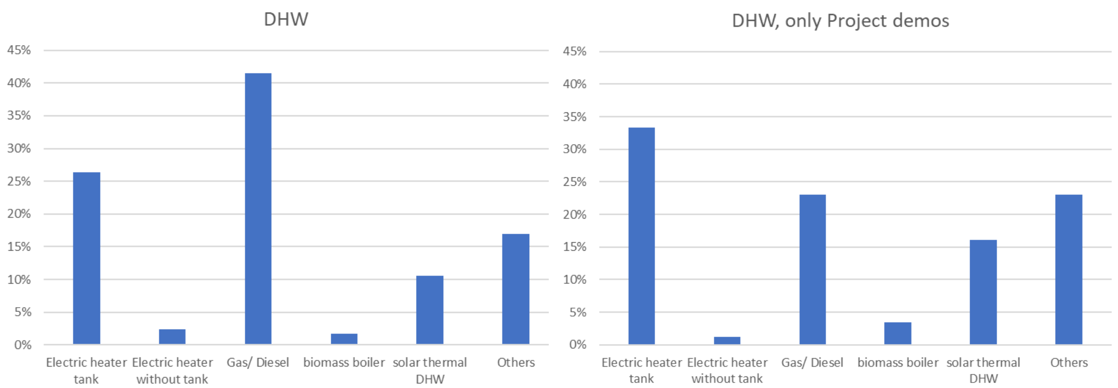


Figure 27. Residential survey DHW system results.

Related to cooling systems, the main technology is air conditioner splits (Figure 28). This trend is increased at demo sites, especially in the Greek and Spanish cases where cooling demand is even higher according to the survey results. These results show again that cooling systems could be an interesting source of flexibility for the project.

Manual ventilation is the main ventilation technique among pilot and non-pilot answers (Figure 28). Only in the Swedish demo forced ventilation is widely used. As a consequence, only in the Nordic demo ventilation can be a flexibility source.

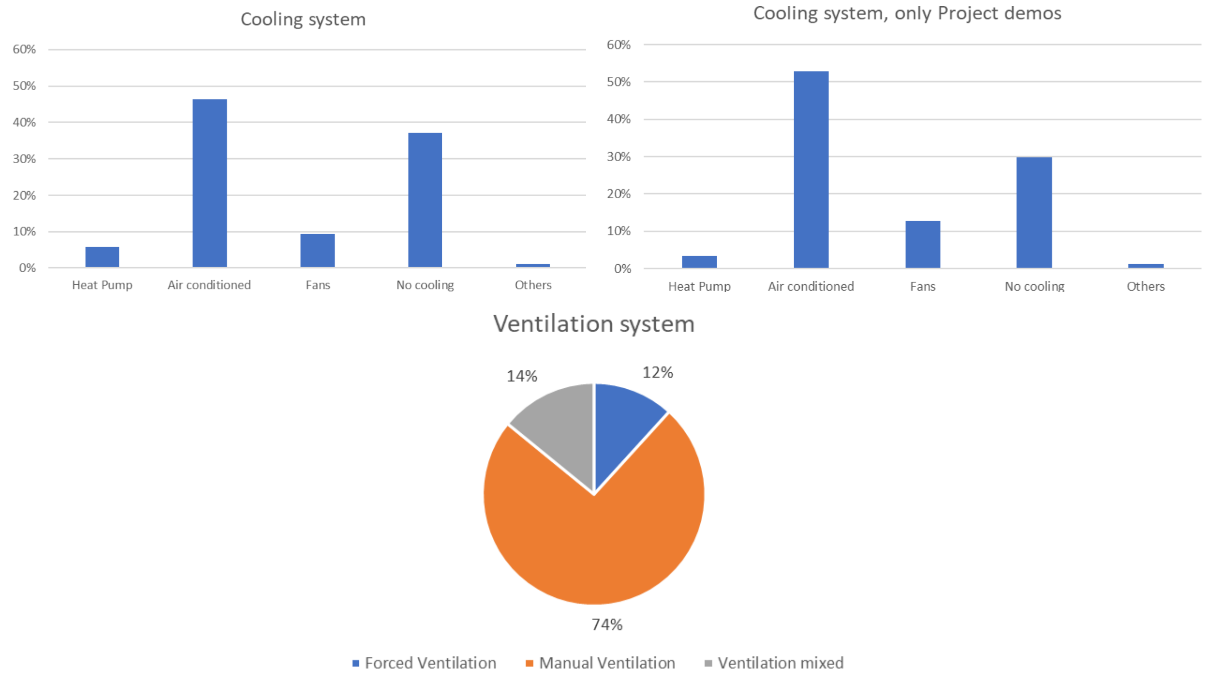


Figure 28. Residential survey cooling and ventilation systems results.

Dimmable lighting is not very used among pilot and non-pilot houses (Figure 29). Only the Swedish demo features a majority of users with dimmable lighting in some rooms of the house. Therefore, dimmable lighting does not seem to be an important flexibility resource.

Most of residential consumers surveyed have no electric vehicles (Figure 29). Most of the EVs (hybrid, full electric or pluggable hybrid) are found in non-pilot surveys, so PARITY project demos would need to enrol EV users to test this flexibility source.

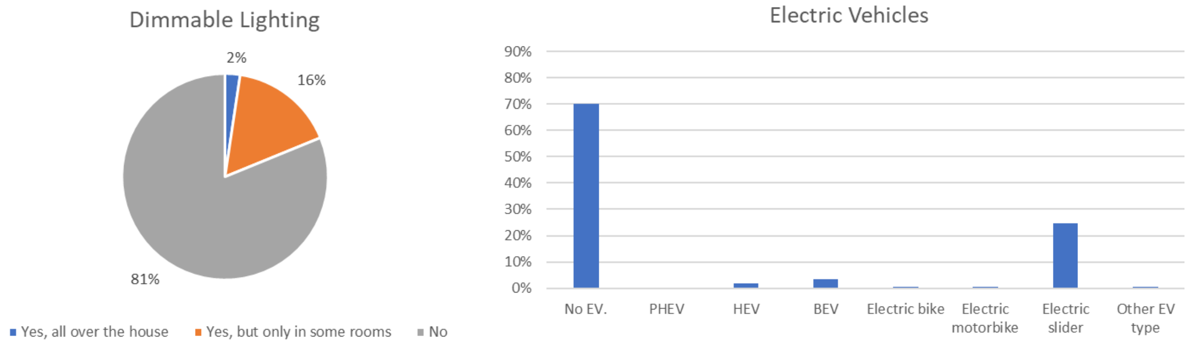


Figure 29. Residential survey dimmable lighting and EV availably results.

Only few houses in the surveyed sample have some sensors in their houses and these devices are mainly temperature sensors (Figure 30). Although some respondents claim to have sensors at home the majority do not monitor them. Additional sensoring equipment might be needed although many PARITY demo sites are smart buildings and are well endowed with these devices.

A small amount, 44%, of answers show that residential consumers have smart meters among pilot and non-pilot houses.

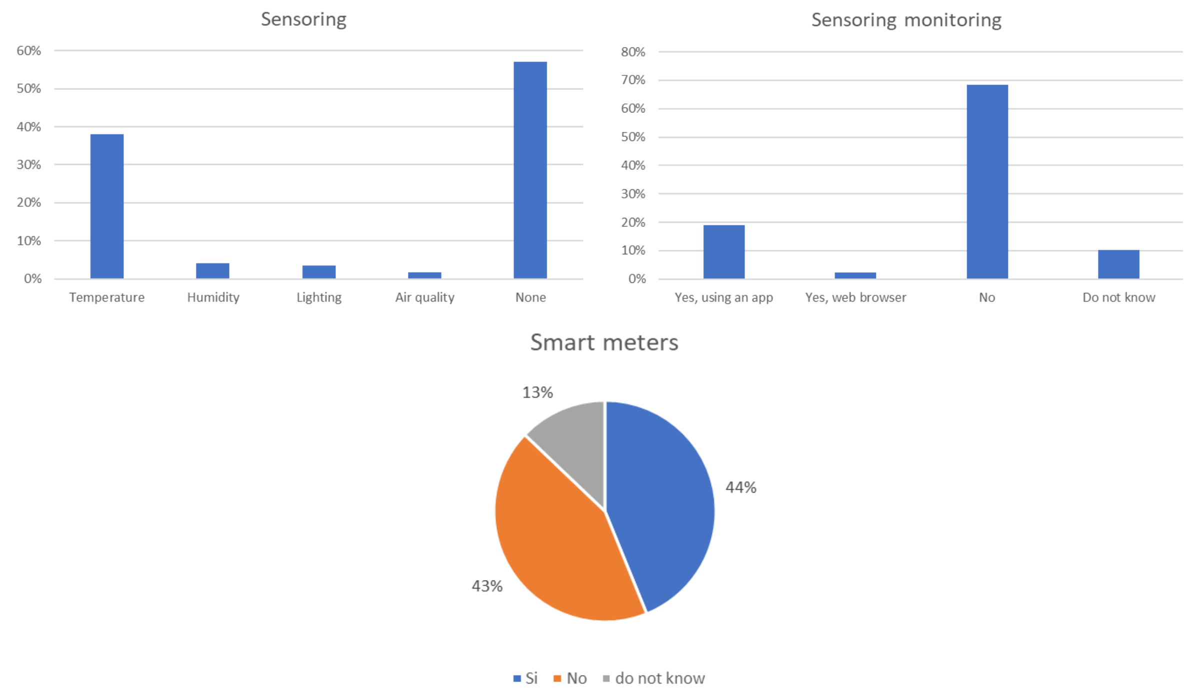


Figure 30. Residential survey sensoring and smart meters system results.

For most of the houses, pilot and non-pilot ones, the smart TV is the most common smart device (Figure 31). Not all the consumers manage their smart devices remotely, anyway the most common management tool is the app for mobile phones or tablets. Smart devices are not a useful flexibility source for many cases in the project at the moment. Other control systems (smart plug for example) and management systems could be used for a complete management of the house loads.

Answers related to heating, ventilation, DHW and cooling showed that in the demo sites these could be a flexibility resource, but as seen the do not seem to be managed using apps, web browser or others. A special effort should be done in this line to extract flexibility from thermal related uses.

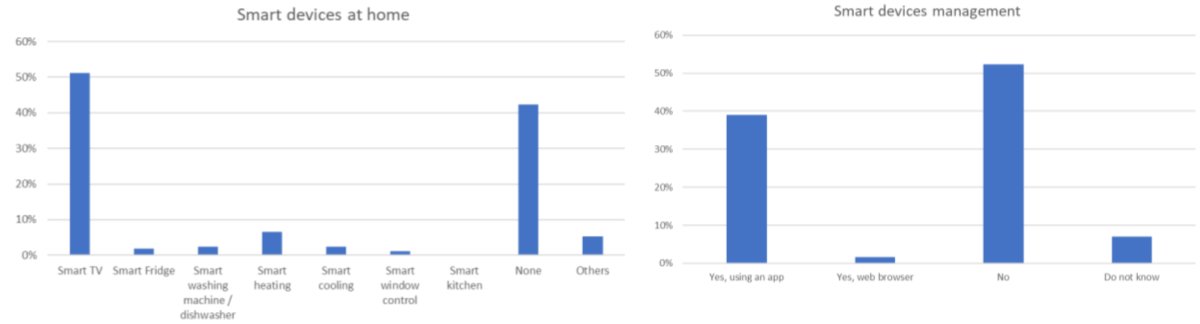


Figure 31. Residential survey smart devices availably and manageability results.

The most common distributed resource is solar PV facilities, other (wind power, CHP or batteries) have lower importance (Figure 32). These devices seem to be controllable, but not all remotely. As a consequence, not all solar PV facilities could be a flexibility resource in its current state, an extra effort should be done in the project to monitor and control remotely these systems.

Most PV facilities serve a single prosumer (Figure 33). Besides, some of the generation facilities are meant for collective self-consumption in the same building. The higher amount of shared generation facilities can be seen in the Swedish pilot.

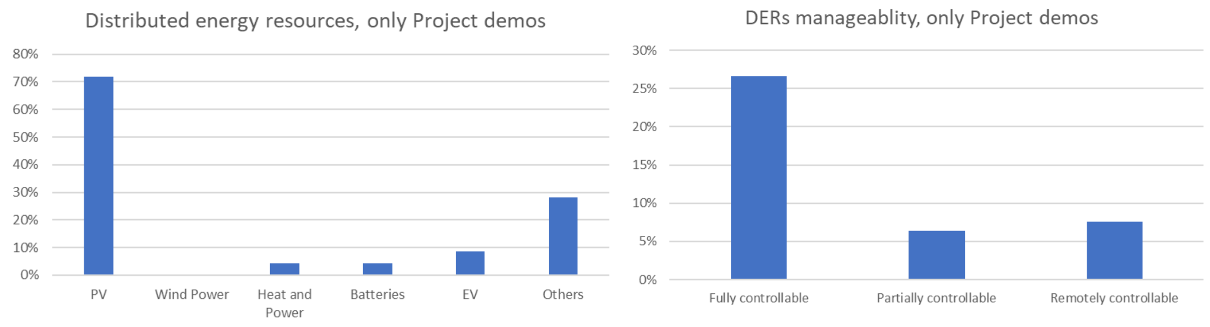


Figure 32. Residential survey DERs availability and manageability results.

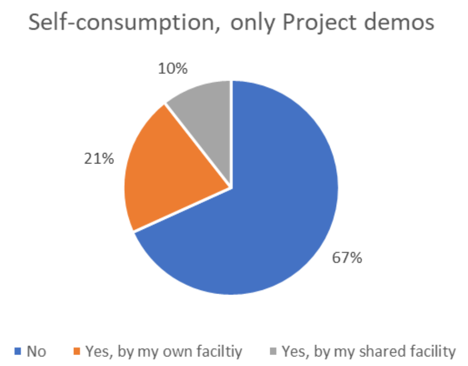


Figure 33. Residential survey self-consumptions availability results.

The average monthly electricity expenditure among the surveyed population (pilot and non-pilot) is between 25 € and 100 € and has medium or low impact in the home budget (Figure 34). The most usual electricity tariffs are fixed and two period tariffs, but an important amount of consumers do not know its energy tariff (Figure 35). Two or more periods tariffs are useful for promoting flexibility trading and implicit demand response.

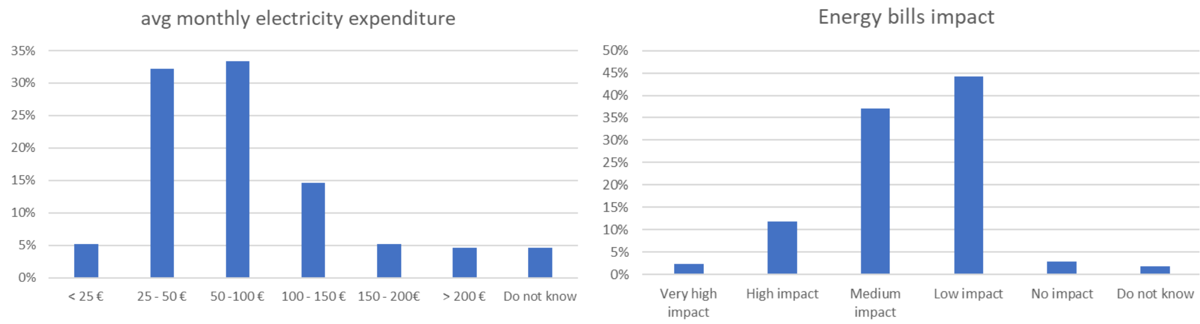


Figure 34. Residential survey electric energy billing results.

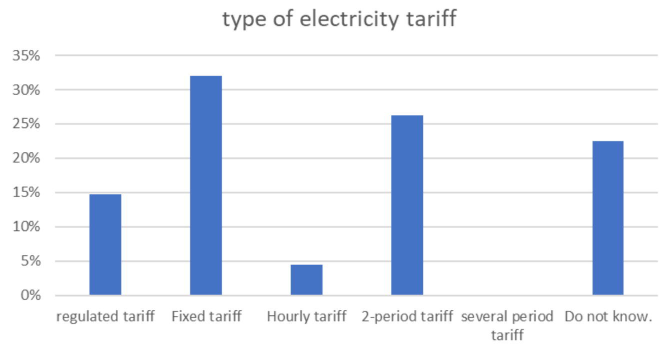


Figure 35. Residential survey type of electricity tariff results.

Most of the surveyed population, have smart devices and use them at different levels (Figure 36). They would be interested in automatizing their distributed energy resources. These two ideas show that these consumers could be flexibility providers managing the operation of their devices. Only the Swedish consumers are a bit more reluctant to the automatization of their DERs.

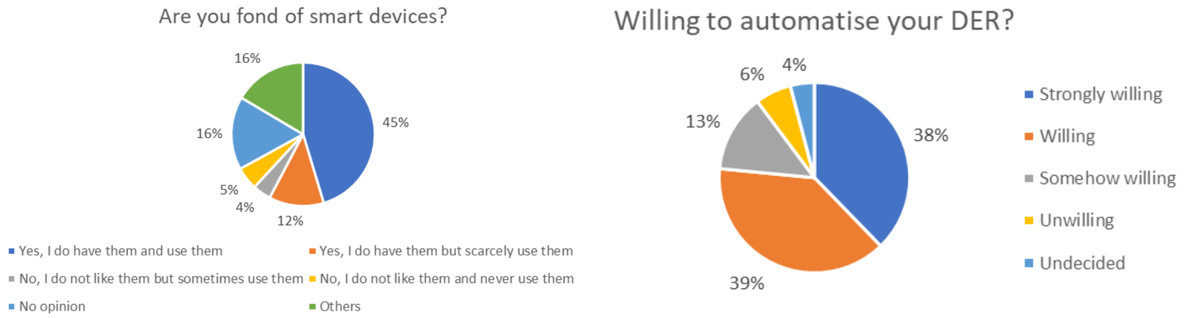


Figure 36. Residential Smart devices and DERs automatization interest results.

Most of the surveyed population is interested in knowing more info about their energy demand, preferably by using mobile apps in the demo sites (Figure 37). Splitting responses by level of interest, answers show that people are interested in knowing different information sets:

- High interest: real time energy demand, energy consumption statistics and real-time and aggregated absolute and average energy consumption.
- Medium interest: flexibility market incentives, comfort data and demotics and automatic remote control info.

Surveyed people prefer mainly to be informed on demand. A second preference is to be informed weekly instead of daily. They are also interested in being informed at every demand response events. As a consequence, PARITY reporting tools should be customizable by the user.

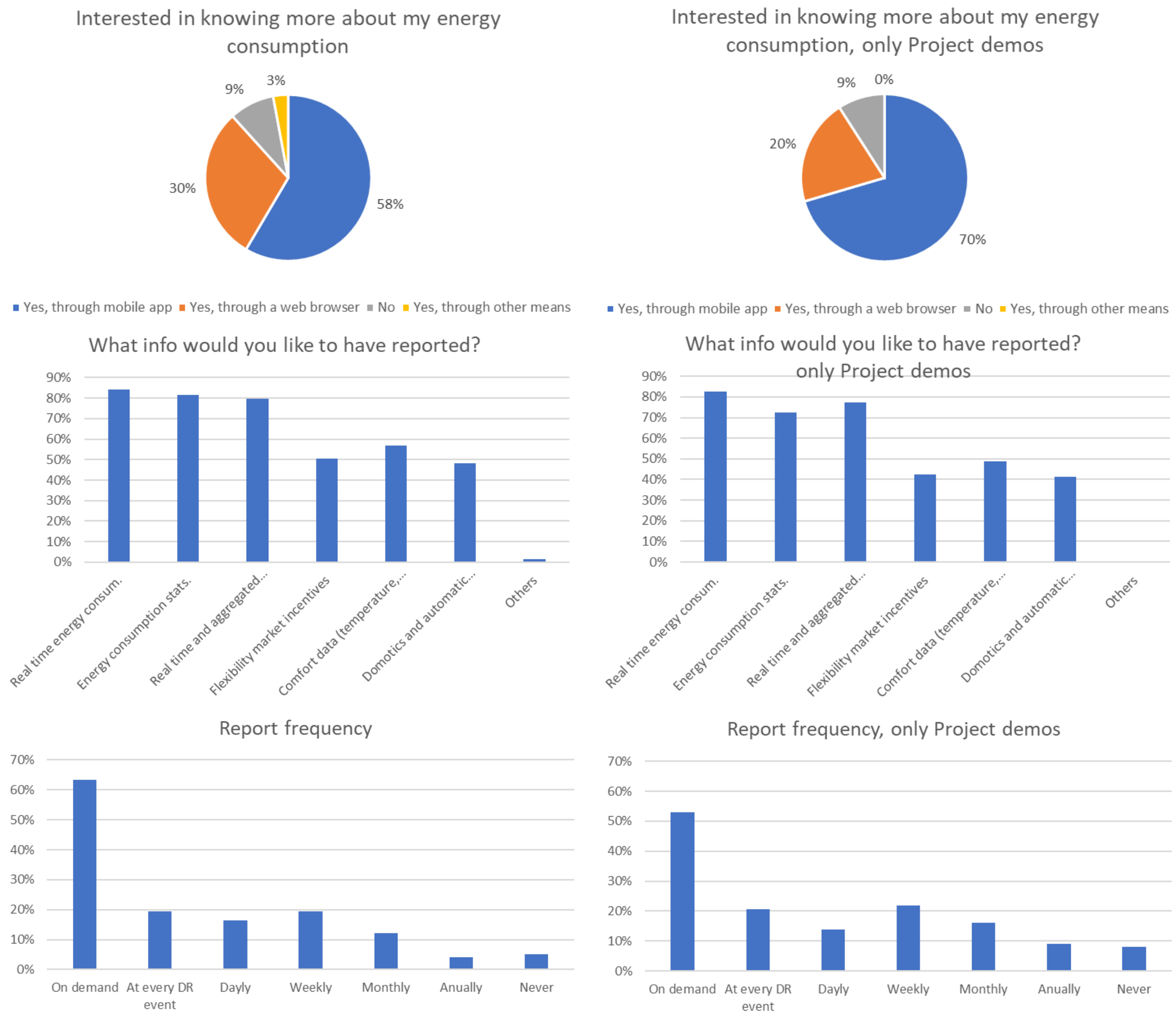


Figure 37. Residential survey systems information interest results.

In general, pilot and non-pilot respondents prefer explicit demand response (automatic management of devices without owner intervention), mainly for economic reasons, than implicit demand response (owner managing devices) (Figure 38).

Most of interviewed consumers would allow a full control of their storage systems rather than other DERs, as dimmable lighting for example (Figure 40). Some users would allow an explicit demand-response control of their resources but with the possibility of limiting it if desired. They are reluctant to a full external control and this is related to the fact that they want information about triggering flexibility events.

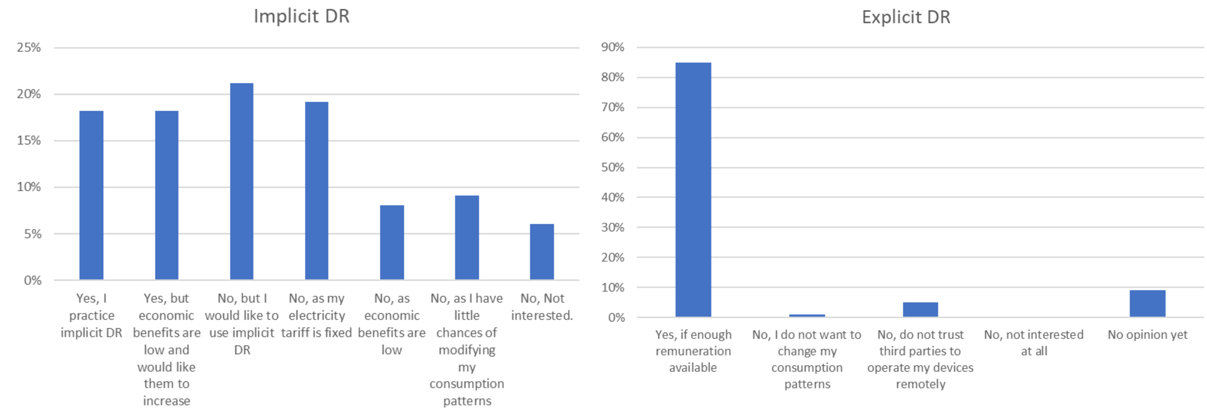


Figure 38. Residential implicit or explicit DR interests results.

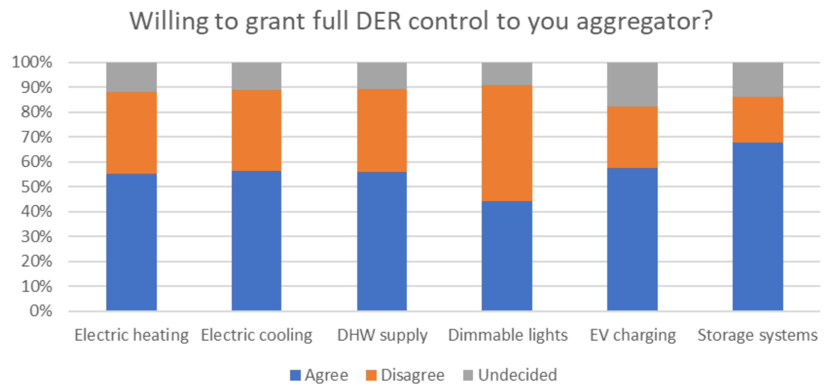


Figure 39. Residential survey grant to DER willingness results.

In fact, related to temperature comfort systems, residential consumers would allow an aggregator to modify temperature in their houses but with their permission, not a full external control (Figure 40 and Figure 41). Below the most preferable temperature ranges for winter and summer are shown.

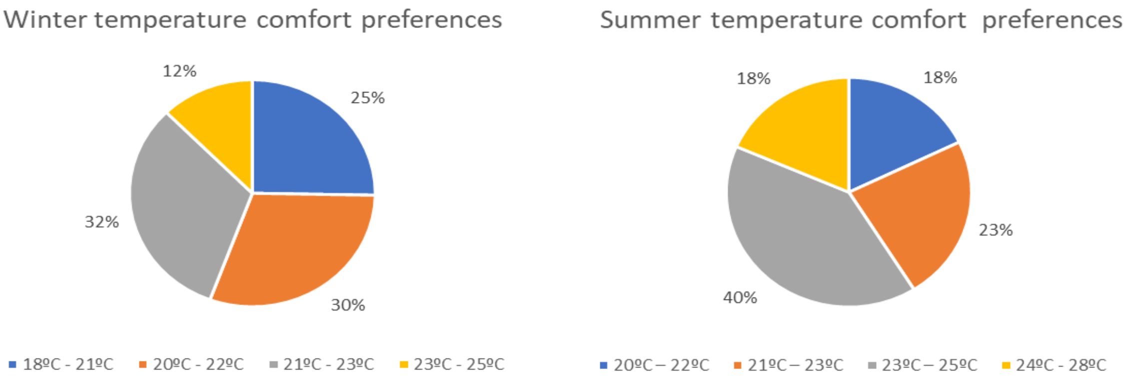


Figure 40. Residential survey comfort settings results.

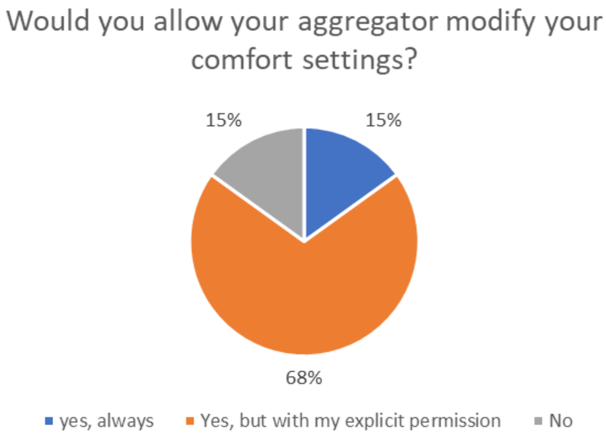


Figure 41. Residential survey aggregator comfort settings modification possibilities results.

Surveyed population is comfortable granting access to their data to aggregators but needs specific data safety measures (an explicit way ensuring GDPR or similar) (Figure 42). Surveyed consumers prefer electronic contracts rather than physical ones, which is a way to make easier the introduction of customer to these mechanisms (Figure 43).

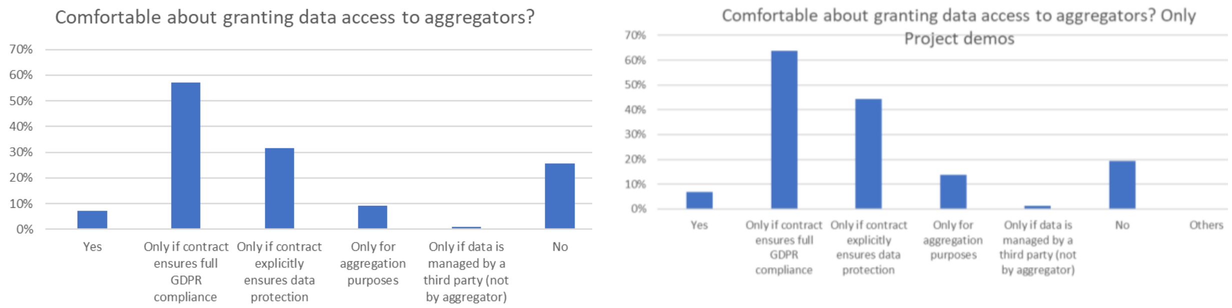


Figure 42. Residential survey data access results.

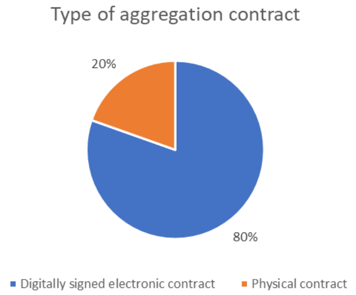


Figure 43. Residential survey aggregation contract type results.

According to the results of the surveys, incentives and barriers for the participation in DR market are very related for residential customers, part or not of the demo sites (Figure 44 and Figure 45). Residential customers need a clear, transparent and secure regulation or legislation and a full respect to personal data. Remuneration is an important concern for surveyed population due to the initial investment. The only way to enrol consumers in demand response schemas is through clear legislation, secure economic incentives and secure use of personal data.

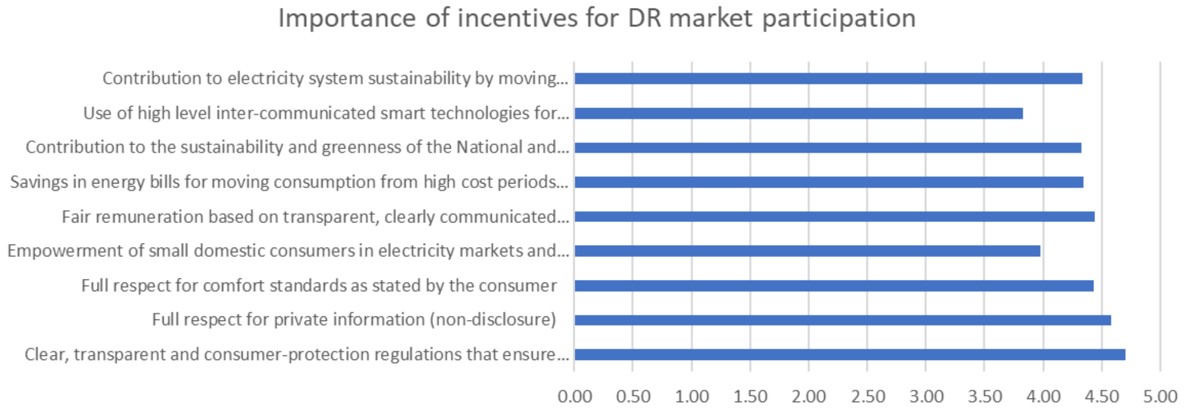


Figure 44. Residential survey DR market participation incentives.

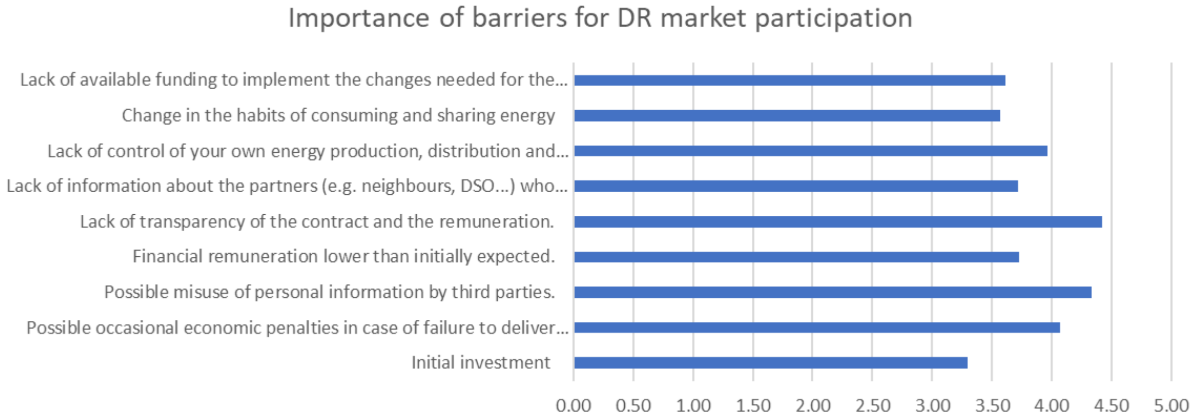


Figure 45 Residential survey DR market participation barriers.

Next set of information describes the demographic data of the survey targeted population (Figure 46). The average residential consumer having answered the survey is a male from 30 to 44 years from a Southern Mediterranean country living in a block of apartments ranging between 50 to 100 m^2. He is the owner therein. The dwelling has never undergone a serious energy refurbishment.

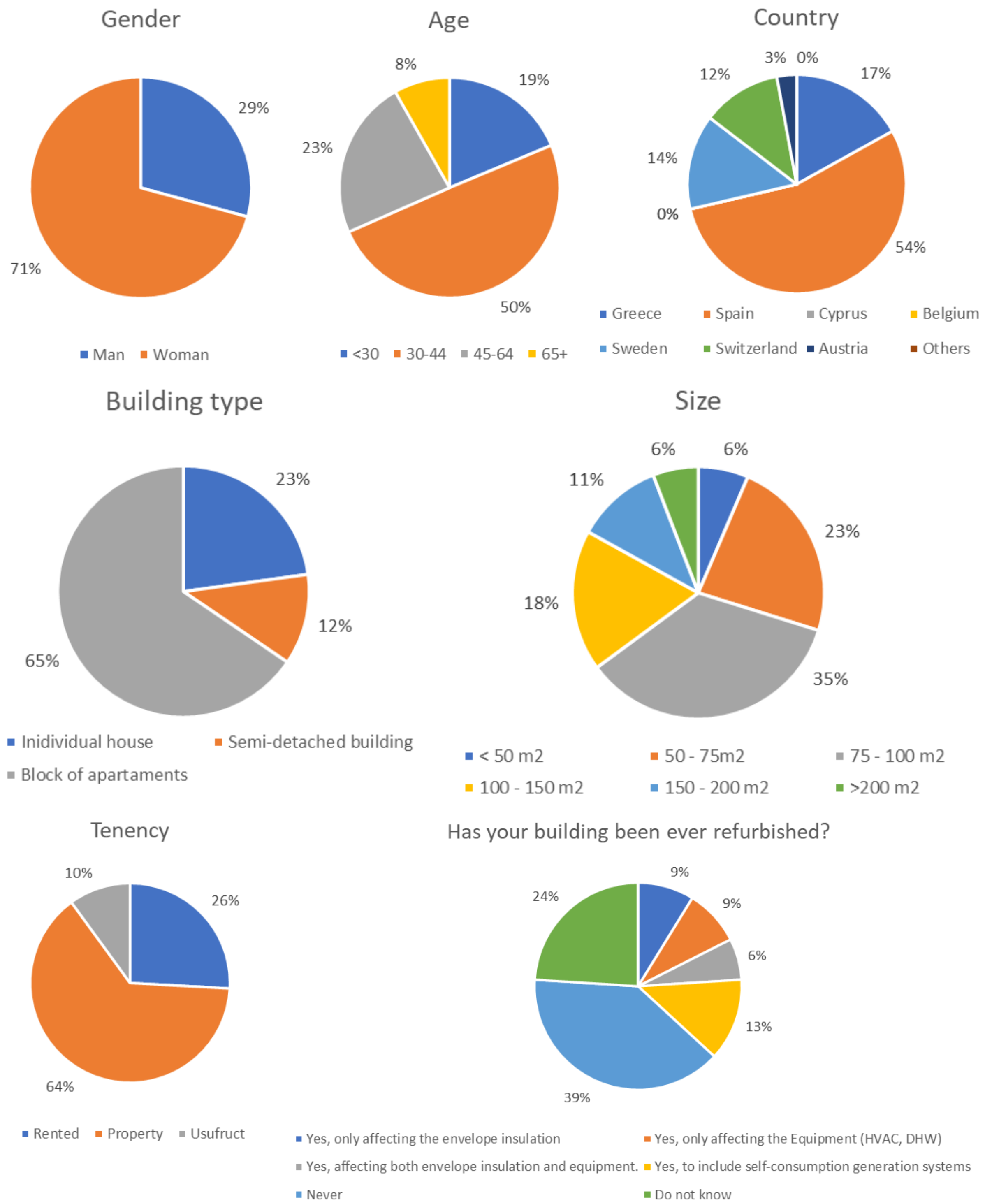


Figure 46. Residential survey demographic description.

Tertiary building users surveys

As explained in previous section, a unique survey was designed for the tertiary building users of the pilot buildings and for the workers of PARITY partners. This unique survey was translated and adapted to every demo to ease the filling process. This section shows the results and graphs derived from the surveys filled by tertiary building users and the main conclusions are highlighted in section 4.2.

The final amount of surveys received is shown in Table 9:

Table 9. Amount of tertiary building users surveys.

Surveyed population	Answers received
Pilot site 5 – Athens – Greece	27
Non-pilot sites	58

The first group of graphics is used to characterize tertiary building users that answered to the survey (Figure 47):

- Most of the respondents work in office building and only a few of them in light industrial or other ones. Greek surveyed population works mainly in 6-20 people groups and non-pilot site workers in bigger groups, 101 – 200.
- Surveyed people work in morning and afternoon shifts, usual in office tasks.

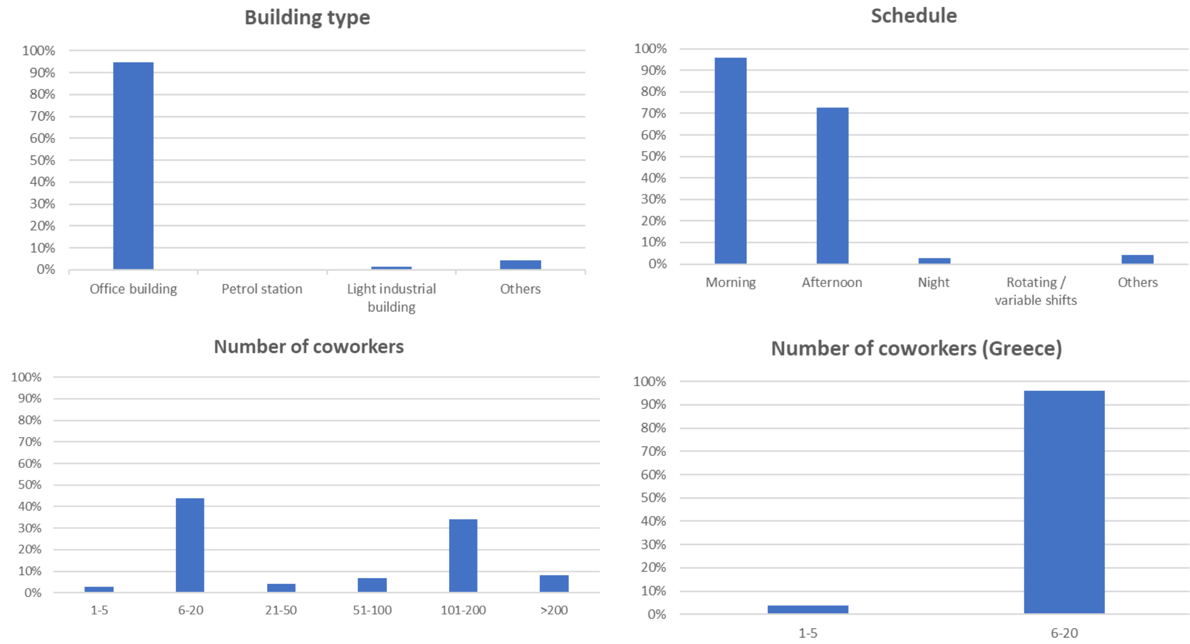


Figure 47. Tertiary buildings users survey building and use description.

Next graphs (Figure 48 and Figure 49) show the manageability capabilities expected by tertiary building users. As it can be seen, most of tertiary buildings user prefer a semi-automatic management (switch on/off by sensors or timers and by user) of climate and lighting systems and an individual, per office or per area management rather than for whole buildings. This shows that this user would accept an external management but with the possibility to adapt climate and lighting systems, the main flexibility sources in office buildings, set-points manually to its needs.

Tertiary building user also think that EV batteries could be a flexibility source, but some minimal SoC should be ensured (for example at forecasted departures) (Figure 49).

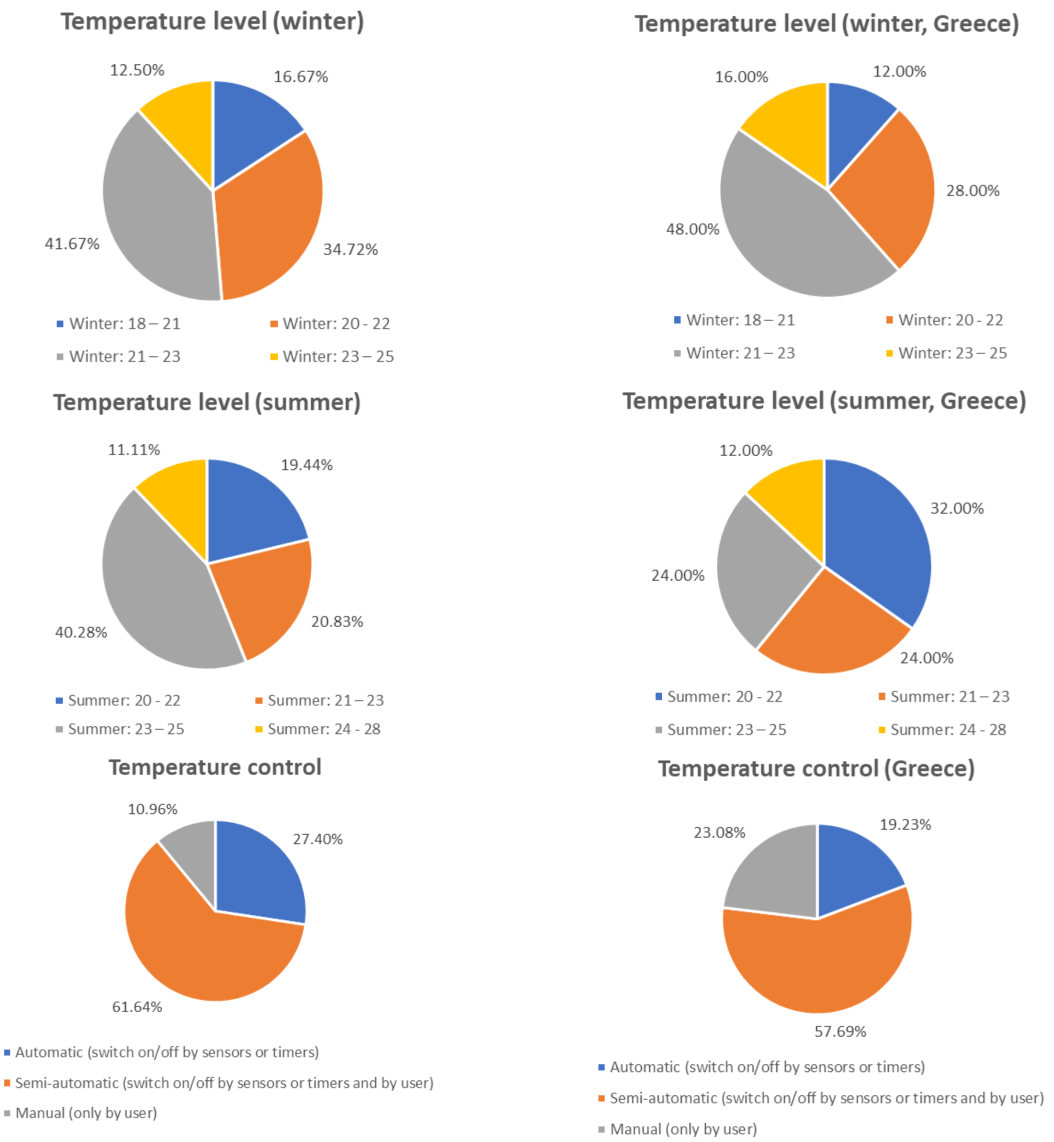


Figure 48. Tertiary buildings users survey temperature comfort results.

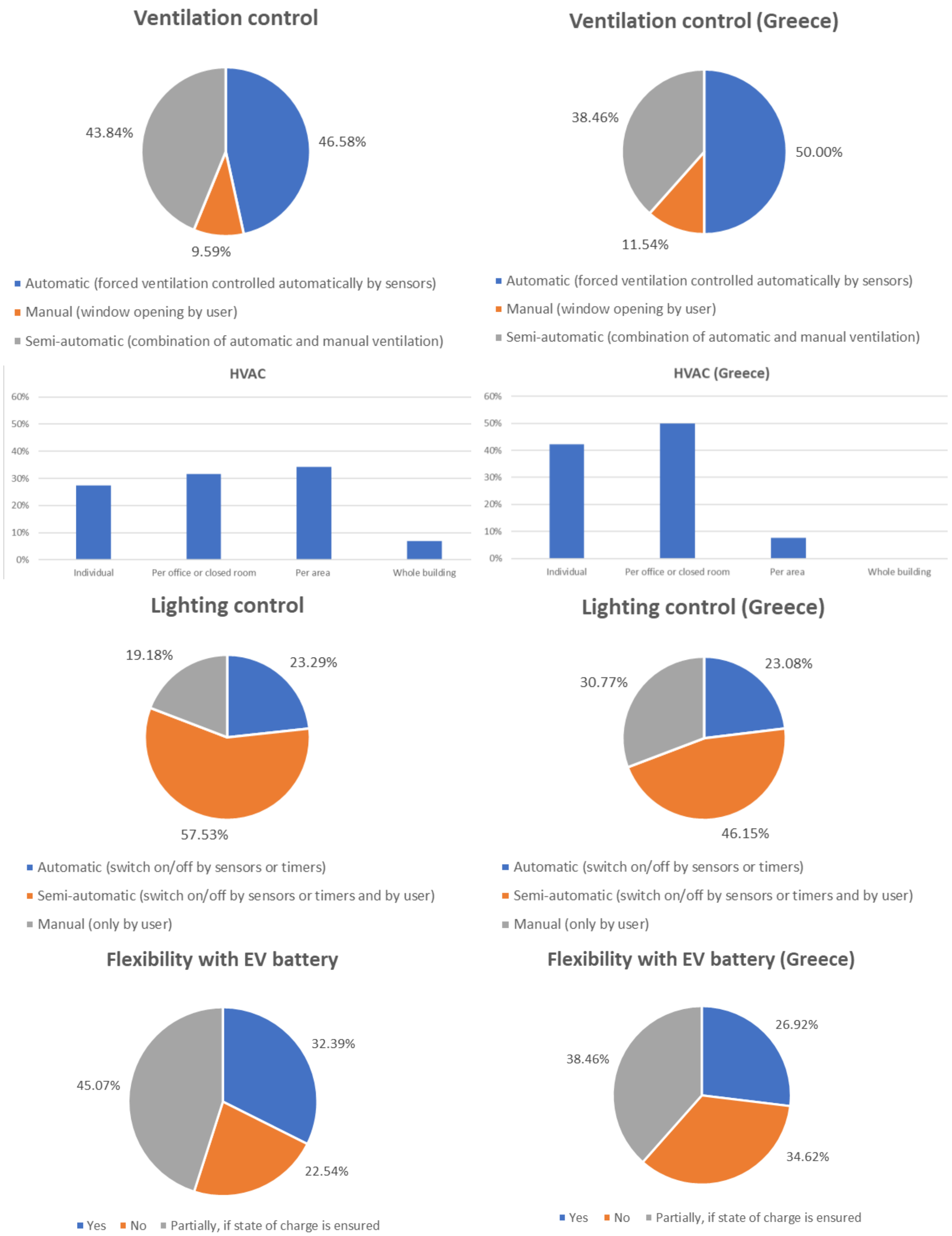


Figure 49. Tertiary buildings users survey assets controllability results.

Most of the tertiary building users are interested in receiving information about the energy consumption where they work, the most usual interest level is medium (Figure 50). The most wanted technique to know this information is using a website and the second are through an app, for Greek users, and through an email, other users.

Most of the interviewed users think that the building where they work can be used in demand management markets or programs with small investments or changes (Figure 51). Environmental reasons are the most important ones.

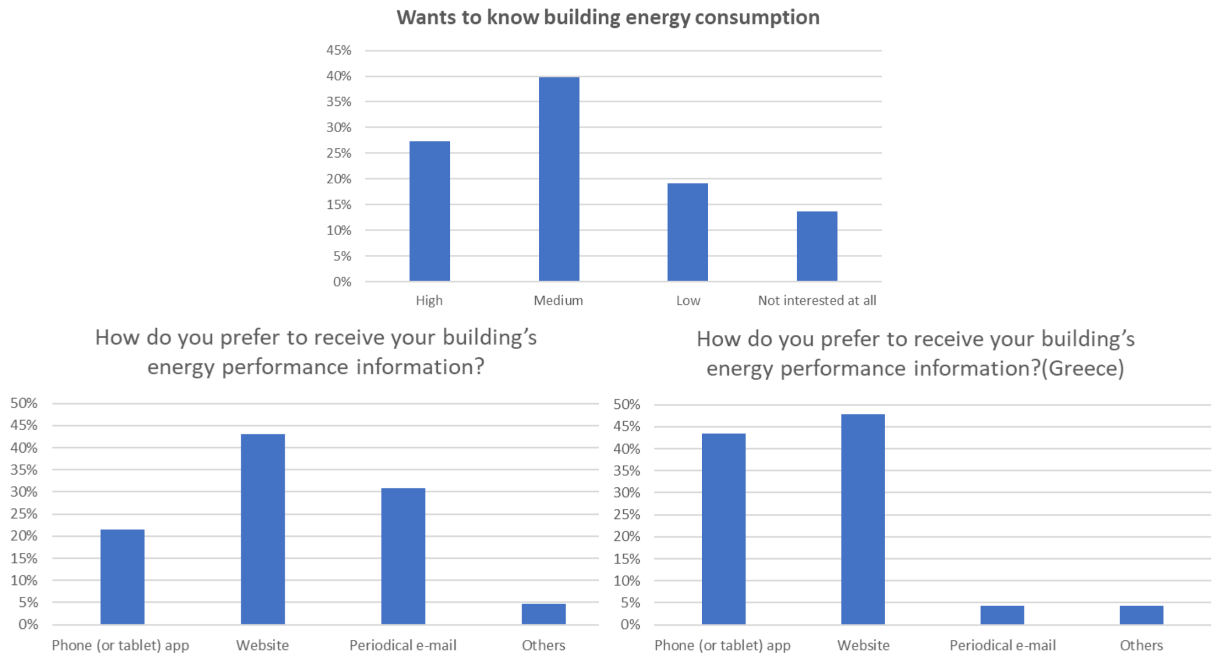


Figure 50. Tertiary buildings users survey building information needs.

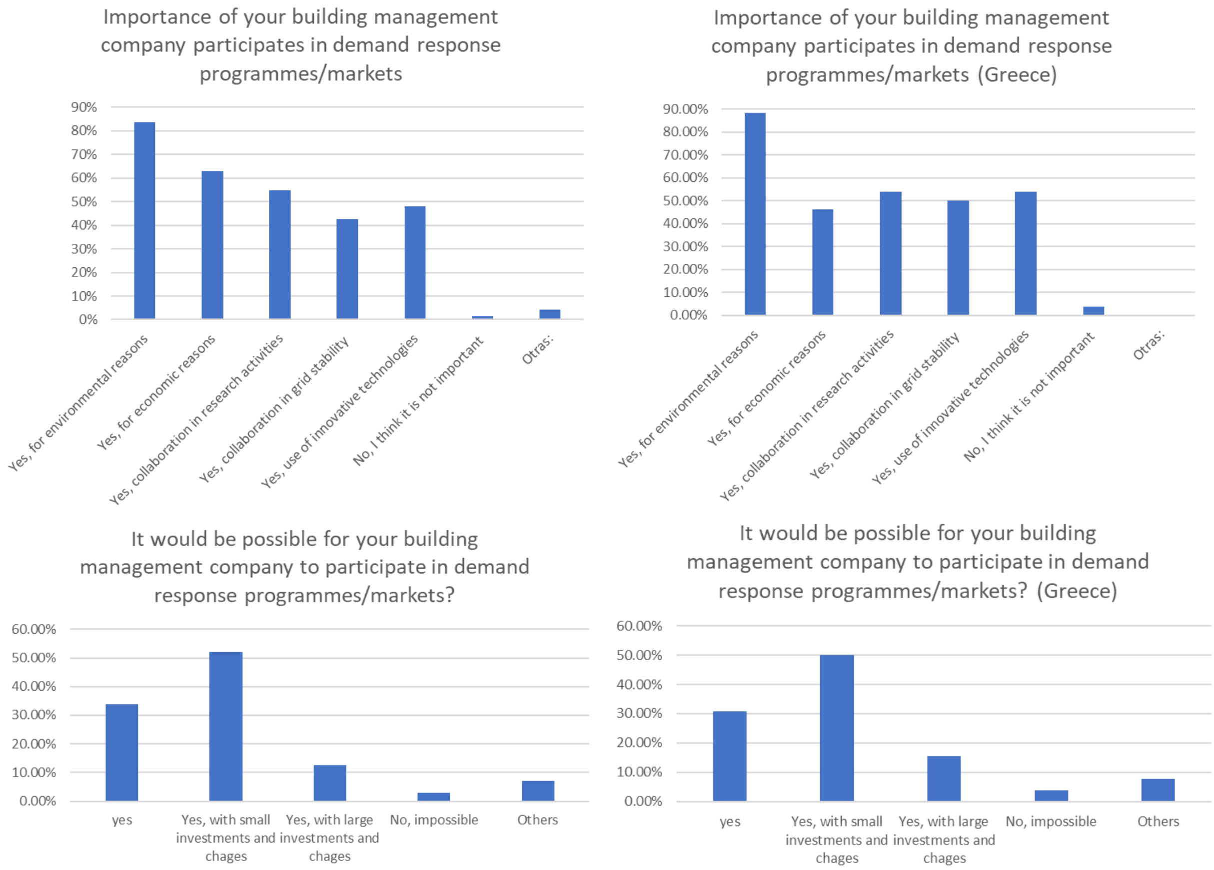


Figure 51. Tertiary buildings users survey demand response acceptance results.

According to the results of the surveys, incentives and barriers for the participation in DR market are very related for tertiary building users (Figure 52 and Figure 53). These customers need a clear, transparent and secure regulation or legislation, a full respect to personal data and respect to comfort set-points. Remuneration is an important concern for surveyed building users.

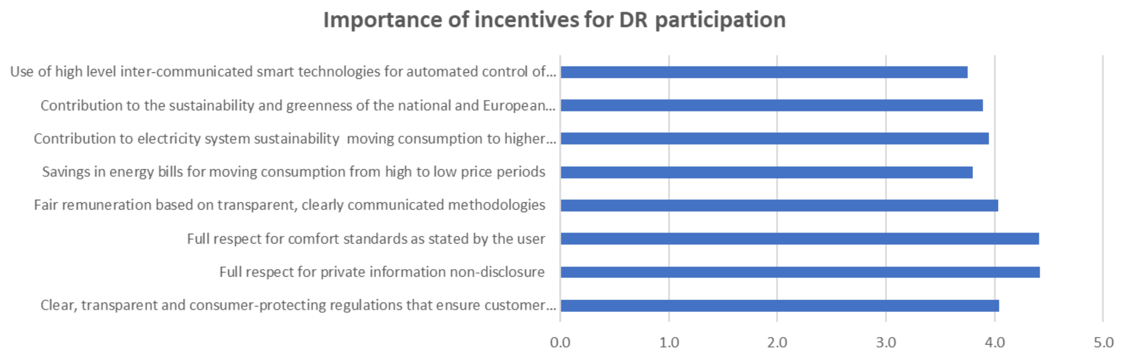


Figure 52. Tertiary building users survey DR participation incentives.

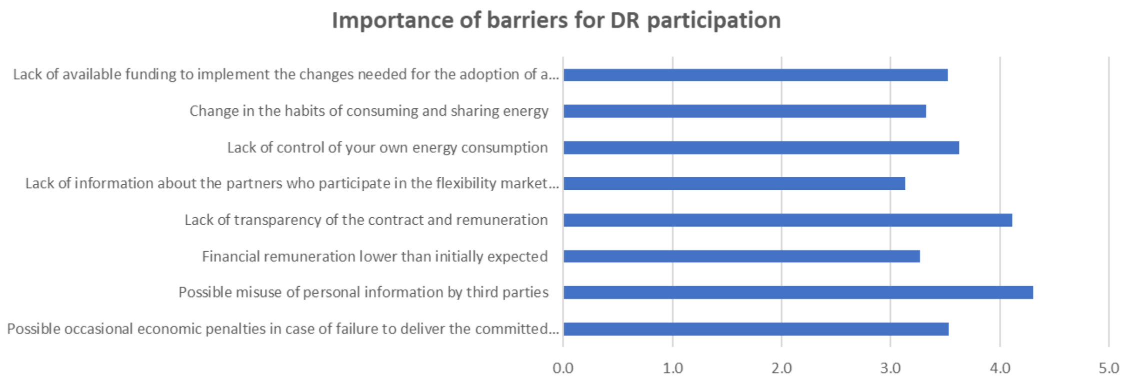


Figure 53. Tertiary building users survey DR participation barriers.

Facility manager interviews

Table 10 shows the main results of the interviews made to Facility Managers (FM).

Table 10. Facility manager interviews results.

Facility managers	FM1	FM2	FM3	FM4	FM5
Type of building	Office buildings, rented or owned per floors	Office building	Office building	3 housing buildings	Smart nZEB
Type of usage	Office building	Office building	Office building	Residential. Community (housing 48 flats)	Residential / Office building used for testing
Self-consumption.	• About 5x100 kW in the buildings • Total:168 MW PV for grid pouring (not in the building)	No. In the future 3 petrol stations with PV	No	2x15 kW PV plants	PV plant with storage 9.6 kWp and 5 kWh storage
HVAC Equipment	• Fan coils for distribution. • District gas heating. • District cooling by heat pumps with storage (11000 m3 cold water)	• 2 x 500 kW boiler • 2 refrigerators • Fan coils	• 2 x 5 kW A2A HP • 200 kWh/month in winter and 800 kWh/m in summer	Biogas boilers	Fan coils, 1 per room
DHW	Electric heater, 30 l per floor	Not in use	1 x 1.4 kW heater	Biogas boilers	Solar water heater
EV	1 charging point.	Yes	Not specified	3 charging stations	22 kW charging station
Monitoring	• Temperature • Occupation • Air quality.	Temp sensors	• Temperature • Humidity • Air quality • Occupancy • Luminosity	• Temperature • Lighting • PV generation and consumption	• Energy smart meters • Temperature • Humidity • Occupancy • Water consumption
Manageable demand	• Almost none. • Mainly from pumping (6 kW pumps) and DHW	Controlling lights, heating and cooling, timetable	Lights, plug loads	Heating, down	• PV, storage • HVAC, lighting, smart white appliances
UCs needed	• Demand forecast • Flexibility aggregation	UC1, UC2, UC5, UC14	UC1, UC4, UC6, UC14	• Demand forecast	• Demand forecast • Flexibility • DER registry • Marketplace

	• DER registry • Marketplace • Local and Global Demand manager			• Flexibility aggregation provision • No data provided to users	• Local and Global Demand manager • Interface and user portal
Data availability	• Separate consumption metering,	• Entrance-exit control • Electricity and fuel consumption.	• Separate consumption metering • Actuators to control loads and thermostats	• Temperature • Electric energy consumed	• External weather station • All consumptions + PV generation
Interest on LFM	Low, out of their scope. Low electric flexibility	• Market no developed yet • Just getting in touch and learning • No previous experience in flexibility markets	• Offering different B2B solutions to end users • Development of intelligent apps • Automatic flexibility forecast	Just participation through an intermediary	• Interest in operate as local energy community • Evaluation of building potential in DR. Research • User-driven. Comfort prevails. Economic secondary
Interest in current DM	Efficiency (pumps, lighting)	Expect to lower down the electricity costs	• Combine Energy Efficiency with comfort in buildings • Participate in energy dynamic tariffs (implicit DR)	• Automated control of DER • Currently controlling ventilation	PV optimization
Willingness for flexibility participation	Low. Maybe in a future with self-consumption assets	• Participation through aggregator. • For the largest building office, direct participation could be envisaged	• Automated participation through aggregator. • Implicit DR contracts	Automated control of DER	• Automated participation, initially with aggregator • Option for final control

Incentives	• Sustainability • Improve comfort and control on energy consumption	• Improve the of control of demand management • Increase energy efficiency and stability	• New services like automated control systems • Comfort services	• Economics via energy savings • Participate in new DR markets	• Research. Economics are of secondary importance
Barriers	• Low economic perspectives • Higher complexity with additional control systems that may fail • Lack of previous aggregation experience	• Feeling of control lost over comfort parameters • Sensitive data handling. • Lack of experience in the market	• Easy to install and operate infrastructure (sensor network) • Wired sensors and batteries limit the application • Complex contracts.	• Technology failure • Lack of awareness of what is going on behind	• Current regulation. No room for DR in markets • Costs not yet compensated • Cyber security is a great challenge • Aggregator should inform about events but automated operation is preferred. • Right to reject intervention if user preferences not respected.

DSO interviews

Table 11 shows the main results of the interviews made to Distribution System Operators (DSO).

Table 11. DSOs interviews results.

DSOs	DSO1	DSO2	DSO3	DSO4
Type and number of possible customers to provide flexibility	PV generators	Hydro+PV generators	Hydro+PV generators	Hydro+PV generators
Type of grid management.	Own or third party grid	Technical / Centralized	Technical / Centralized	
UCs needed	• Demand and generation forecasting • Flexibility provision • Aggregation of Flexibility • DER registry • Contractual data repository • Local and global Demand manager • Interface and user portal • Provide to the final customers complete data about their facilities	• >Demand and generation forecasting • Flexibility provision • Aggregation of Flexibility • DER registry • Contractual data repository • Local and global Demand manager • Interface and user portal • Provide to the final customers complete data about their facilities	• -Demand forecast • flexibility provision • Aggregation of flexibility • DERs registry • contractual data repository • Local and global demand manager	• UC1, UC2, UC3 (plan to install in 2020 self consumption zone), UC4, UC5, UC6(at local level), UC7, UC8 (want), UC10, UC13, UC14 (want)
Data availability • Granularity • Smart metering deployment • Availability of historical data • Availability of data from clients' DERs • Monitoring of other external data	• 15 min • 40% in LV and 1,4% in MV • 5 years in MV and 2/3 years in LV • separate meters for consumption and generation • Yes	• 60 min • 99% • 5/6 years • Generation and consumer data yes. They don't have data on self-consumers yet. • No	• every hour • 100% • Save date since 2016: DERs, sensor by zones • Generation and consumer data yes. • Whether and market data	• data each 15 minutes • 90% • Data from 2020-5 years theorical, 3 years in server, 1 year in practice • DERs-only PV, from consumption: only knows load flow, and theorical production • Weather data (on transformer) and planning install sensor (for real time)

Interest demand response management	Grid balancing, Grid stability and congestion management	• Grid stability and congestion management • RES generation matching (future)		• Use algorithm for Regional level: Consider Storage capacity (hydro plant) + manage remotely private sources of flexibility. • Zones uses district battery (50kWh capacity, 50 kW peak bidirectional) • Planning: New self-consumption zone based on a CHP facility
Interest in becoming a LFM operator	• Economical sustainable, must be regulated • Explain to consumers that DR is interesting for them	Explain to consumers that DR is interesting for them	Very interested in becoming LFM (open market) and also Aggregator	Prefer an economic approach: flexibility tool for balancing LV and MV
Interest DER network operator	Restrained LFM	Restrained LFM		Interested as long as it helps the grid management efficiency
Type of integration of new flexibility tools with current systems	Aggregation tools in the current IT systems	Aggregation tools in the current IT systems	Aggregation tools in the current IT systems (automatic and customized reports)	• Centralized data and management on centralized server • Majority household users (small consumption): Identify and aggregate them to have a significant to play markets/EV less favourable/Forecast work with any limitation
Incentives	• Fair remuneration • Contribute to grid balancing • Improve the control and management over customer's… • Avoid investments (islands and enforcement network) • Fair remuneration to flexibility providers	• Fair remuneration • Improved control and management to be more efficient in distribution	• Fair remuneration, difference between 2 incentives: Costumers/Grid management • Offer data verification to their client as a service	• Fair remuneration • Service cost to contribute to the grid security • Contribute to own grid balancing mechanism • Offer an additional value-added service to your clients, as they could become flexibility providers

Barriers	• Learning curve • Possible penalties in case of failure • Concerns about how the market will be regulated and who is responsible for the supply, DSO or TSO	• Lack of previous aggregation experience in a new business market • Lack or not settled legislation regarding flexibility markets in most EU countries	• Too much investment with no return or little profit margin • Limited budget • Lack of transfer to the market • Lack of legislation	• May demotivate people to participate: free market but possible fixes prices • Possible new technology failure or malfunctioning • Initial investment • Possible misuse of customers' personal data • Lack of available funding to implement the changes needed for the adoption of a flexibility market

Aggregators interviews

Table 12 shows the main results of the interviews made to Aggregators (A).

Table 12. Aggregators interviews results.

Aggregators	A1	A2	A3	A4
Type and number of potential flexibility providers / customers	All its customers interested in flexibility	Great potential: • 2-3kW in low voltage, small consumers	Great potential: • residential, industrial, commercial… • a few hundreds of kW in PV	Great potential: • residential, industrial, commercial…
Current IT system architecture	• Own software • Extract info from consumers' meters • All communications encrypted and secure	• Own servers and on cloud for redundancy • System secure but can for sure be improved	• PV by platform providers • Meter data by third parties	• Own software and app • Smart meters, cloud concentrator, blockchain
UCs needed	UC1, 2, 3, 4, 5, 6, 7, 10, 12, 15	UC1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13,	UC3, 4, 5, 11, 12	UC1, 2, 3, 4, 5, 6, 9, 10, 11, 12
Data availability	• Meter data from customers (consumption and generation) • Weather	• Meter data from customers (consumption and generation) • Smart meter: active energy (minutes) V, I, Q, PF • Weather	• Meter data from customers (consumption and generation)	Meter data from customers
Interest on LFM	Economical	• Very interesting market, high potential in the future. • Sustainability, economics, etc	• Platform for aggregating power • Batteries installation	• Very interested, their system can be considered a FM
Interest in Retail market participation	Economical	Not interested		Not interested
Interest for ancillary services (AS) market	Economical, initial investment risky	Ancillary services (voltage or frequency regulation, etc) in Sweden are included in the flexibility ones	Batteries to participate in the frequency market	Not interested
Type of integration of new aggregation tools with current systems	• No integration, business as usual • Reporting: automatic but parameterizable	• Everything integrated in one system, downstream and upstream • Flexibility markets, prices and external data	• Separate system communicate with batteries • Solve congestion problems • Data reporting preferred automatic	They are going to develop the tools of the project

		• Data reporting preferred automatic		
Incentives	Fair remuneration	• New market with new technologies • Reduction of CO2 impact • Improvement of the efficiency of the grid • New value-added services to the customers • They would like a regularization and balancing of the grid.	• the marketplace itself: supply energy to the grid, frequency regulation, economic incentives	New challenges and new opportunities
Barriers	• Risk of low remuneration and high investment • Residential aggregation not interesting, too small • Interesting bigger for enterprises / consumers • Regulatory	• Standardization • Legal aspects and new contracts and how is going to work the new business models	• Install batteries, not economic sense • Battery MWs are needed but kWs are available	• Difficult to control and forecast • Limited capability to connect new technologies in residential areas • Regulation
Others:			• Local peak shaving with batteries. • Aggregation tools for trading and frequency market	Blockchain is not going to be the optimum in a few years

General expert surveys

In a complementary way to the surveys and interviews made to project stakeholders, internal and externals to PARITY, an extra survey has been designed. This last questionnaire, in the shape of survey, has been made to 7 general experts with a high knowledge in electric markets and systems, demand management and flexibility programs.

Experts state the next about Demand management/flexibility operation (Figure 54):

- Consumers and prosumers (residential or tertiary) will have a medium willingness (2.3 in 5 points) to share their information (consumption, generation and/or storage).
- Consumers and prosumers would allow a medium controllability level (2.7/5) over their facilities (consumption, generation and/or storage).

These results are similar of previous surveys ones, where residential consumers and tertiary users stated that they would like to participate in DR programs but maintaining the possibility of limiting or cancelling external set-points.

Related to the possibilities and importance of some stakeholders in flexibility markets (Figure 54)

- Residential consumers with manageable demands, and no generation or storage: medium, 2.7/5
- Residential prosumers with generation, storage and manageable demand: 3.7/5
- Tertiary building users in buildings with manageable demand but no generation or storage: 3/5
- Tertiary building users in buildings with manageable demand, generation and storage: 3.7/5
- Consumers and prosumers, both at residential and tertiary buildings aggregated in large quantities by a third party aggregator: 4.7/5
- Consumers and prosumers, both at residential and tertiary buildings operating in these LMF directly without aggregators: 3.33/5
- Interest of DSOs in purchasing flexibility from building users (residential or tertiary): 3/5

As one aggregator stated, tertiary buildings have higher interest for demand flexibility that residential ones because of higher power and consumption demands are involved. Aggregation of consumers is the best way to include small consumers in DR mechanisms and LFM, which coincides with the initial objectives of the project. DSOs would have a medium interest to purchase flexibility from building users (residential or tertiary), it seems that it would be more efficient to deal with the flexibility provided by big consumer, as huge factories, and bigger energy generators.

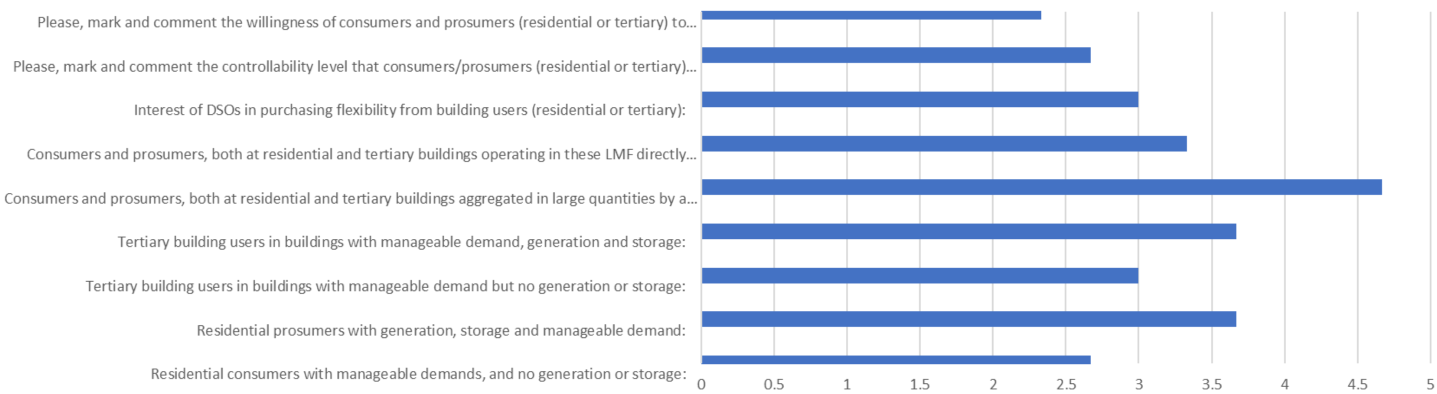


Figure 54. General experts general questions results.

The most interesting flexibility sources, according to general experts answers, are:

- From residential customers: solar PV generation facilities, electric energy storage systems, EV batteries, manageable demands and thermal loads supplied by electric energy.
- From tertiary buildings: thermal loads supplied by electric energy, solar PV generation facilities, electric energy storage systems, EV batteries and manageable demands.

These answers is in line with PARITY project design, as these resources can be found in the pilots.

Related to the incentive and limiting aspects of demand management schemas and flexibility markets the next has to be highlighted (Figure 55 and Figure 56):

- The main limiting aspect is the lack of legislation of these markets. A common answer among all the project stakeholders.
- A second stage of limiting aspects is formed by: issues with personal data, economic penalties and high initial investments. Again, repeated options in other surveys and interviews.
- The main incentives are: contribute to electric systems sustainability and grid operation, fair remuneration and participating in new markets that could generate new incomes for consumers and prosumers. The incentives list for LFM and DR mechanism spread are a bit different, these answers seem to focused, in general, on the interest of these new markets rather than in the topics that would incentive different stakeholders to participate in them.

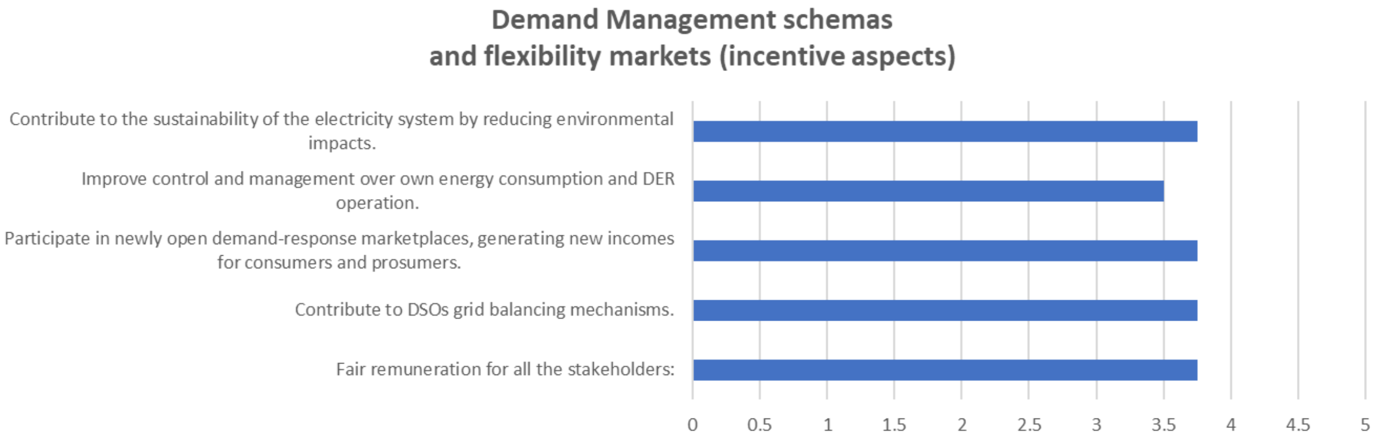


Figure 55. General experts survey demand management and LFM participation incentives.

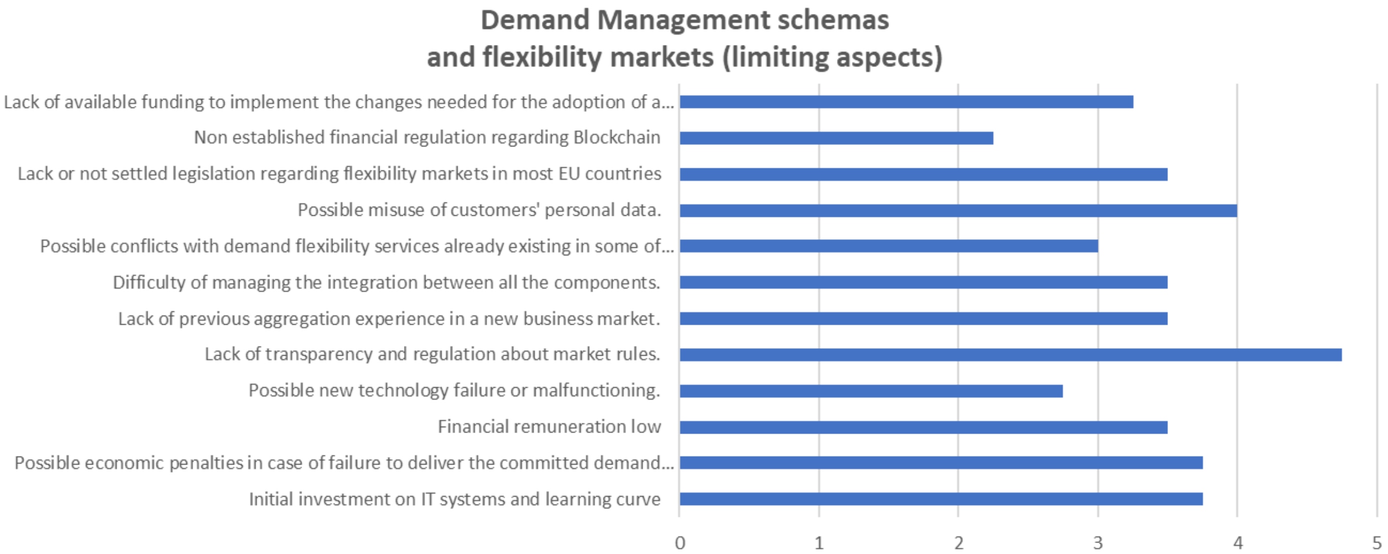


Figure 56. General experts survey demand management and LFM participation barriers.

Finally, the main interesting functionalities for a set of tools of those to be developed in PARITY project are:

- The most interesting functionalities:
    - Demand and generation forecasting.
    - Local and global demand manager (Automatic interaction with the DER systems).
    - Aggregation of flexibility of different providers.
- Medium interest functionalities:

  - Automatic flexibility provision (calculation, offer to grid operators, purchases reception and set-points application).
  - DER data registry (power, number, schedule, type).
  - Interface and user portal (for consumers, buildings/facility managers, generators and aggregators providing flexibility services and for DSO purchasing flexibility).
- Lower interest functionalities:
  - Contractual data repository (Marketplace participation registry and other information).
  - Integration of economic exchanges using blockchain technologies.
  - Provide to the final customers complete data about their facilities.

This list is similar to those extracted from answers and interviews made to project stakeholders: demand and generation forecast, automated resources management and flexibility aggregation are the most popular functionalities.

ANNEX B: SURVEYS AND INTERVIEWS

The surveys and interviews templates used in task 3.1 are available on the project website. This information is accessible: https://parity-h2020.eu/end-user-questionnaires-interviews/

Residential consumers surveys

https://parity-h2020.eu/wp-content/uploads/pdf/Parity%20H2020%20-%20Residential%20Consumers%20Survey.pdf

Tertiary building users surveys

https://parity-h2020.eu/wp-content/uploads/pdf/Parity%20H2020%20-%20Residential%20Consumers%20Survey.pdf

Facility manager interviews

https://parity-h2020.eu/wp-content/uploads/pdf/Parity%20H2020%20-%20Interview%20Facility%20Managers%20(v06).pdf

DSO interviews

https://parity-h2020.eu/wp-content/uploads/pdf/Parity%20H2020%20-%20Interview%20DSO's%20(v06).pdf

Aggregators interviews

https://www.parity-h2020.eu/wp-content/uploads/pdf/Parity%20H2020%20-%20Interview%20Aggregators%20(v06).pdf

General expert surveys

https://www.parity-h2020.eu/wp-content/uploads/pdf/Parity%20H2020%20-%20General%20Expert%20Survey.pdf

ANNEX C: USE OF JIRA PLATFORM TO HOST, TRACK AND MANAGE USER AND SYSTEM REQUIREMENTS

A JIRA online platform was deployed by CERTH to host user and system requirements and allow their management, convenient tracking and prioritization. Thus, all partners can access the platform and create, edit, track, and comment the requirements. The user requirements derived from T3.1 activities described in this deliverable have been uploaded to the JIRA platform, as shown in Figure 57, Figure 58 and Figure 59 present indicative user requirements as shown on the JIRA platform. For each requirement, several properties are defined apart from the title, such as detailed description, label, source of origin, priority, status, and other.

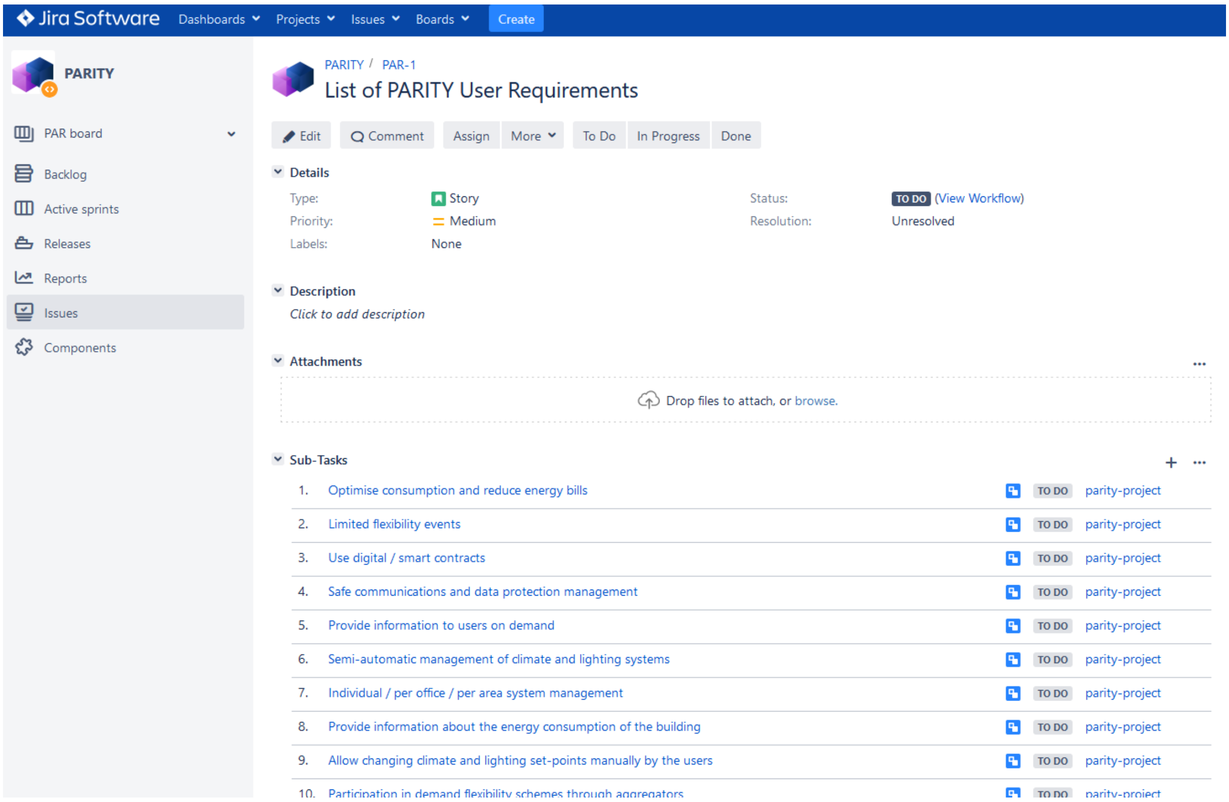


Figure 57. List of PARITY user requirements in JIRA platform.

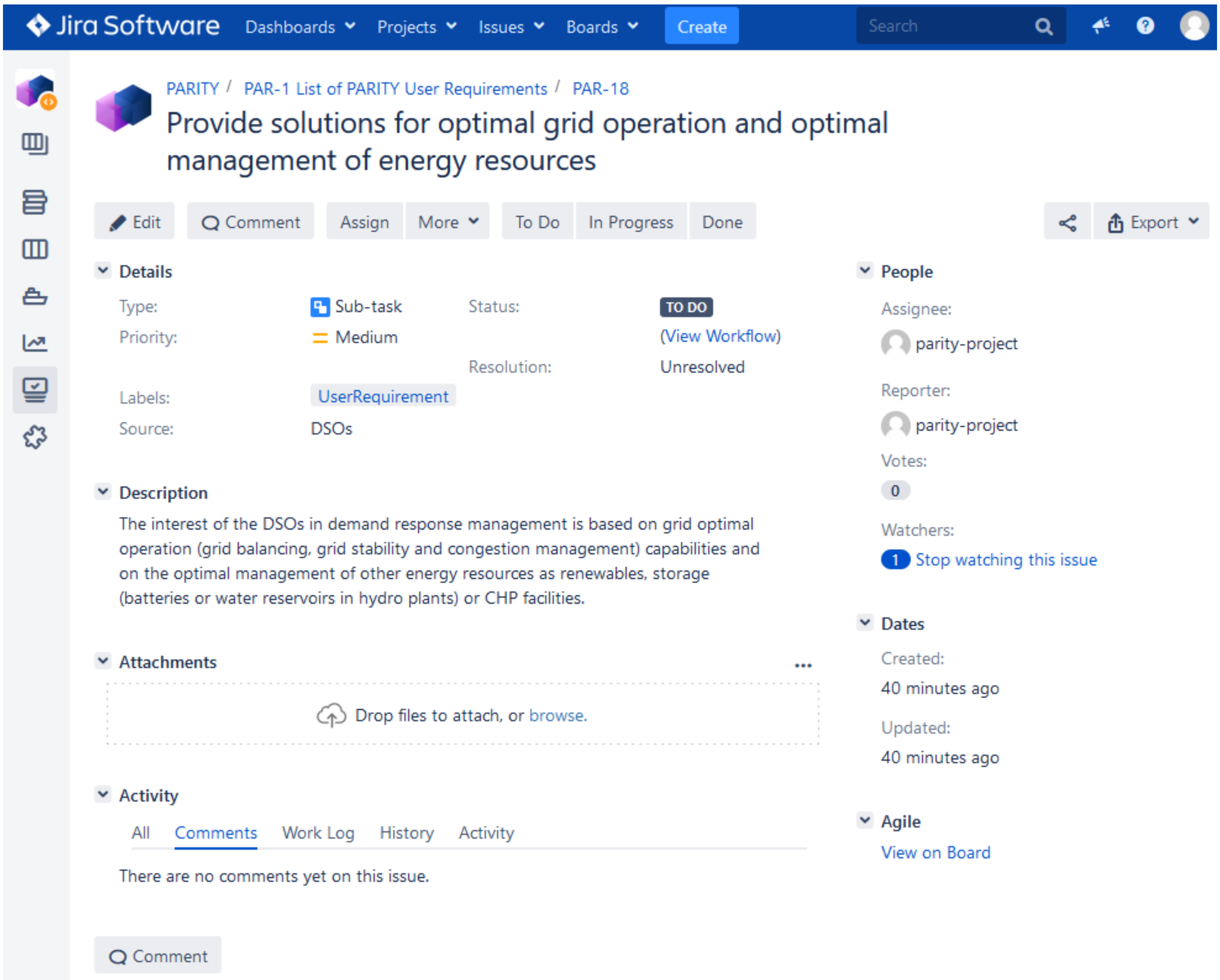


Figure 58. User requirement example from DSOs in JIRA platform.

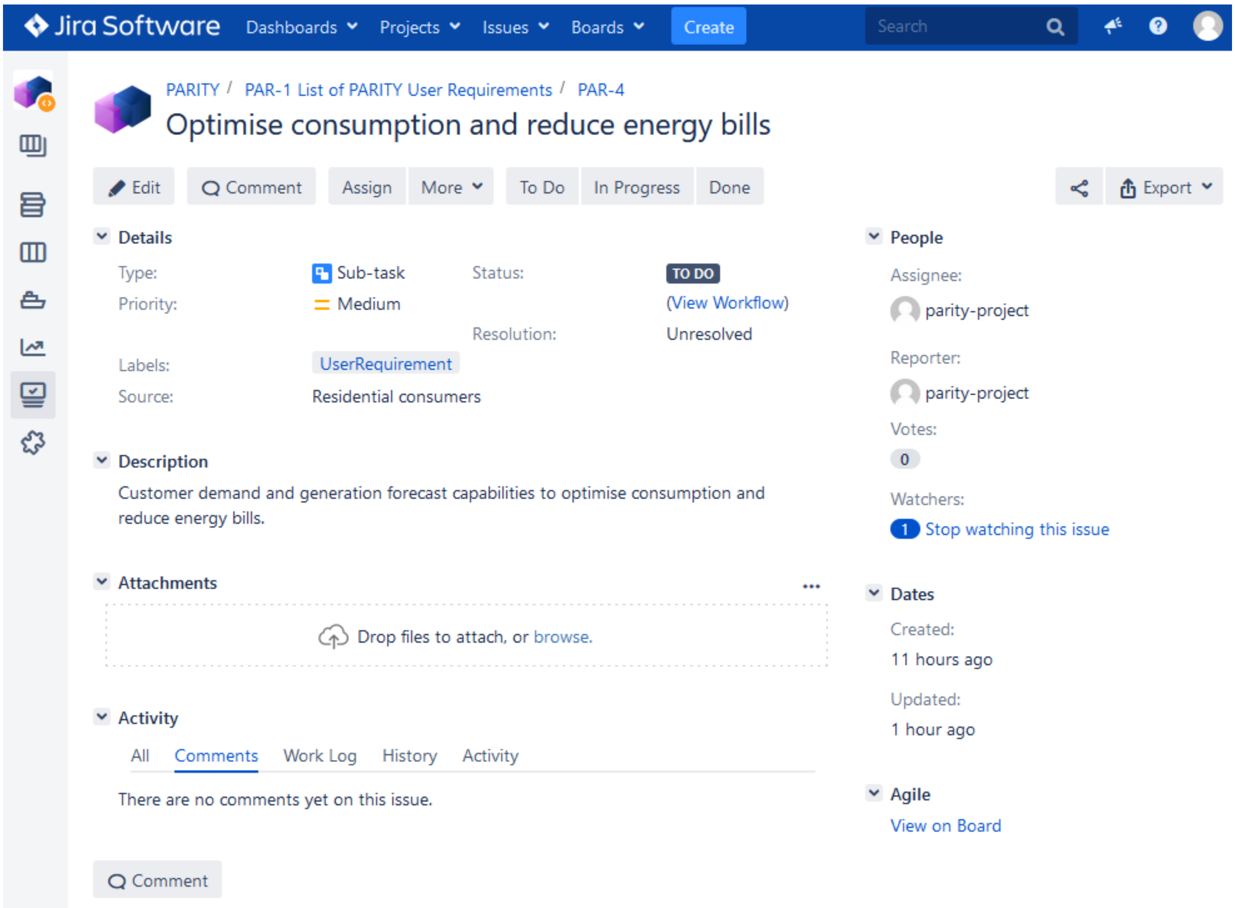


Figure 59. User requirement example from residential consumers in JIRA platform.