D2.2 – End-user & Business requirements analysis for big data-driven innovative energy services & ecosystems - b

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Abbreviations

API	Application Programming Interface
BS	Business Scenario
DoA	Description of Action
DR	Demand Response
DSO	Distribution System Operator
EPC	Energy Performance Contract
ESCO	Energy Service Company
GHG	Greenhouse Gases
HVAC	Heating Ventilation Air-Conditioning
ICT	Information and Communications Technology
OPEX	Operating Expenses
SECAP	Sustainable Energy and Climate Action Plan
TSO	Transmission System Operator
UC	Use Case
VPP	Virtual Power Plant

EXECUTIVE SUMMARY

This document shows the BEYOND project foundations that will further trigger the implementation of technical activities in the project. It comprises of the second and final version of End-user & Business requirements analysis for big data-driven innovative energy services & ecosystems (the first version was delivered under D2.1) that serves as input to the final architecture of the BEYOND platform.

At first, following the methodological approach as agreed among the partners, the main actors (stakeholders) related to the project solution are defined and described. This is a crucial step in order to shape the basic business motivations for the conceptualization of the project solution.

In addition, taking into account the feedback from the business actors of the project, the details about the project business scenarios and use-cases are defined, to drive the whole design process of the BEYOND framework. This business-centred analysis is further complemented by the active participation and involvement of building occupants (as key actors of the project) in the BEYOND co-creation and design process. Questionnaire surveys were circulated to the building occupants in an anonymous way in order to gather their feedback to further drive the design of the platform. On the other hand, the key business actors of the consortium were also contacted in order to provide their wish list requirements about the BEYOND services and solutions. Using this methodology, a list of 16 Business Scenarios, 33 Use Cases, 247 business requirements and 38 user requirements was determined.

The feedback from the business stakeholders and the building occupants further leads to the extraction of a list of end-user and business requirements as derived from the key actors targeted by the project to create the necessary inputs for defining the framework of the BEYOND proposed technology and services specifications.

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1 Introduction

1.1 Scope and Objectives

The scope of the deliverable is to specify the business and user requirements of the BEYOND solution that will further guide the implementation of the technical activities in the project. This is achieved after the definition of the project main actors and beneficiaries, and the determination and description of the Business Scenarios and Use Cases.

The main purpose is to clearly express the needs for the proposed solutions that are driven by existing barriers and the increased technological state-of-the-art, the smartification in grid and building level, the vast capabilities on data collection, handling and sharing. It is crucial for the project to provide solutions that will result in actual profit for the stakeholders, so this document will try to provide a list of requirements that will lead the project activities to concrete business plans. For that reason, the work for this deliverable included:

- The definition of the main actors/stakeholders that represent the beneficiaries of the project solution;
- The determination of the Business Scenarios based on the benefits for each stakeholder of the project;
- The determination and description of the data and energy related Use Cases derived by each Business Scenario;
- The business requirements derived by each of the Use Cases;
- The user requirements derived by an end-user survey (questionnaire) conducted for the purposes of this task.

1.2 Relation to other tasks

This document is aimed to define the project business objectives, to provide the main high-level specifications of the project solutions for the purposes of the T2.1. In addition, the extraction of project requirements will drive the work for the development of the different ICT solutions to be performed on WP3, WP4, WP5, WP6.

Moreover, this deliverable will feed with its results most of the other tasks and deliverables of the WP2. Specifically, the list of business requirements will prove useful to the activities of T2.5 which will design and deliver the final architecture of the BEYOND project.

1.3 Structure of the document

The document includes the following contents:

- Chapter 1 with the introductory section, including the scope of the document, its relation to other tasks of the project and its structure;
- Chapter 2 with a description of the methodology used in the task for the definition and final determination of the project business and user requirements;
- Chapter 3 with a list of stakeholders related to the project activities and the beneficiaries of the BEYOND solutions, as well as the description of each;
- Chapter 4 with a listing and description of the project Business Scenarios and Use Cases;
- Chapter 5 with a list of the determined business requirements derived by the Use Cases, and the user requirements derived by the results of the conducted user survey;
- Chapter 6 with a summary of the task activities and the main extracted conclusions of the deliverable;
- Chapter 7 with a short reference on the next steps of the project.

The final chapters include a list of references mentioned in the text, as well as an annex with more thorough pieces of information regarding the task activities, such as the complete questionnaire used for the user survey.

2 Methodology

A successful extraction of business and system requirements is never an easy task as a good understanding of the needs and requirements of all the project-relevant beneficiaries is required. This fact guides the structuring of the methodological framework which includes the definition of the main stakeholders benefiting from the project solution, the definition of the business scenarios which are based on the needs of the aforementioned stakeholders, the definition of the Use Cases that the project is going to deal with, and finally the definition of the project requirements.

This framework is, thus, composed by 5 main steps in line with the design principles presented above:

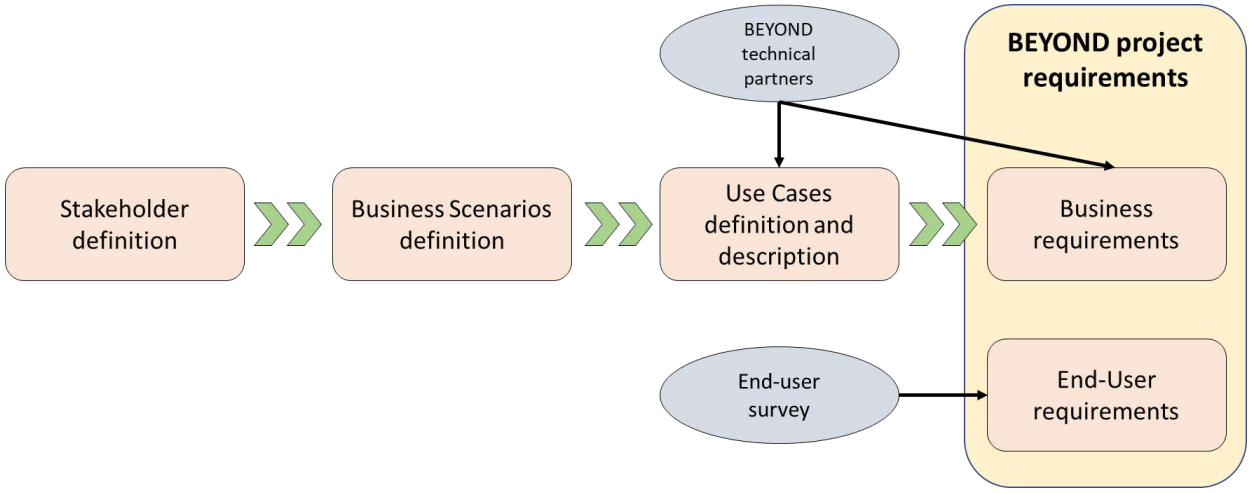

FIGURE 2-1: METHODOLOGICAL FRAMEWORK FOR THE DEFINITION OF THE BEYOND REQUIREMENTS

Step 1: Definition and description of the project-relevant stakeholders

As a first step, it is important to define all the relevant actors and roles that are supposed to be engaged, participate and interact during the application of the project results. A description of these stakeholders' characteristics will enable a deeper understanding of their needs, the existing barriers, and their possible benefits.

Step 2: Definition of the project Business Scenarios

The Business Scenarios are stakeholder-oriented, they express the certain benefits, revenue streams that can be produced and guide the services framework to be tested during the project activities. The benefits and the profits which are derived from the project are better understood by analysing the Business Scenarios for each individual category of stakeholders. The starting point for the definition of the Business Scenarios is the DoA and the point of view of the business partners of the project.

Step 3: Definition and description of the project Use Cases

The definition of the Use Cases aims to follow the guidelines defined in the Business Scenarios and try to construct case-specific solutions that will try various approaches to the problem described in the Business Scenarios. The basis for the Use Cases definition is also the DoA. However, the description was conducted with the contribution of the technical partners of the project who were able to provide a high-level conceptual framework of each Use Case without any technical functionalities.

Step 4: Definition of the project business requirements

The description of the Use Cases provides the basis for the extraction of the business requirements of the project. The extraction of the business requirements was performed by the technical partners. These requirements describe what the project solution shall or should do according to the business needs.

Step 5: Definition of the project end-user requirements

The definition of the end-user's requirements requested special feedback which was acquired through a questionnaire circulated to a pool of proxy users (similar profiles to the ones expected to get involved in BEYOND) from the clientele of our demo partners. The analysis of the survey results provided useful feedback for the end-user's requirements, but also for the socio-economic analysis performed in T2.2.

3 BEYOND stakeholders

3.1 Stakeholder taxonomy

The BEYOND project aims to provide ICT enablers to support the market and provision of energy and non-energy services among energy stakeholders and energy consumers. A dual-axis taxonomy for the definition of the stakeholders is required. This is due to the fact that the BEYOND project does provide not only energy related services but also the whole infrastructure for the acquisition, curation and sharing of the respective data in parallel with the corresponding data markets. The abovementioned dual-axis taxonomy can be defined as:

- **Data relevant horizontal roles**
- **Energy value-chain roles**

This taxonomy supports the idea that each stakeholder belongs to a category in both axes simultaneously. For example, an energy supply company is both a data consumer (and data owner) concerning the data-relevant axis and a retailer in the energy-relevant axis.

3.2 Data-relevant horizontal roles

The data-relevant stakeholders are:

- **Data owners/providers**
- **Data brokers**
- **Data consumers**

It is important to mention that each stakeholder can play more than one role. For instance, a data consumer may also behave as a data provider etc. The following paragraphs describe the characteristics of these three data-relevant roles as well as the impact of the BEYOND project to their interests.

3.2.1 Data owners/providers

They are able to gather building-relevant (energy and non-energy) data from various building load assets. These data derive either from the retailer portfolio management or the network operation. The curation and linking of these data can add significant value increasing the quality. In that case, these data are valuable for many, mainly energy stakeholders, such as retailers or ESCOS. Retailers could use historic or real-time data for the optimisation of their portfolio management while ESCOs for the improvement of the energy performance of their buildings.

Moreover, data owners can represent other stakeholders like retailers and aggregators that can have in their possession useful data from which network

operators can benefit. They can predict their portfolio demand, as well as the flexibility loads that can enable the reduction of the imbalances in the network.

The data owners can decide to share and exploit their data as it is or by employing analytics that could prove useful to them and their stakeholders. They can control the access of their data to any other stakeholder, deciding whether to proceed with a data contract when a data consumer expresses interest in a specific data asset they own.

The BEYOND platform will safeguard the rights of the data owners' interests by letting them define the terms of the availability and accessibility of their data assets. It will provide various mechanisms for increasing the data quality, as well as semi-automatic contracts for their sharing with any stakeholder interested to acquire either the specific data asset or its derived data intelligence in the form of an analytics report.

3.2.2 Data brokers

Data brokers are data market actors interested in enlarging their data portfolio in order to increase their revenue streams. They are not only interested in using and trading data in raw or almost raw form, but also in the form of analytics. This means that they try to perform an analysis on top of the data they acquire and then trade their outputs along with the initial data, with the respective contribution from the side of the data consumers.

BEYOND will serve the needs of the data brokers allowing the creation of multi-party agreements between data owners and data consumers in the form of semi-automatic contracts depending on the availability of the data, the requests from data consumers and on other terms/conditions included in the contracts.

3.2.3 Data consumers

The data consumers represent any stakeholder in the energy value-chain from the network operator to the energy consumer. They can acquire this data by paying through data contracts with one or multiple data providers and consumers. This data can be acquired and exploited either in raw form or even in the form of analytics. Moreover, they may analyse the purchased data by themselves utilizing pre-trained descriptive-predictive-prescriptive analytics, may conduct complex computations that can be afterwards presented and visualised in an intuitive manner. This data or the resulted analytics can be further purchased, turning in that sense the data consumers into data providers.

The BEYOND project will utilize the data-driven innovation and collaboration potential across currently diversified and fragmented energy market actors, focusing on the curation, sharing and trading of data in order to multiply its value. These activities will enable the data consumers (city authorities, energy retailers, energy network operators, ESCOs and aggregators) to acquire access to data that can provide holistic

optimization of the energy performance from building level to network scale operation through appropriate services that support decision-making and multi-parameter management of the various components and assets serving their individual interests.

3.3 Energy value-chain roles

The stakeholders with interests in the BEYOND solutions that are engaged in the energy value-chain can be categorized in:

- **City authorities**
- **Building/Facility Managers**
- **Building occupants – Consumers**
- **Network Operators**
- **Energy suppliers/retailers**
- **ESCOs and Construction companies**
- **Aggregators**

These categories have mostly individual benefits derived from the Business Scenarios that will be defined and described in the next chapter.

3.3.1 City authorities

When talking about the city authorities, we refer to the local city governance that is responsible for the decision-making regarding the implementation of innovations and their maintenance at city-level. The city schedule includes, among others, the urban energy policy planning aiming at the city transformation to a smart and sustainable ecosystem. The optimization of these policies is based on data or analytics provided by multiple sources inside the city, the characterization and prediction of heavy loads from lighting, building demand/generation, etc. The results of this feedback can enable the mid- and long-term action plan.

During the BEYOND activities, algorithms will be developed that will increase the forecasting accuracy of generation and demand of buildings and other load assets of the city, which will provide demand data of high granularity. These algorithms will support and enhance the operations of existing software (Crystal City tool) in order to reach ideal decision-making support on the mid- and long-term policy making of the local authorities in terms of cost effectiveness and sustainability.

3.3.2 Building/Facility Managers

They are responsible for the operational maintenance of the main assets of a building, and the comfort and well-being conditions of the building occupants, both at the lowest possible cost. In order to do so, they require a wide range of data and analytics that represent the present conditions in the building, predictions concerning the

maintenance activities to be scheduled in the near future, but also historic data for the evaluation of the present operations and conditions.

BEYOND will enable the effective collection and management of all the data provided by internal (IoT) and external sources (bills, weather forecast) in order to use the Digital Twin model. The Digital Twin model utilizes extensive historic and aggregated data to shape the model profile of the building. The goal is to enable a more effective management of all kinds of assets of the building including the energy assets. This can be achieved by increasing the self-consumption and decreasing energy-related costs and losses due to insufficient maintenance.

3.3.3 Building occupants – Consumers

The building occupants belong to the data owners/providers category. They are the energy consumers, and their main concern is the reduction of their energy cost without reducing their consumption. Offering them extensive support and making them aware of their energy consumption pattern, can enable them to deliver flexibility services to retailers and network operators who can find added value to the acquisition of data concerning the building demand profile concerning their scheduling and operational management. Since the exchange of such data is not yet widely used, the occupants can be sceptical to such a perspective. This can affect their participation in the flexibility markets, which is common only in the industrial sector.

The BEYOND solution will provide support for effective decision-making for increased energy savings, the definition of the flexibility potential, as well as the delivery of DR signals and personalised guidance, even automated activations in load control to serve the peak shifting needed by retailers and network operators. Their participation in such markets goes through their need to reduce the level of their energy bills, but also to maintain their comfort, especially concerning their living experience in the building. In order to do so, the BEYOND solution will include AI big data personal analytics that will enable the shaping of personal comfort profiles according to which explicit monitoring, consulting and triggering actions based on the comfort and hygiene conditions in the building will be provided. Finally, an important scope of the project is to define the income generation opportunities. This can be achieved by monetizing the data assets as well as by participating in the flexibility markets either individually or through intermediaries like retailers and aggregators.

3.3.4 Network Operators

They are responsible for the smooth operation of the electricity distribution system (DSOs) or the district heating network (District Heating Network Operators). They should guarantee that the input of the system should be able to satisfy the demand at every single moment. Bearing that the demand has peaks which affect both the cost of the energy and the sustainability of the system, it is valuable to the to

accurately forecast the demand and to be able to make changes in order to balance the difference between supply and demand. They are responsible for the system management, so the definition and development of the energy markets is performed according to their need to satisfy the corrections in the demand forecasting during the day, hour or even instantly (balancing markets). It proves crucial to have as accurate demand forecasting as possible, so the technology enhancement, the upgraded data acquisition and sharing and development of energy flexibility markets with building (not only industrial) participation can greatly support their level of management, as well as their ability to plan the most suitable mid- and long-term network reinforcement strategies.

BEYOND will utilize and enrich existing software designed for the optimization of the asset management in the scale of a city or a network, in order to equip system operators with data-driven and data-sharing intelligence involving accurate demand forecasting algorithms, flexibility analysis and support in long term decision making and strategy planning concerning the installation and sizing of new system infrastructure. These guidelines will take into account both technical future requirements and cost-effective solutions and alternatives. Peak shifting can be achieved through the exploitation of the flexible demand data. This peak shifting can enable the deferral of investments to reinforce the energy networks and cover demand growth.

3.3.5 Energy suppliers/retailers

The energy retailers manage large portfolios of consumers including the domestic sector and not only large industrial and commercial consumers. They buy energy according to predictions of their customers' demand and they pay for the imbalance charges, which represent a considerable cost sometimes.

BEYOND will focus on the development of algorithms for the accurate day-ahead demand forecasting of the retailers' customers, including the flexibility predictions at device level taking into account the comfort profiles of the customers. At the same time, the management of the portfolio will become more effective since the purpose is to cluster and segment the retailers' portfolios according to the customers elasticity profiles, flexibility loads, demographic characteristics etc.

The accurate customer elasticity forecasting as well as the meaningful segmentation according to several key characteristics will help retailers minimize the imbalance charges and deliver novel services around Implicit Demand Response.

3.3.6 ESCOs and Construction Companies

ESCOs take over the initial construction or renovation of buildings in order to increase the building energy performance which is guaranteed through the signing of Energy Performance Contracts with their customers. Their main concern is to accurately

appraise the initial energy performance and to find the optimized solution for the highest increase in this performance, at the lowest possible cost.

BEYOND will step on existing software to move forward to perform real-time building energy certification, which will enable improved decision-making on the proposed renovation solutions regarding the optimization of the energy-efficient design of the buildings. The elimination of the gap between the predicted and the actual energy performance can defer costly investments, both in the initial construction and the renovation. Appropriate AI analytics and services can facilitate the proper diagnosis and predictive maintenance, and generally to provide an optimized asset management.

The purpose is to accelerate the penetration of Energy Performance Contracts by increasing the suitability of terms per occasion so as to enable certain profit for ESCOs and energy consumers. Overall, this will enhance the optimisation of the energy performance and the cost savings bringing profit to all related stakeholders.

3.3.7 Aggregators

They are groups of small energy consumers, prosumers and battery owners in the energy market. They group their portfolios in Virtual Power Plants (VPPs) which have a separate internal energy management having a common generation, consumption and storage. In this way, the imbalances between the generation and consumption of an individual prosumer, are possible to be handled by the reverse imbalances of others. The aggregators exploit flexible loads of their grouped consumers in order to be able to satisfy all demand with self-generated energy. Thus, the network plays less the role of the constant energy supplier but allows more responsibility for the balance and quality of the energy. This can enable the surpassing of the various barriers and limited capabilities of the prosumers, who find profit through an intermediate aggregator.

BEYOND will work on existing software to upgrade its capabilities in portfolio management, and specifically in the flexibility clustering in the VPPs and the implementation monitoring of DR strategies, providing analytics and forecasting that can optimize the energy management of their grouped consumers, scoping to the maximization of self-consumption. This will decrease the dependence of their portfolio to the grid, lowering the energy costs and increasing profit.

4 BEYOND Business Scenarios & Use Cases

4.1 Business Scenarios

In the sense of determining the benefits for each one of the stakeholders listed in the previous chapter, the following Business Scenarios are defined targeting their specific interests derived by the project activities.

In order to follow the taxonomy of the stakeholders' list, the Business Scenarios are divided into 2 categories. These categories can be distinguished by defining whether they refer to the data stakeholders or to the ones belonging to the energy value-chain. Each BS's id includes a "D" or an "E" indicating this division:

Table 4-1: Data-relevant Business Scenarios

BS id	Business Scenario Title	Main Beneficiary
BS_D_01	**Increase of the data value through added value services**	Data owners
BS_D_02	**New operational insights through the analysis of data**	Data owners
BS_D_03	**Creation of new revenue streams through trading of data**	Data owners
BS_D_04	**Maximization of service offerings by gaining access to more data**	Data brokers
BS_D_05	**Improvement of operations through increased outreach to external data and analytics**	Data consumers

Table 4-2: Energy-relevant Business Scenarios

BS id	Business Scenario Title	Main Beneficiary
BS_E_01	**Reinforcement of the effectiveness and de-risking of the viability of Energy Performance Contracting through reliance on accurate occupancy-related schedules**	ESCOs
BS_E_02	**New revenue creation through new services for real-time energy performance certification, complemented by Smart Readiness Certification services**	ESCOs
BS_E_03	**EPC optimization through real-time monitoring and improvement of energy performance of buildings, as well as, through predictive maintenance of building assets**	ESCOs

BS_E_04	**Avoidance of costly investments through evidence-based, data-driven sizing of energy networks**	Network Operators
BS_ E_05	**Cost-effective planning of network operation, OPEX reduction and avoidance of peak loads and network congestion through accurate estimation and utilization of flexibility offered by building assets**	Network Operators
BS_ E_06	**Energy costs savings with preservation of well-being preferences through the deployment of personalized and advanced human-centric energy services incl. self-consumption**	Building Occupants / Consumers
BS_ E_07	**Creation of new revenues through flexibility provision for ancillary services**	Building Occupants / Consumers
BS_ E_08	**Improved profitability through utilization of the unleashed flexibility potential of the building sector**	Aggregators
BS_ E_09	**New revenues through provision of services to Network Operators (Implicit DR) and avoidance of unnecessary charges through imbalance management**	Retailers
BS_ E_10	**Increased profitability and long-term sustainability through the transformation of their business-as-usual to data and intelligence-driven Energy-as-a-Service offerings**	Retailers
BS_ E_11	**More effective decision-making for urban planning and evidence-based realistic target setting for their transformation to smart and sustainable ecosystems, through advanced forecasting of demand in buildings**	Local Authorities

4.2 Use Cases

A use case is the definition of a specific business objective that the system needs to accomplish. A use case will define the process by describing the various external actors that exist outside of the system, together with the specific interactions they have with it, in the accomplishment of the business objective. The use cases, after being well defined, can serve as the basis for the formulation of the business requirements. The intended behaviour of the system, the desired functionality, the possible constraints imposed and the objectives that need to be satisfied (from the system point of view) belong to the definition of the business requirements.

4.2.1 Use Cases Taxonomy

The Use Cases were defined according to the specific individual issues that are to be addressed during the project activities. Each of them responds to one of the Business Scenarios listed in the previous paragraphs:

TABLE 4-3: DATA-RELEVANT BUSINESS SCENARIOS AND USE CASES

Business Scenarios	Use Cases
BS_D_01	Data validation, cleaning, completion, harmonization and linking
	Data enrichment and development of composite datasets from different sources owned
	Continuous multi-source data collection, management and availability
	Security guarantees to safeguard data artefacts
BS_D_02	Data analytics methods utilising cloud and/or on-premises resources
	In-situ privacy preserving data operations by blending external data
	Advanced analytics through the blending of in-house and third-party data
BS_D_03	Provision of Data-as-a-Service or Analytics-as-a-Service to interested parties by signing data contracts
	Trusted data sharing and revenue flow via a blockchain-powered data marketplace
BS_D_04	Enlarging the data portfolio by signing multi-party data contracts
	Provision of multi-source data analytics/insights services based on data acquired from data owners
BS_D_05	Definition of data asset matchmaking scenarios which enable overcoming specific data unavailability
	Advanced analytics through the blending of in-house and third-party data
	Intuitive data discovery and collection

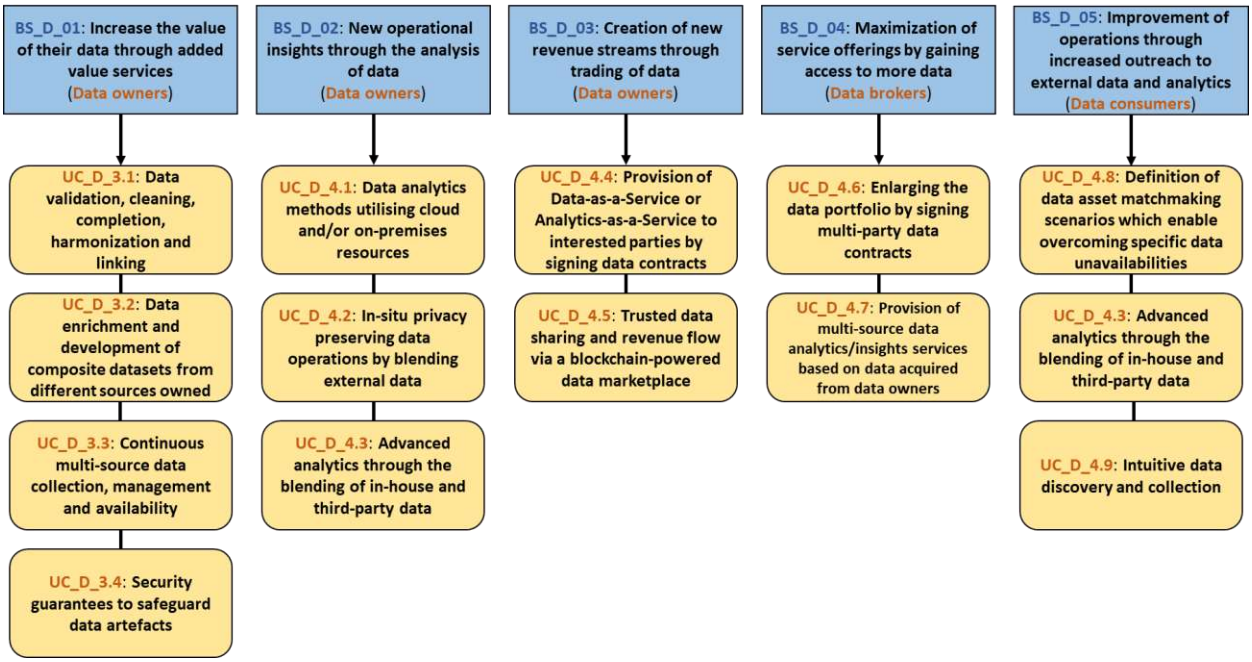

FIGURE 4-1:DATA-RELEVANT BUSINESS SCENARIOS AND USE CASES LINKED WITH THEM

TABLE 4-4: ENERGY-RELEVANT BUSINESS SCENARIOS AND USE CASES

Business Scenarios	Use Cases
BS_E_01	Accurate building energy performance simulation, considering fine-grained occupancy and comfort profiles of building occupants
	Building Energy Passport configuration for tracking renovation actions and increasing transparency building assets and performance
BS_E_02	Real-time assessment of building energy performance in different spatio-temporal granularities
	Enriched building performance assessment including the on-the-fly calculation of Smart Readiness indicators
BS_E_03	Energy Performance monitoring in real-time
	Predictive maintenance of HVAC systems
	Continuous optimization of building energy performance and self-consumption maximization through the utilization of the Digital Twin concept
BS_E_04	Simulation-based network performance assessment
	Optimized sizing of network assets
BS_E_05	Energy Network-wide flexibility availability estimation
	Flexibility-based operational planning of energy networks

BS_E_06	**Personalized energy analytics and awareness of energy consumption characteristics**
	Smart control functions including human-centric features for energy and non-energy services
	Continuous optimization of building energy performance and self-consumption maximization through the utilization of the Digital Twin concept
BS_E_07	**Consumer-Centric Demand Response Optimization (automation)**
	Smart control functions including human-centric features for energy and non-energy services
BS_E_08	**Flexibility Analytics and VPP Configuration**
	Smart control functions including human-centric features for energy and non-energy services
BS_E_09	**Retailer portfolio analytics for elasticity estimation (referred to also as elasticity profiling) and extraction of useful insights**
	Elasticity utilization in demand response and imbalance reduction strategies
BS_E_10	**Personalized energy analytics and awareness of energy consumption characteristics**
	Smart control functions including human-centric features
	Non-energy Services for Comfort, Well-being and Security
BS_E_11	**Urban planning optimization and SECAP target-setting**
	SECAP target monitoring and revision

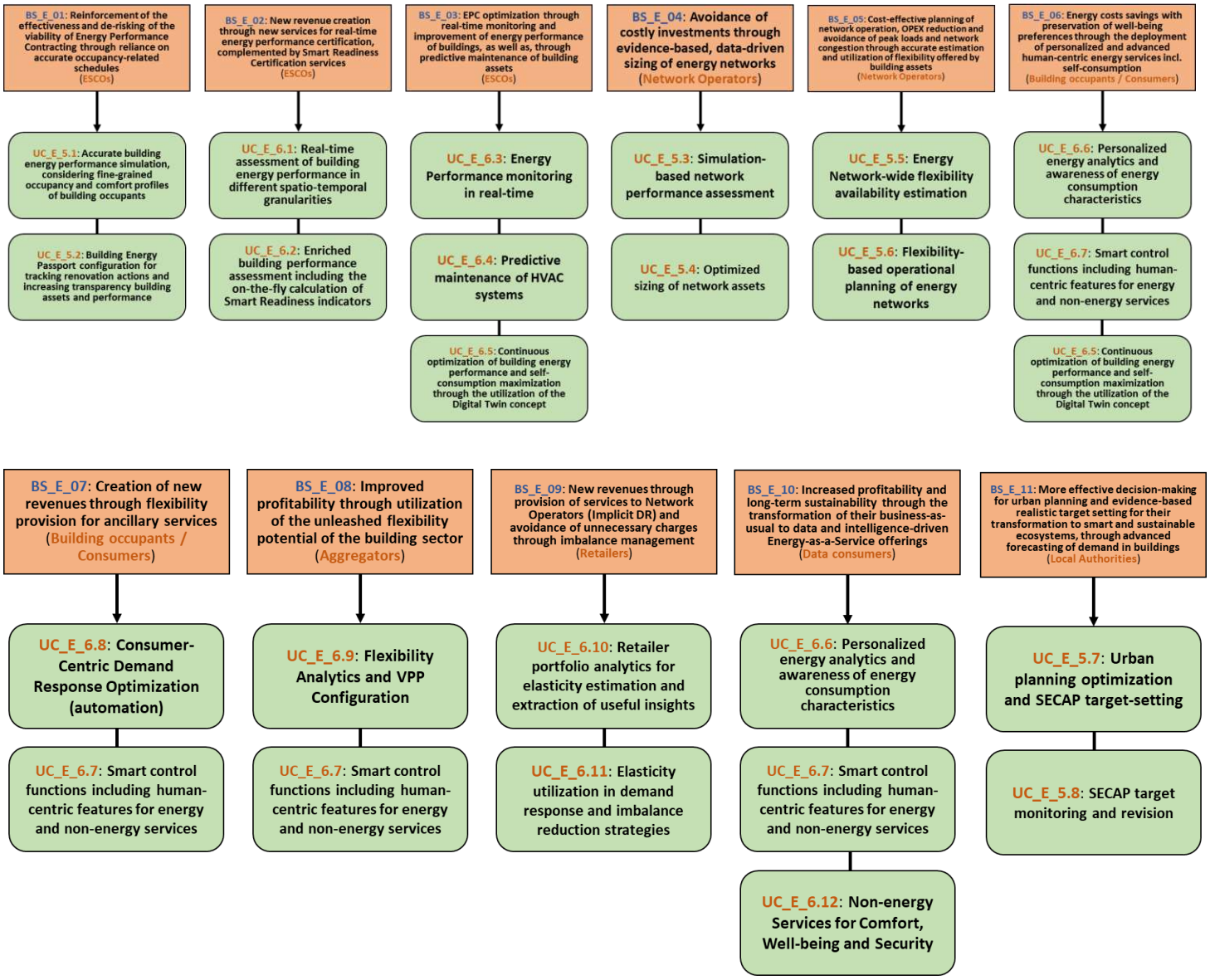

FIGURE 4-2: ENERGY-RELEVANT BUSINESS SCENARIOS AND USE CASES LINKED WITH THEM

The next figures present the mapping of the Use Cases according to their relevance to each WP of the project:

- 4 UCs for WP3, as they deal more with the data management tasks of the BEYOND ecosystem
- 9 UCs for WP4, as they deal more with data analysis and trading activities foreseen to happen over the BEYOND platform.
- 8 UCs for WP5, as they deal more with the applications on energy policy planning and infrastructure sizing
- 12 UCs for WP6, as they deal more with the applications on optimizing building energy performance

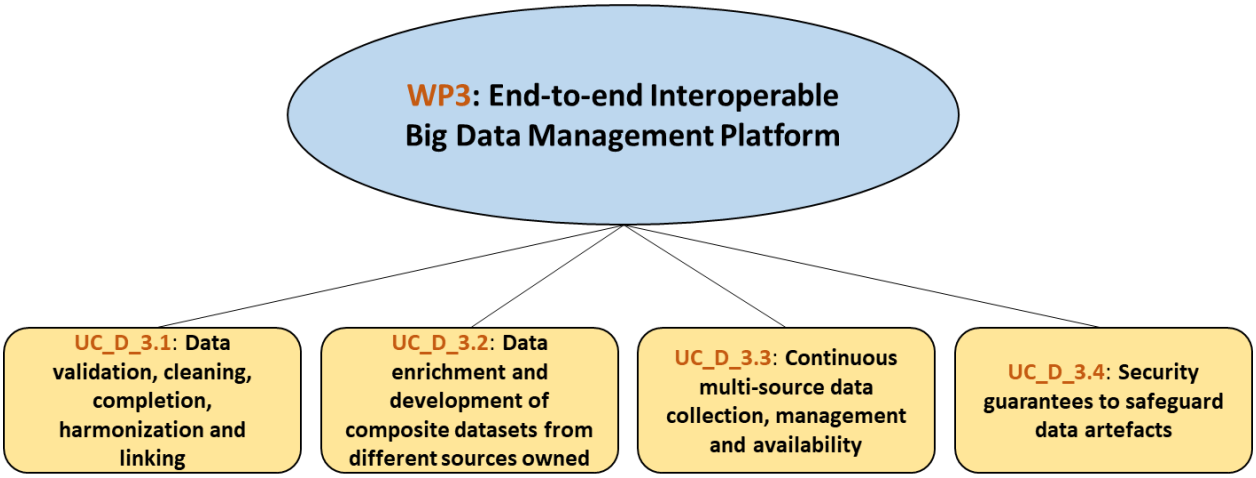

FIGURE 4-3: USE CASES RELEVANT TO WP3

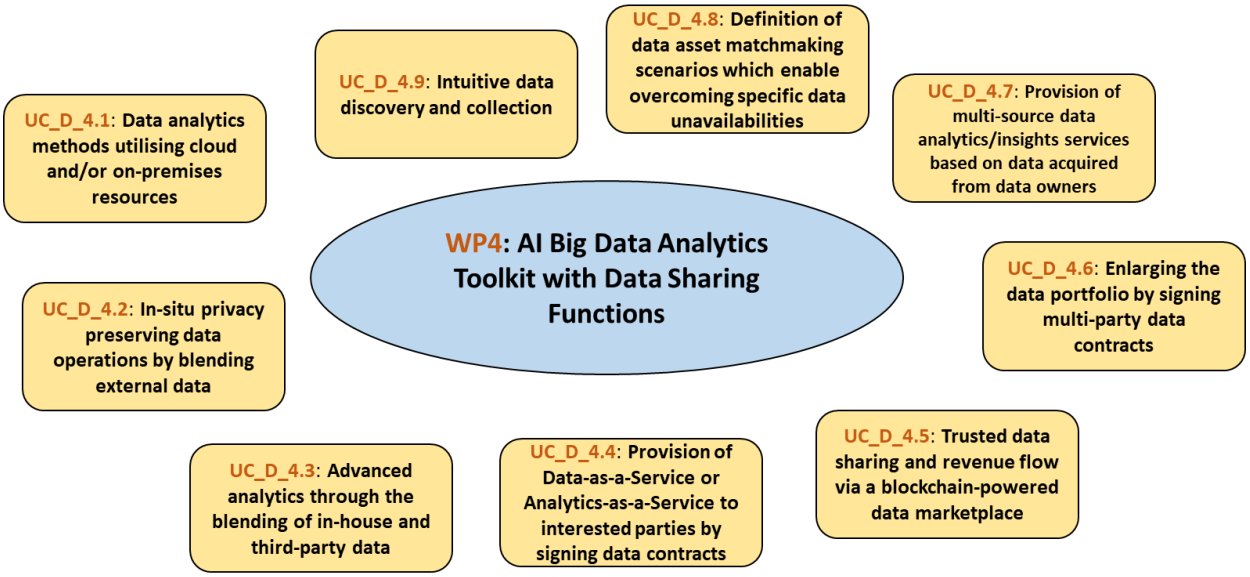

FIGURE 4-4: USE CASES RELEVANT TO WP4

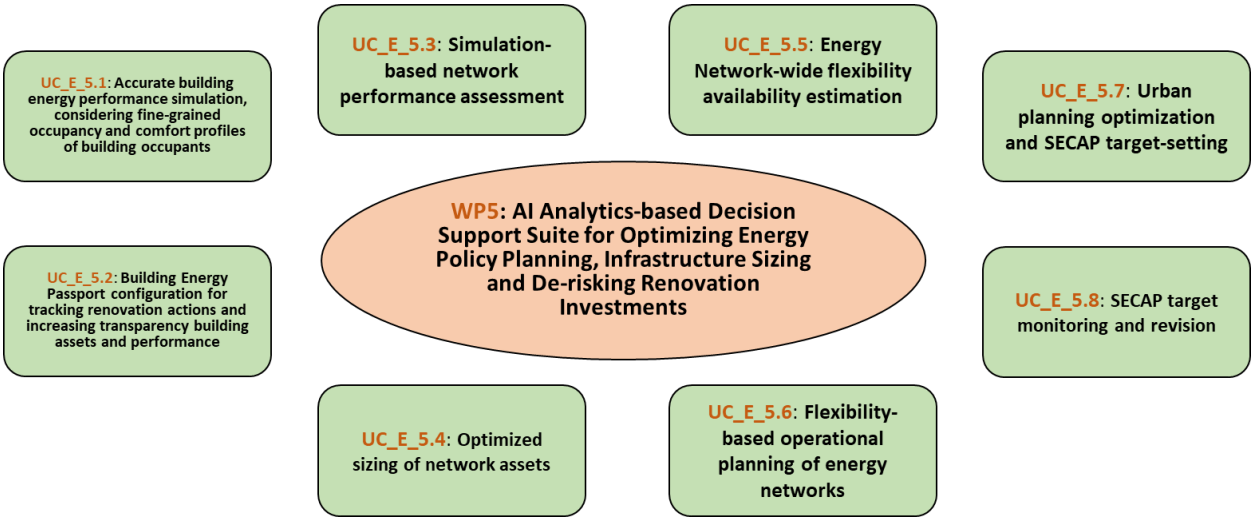

FIGURE 4-5: USE CASES RELEVANT TO WP5

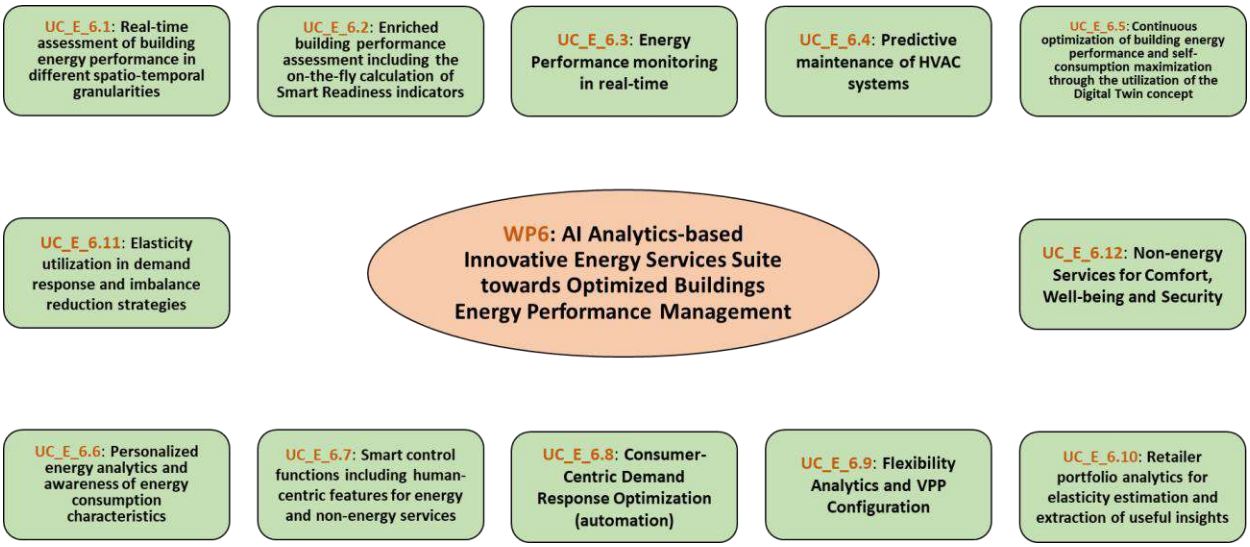

FIGURE 4-6: USE CASES RELEVANT TO WP6

4.2.2 Use Cases Description

The id of each UC includes a "D" or an "E" depending on whether it is data related or energy-related, the number of the respective WP, and then the numbering.

4.2.2.1 Data-relevant Use Cases description

Data validation, cleaning, completion, harmonization and linking	
Use Case Id	UC_D_3.1
Description	Prior to making data available for other stakeholders, or even for own usage, there is a need to manage the data in such a way that it becomes ready to be ingested by different IT systems and that it adheres to data interoperability principles, as to make it universally usable. In this context, the user should be offered with a set of services that are able to treat incoming data streams in such a way that it is transformed into a well-structured, interoperable object, following specific data formats, semantics and properties which ensure its proper consumption and ultimately increase its value, by making it usable not only for its owner, but also for other stakeholders which will be provided (by the owner) access to the data asset, as part of a data sharing agreement Therefore, any incoming data should pass the following stages a) data validation, which refers to services that are able to analyse and validate that data objects are of the appropriate format, range and content and do possess information that is expected to be part of that object, b) cleaning, through services that are able to detect and remove, or correct corrupt or incomplete entries, c) completion, which call for methods to fill in gaps in data records, d)

	harmonisation that is performed by services which bring different data formats together and provide a coherent, homogenous data object and finally e) linking, which is performed by services that conduct semantic interlinking of entities and is facilitated by mapping objects to a commonly agreed vocabulary, which in our case is the BEYOND Common Information Model.
Beneficiaries	Data owners
Relevant BS	BS_1: Increase of the data value through added value services

Data enrichment and development of composite datasets from different sources owned	
Use Case Id	UC_D_3.2
Description	Data assets that are uploaded to a system do hold value themselves, but by ensuring their enrichment with other data both on a semantic and payload levels can greatly improve the quality of the data and the intelligence that is carried, while it allows to identify in an easy manner other available data assets that could be used in conjunction with the ones at hand, to generate more sophisticated , value added services. As such, the data to be stored in the system should be complimented on a semantic level with various metadata and allow the performance of data linking operations towards improving its discoverability, linkability and revealing other relationships that might exist with other assets. Furthermore, the users of this data should be able to process and transform the data assets into a composite asset which can accommodate other columns of data coming from other assets, to create new data assets that carry more valuable knowledge.
Beneficiaries	Data owners
Relevant BS	BS_1: Increase of the data value through added value services

Continuous multi-source data collection, management and availability	
Use Case Id	UC_D_3.3
Description	In most of the cases, data is a dynamic object that evolves over time and does not remain static. It is this dynamicity and constant evolution which makes data valuable and calls for sophisticated analysis methods, as the different analytics models that are employed aim to understand the way data is changing and build their operations on the basis of the fluid nature of data. As such, it is important for a data owner to be in a position to constantly access and collect the newly created data, manage it and make it available to collaborators, and not regard these activities as a once-only operation. In this context, the user (data owner) should be served with the necessary methods to support him to continuously collect data from multiple sources in a semi-automated manner that requires only

	minimum interaction, automate as much as possible the different data management operations identified under UC_3.1 and make the data outputs available to him for further processing and sharing.
Beneficiaries	Data owners
Relevant BS	BS_1: Increase of the data value through added value services

Security guarantees to safeguard data artefacts	
Use Case Id	UC_D_3.4
Description	On analytics-heavy platforms and tools it is a common place to introduce guarantees that will satisfy the security and privacy requirements set by the involved parties and, more importantly, imposed by the level of sensitivity of the data which is something important when it comes to both personal as well as business relevant data. There are plenty of examples of sensitive data in the energy landscape such as building-specific information, overall energy consumption of a district and energy consumer details among others. In order to overcome the obstacles posed by data privacy concerns, it is of paramount importance to tackle those problems effectively with the specification and development of a security pipeline that will ensure both the integrity of the data and the privacy of the users. Thus, a combination of well-established and widely used techniques will be deployed to support the above needs and safeguard both data and privacy as required. More specifically, BEYOND should offer services that guarantee the secure and safe communication among the different components of the platform, as well between the different stakeholders that take part in the data sharing ecosystem, while at the same time it should offer data safeguarding methods which guarantee that data is accessed by the stakeholders that do actually possess the rights to do so, that the latter are attested before taking part in such transactions and that data locality is handled based on the requirements of each stakeholder (e.g. on-premise or cloud-based storage).
Beneficiaries	Energy Retailers, Building Managers
Relevant BS	BS_1: Increase of the data value through added value services

Data analytics methods utilising cloud and/or on-premise resources	
Use Case Id	UC_D_4.1
Description	The availability and collection of data calls for data owners to also perform analysis operations on their own data to get insights and utilise the hidden in the data knowledge for own purposes or for exploiting it, commercially or not. As such, data owners shall be provided with the necessary services to run analytics on their collected data, utilising state of the art

	analytics frameworks and methods. These services should allow the conduction of analytics on cloud-hosted resources, as well as on-premises environments, depending on the type of analysis and the resources to be required, as well as on the privacy and security considerations that accompany the data to be analysed.
Beneficiaries	Data Owners
Relevant BS	BS_2: New operational insights through the analysis of data

In-situ privacy preserving data operations by blending external data	
Use Case Id	UC_D_4.2
Description	As security and data privacy is highly important in specific business cases, users should be provided with methods and services that allow for the local execution of data operations, and at the same time permit the blending of external data sources in order to enrich their core datasets and improve their value. This should be done without exposing the private data beyond the required environment chosen by the user, and making sure that operations are performed in-situ, taking advantage of external data, and not the opposite where intelligence and business critical information could be leaked to third parties.
Beneficiaries	Data Owners
Relevant BS	BS_2: New operational insights through the analysis of data

Advanced analytics through the blending of in-house and third party data	
Use Case Id	UC_D_4.3
Description	In many cases, the value of any data analysis improves as the number of valuable data points increases. As such, data owners, as well as data consumers can greatly benefit from services that allow adding new data sources in analytics models that tackle internal data, promoting a shift from mainstream statistics and simple analysis to more complex algorithms that can leverage data from external/neighbouring environments which are related to their business operations and do have interaction points and influence their internal data. As such, both data owners, as well as data consumers should be served with the means to build more advanced analytics models that take into advantage third-party data sources towards improving the overall value of their analytics results.
Beneficiaries	Data Owners, Data Consumers
Relevant BS	BS_2: New operational insights through the analysis of data BS_5: Improvement of operations through increased outreach to external data and analytics

Provision of Data-as-a-Service or Analytics-as-a-Service to interested parties by signing data contracts	
Use Case Id	UC_D_4.4
Description	The sharing of data assets (plain datasets or analyses as the derivatives of the former) in a data marketplace environment such as the one to be promoted by BEYOND should be grounded on an undisputed, fair and transparent sharing mechanism. As such, the users who would like to share their data should be provided with the appropriate services that allow for the establishment, negotiation (if any), signature and validation of data sharing contracts between themselves and interested third parties. These services should allow for data assets to be provided as-a-service and need to support a value flow mechanism to enable data owners to receive the anticipated compensation based on each contract signed. These services should also keep the list of transactions on an immutable list to allow for auditing.
Beneficiaries	Data Owners
Relevant BS	BS_3: Creation of new revenue streams through trading of data

Trusted data sharing and revenue flow via a blockchain-powered data marketplace	
Use Case Id	UC_D_4.5
Description	Users engaging in a marketplace are highly interested in being offered with services that can ease many transaction-related activities and at the same time guarantee and increase their revenue (by handling various aspects from buyer's validation to transaction monitoring), while allowing them to focus more on their normal business operations and expertise. As such, Data Owners need to be provided with a marketplace that is able to automate parts of the data sharing and trading activities and to guarantee for the completion of the different transactions, and at the same time be in a position to guarantee transaction and transaction's parties integrity. Those services should be offered by a blockchain-powered marketplace that can take care of revenue flows, and also allow for third parties to become part of a trusted data sharing marketplace, and as a result increase the potential market pool where data can be made available.
Beneficiaries	Data Owners
Relevant BS	BS_3: Creation of new revenue streams through trading of data

Enlarging the data portfolio by signing multi-party data contracts	
Use Case Id	UC_D_4.6
Description	Data Brokers are entities that deal with data and one of their main interests is to enlarge their data portfolio in order to facilitate as many clients as they can and increase their revenue streams.

	These users will be served with services that allow the conduction of multi-party agreements between data owners and data consumers and that should be performed in the nature of contracts that can be semi-automatically executed depending on the availability of the data, the requests from data consumers and on other conditions that can be part of such contracts.
Beneficiaries	Data Brokers
Relevant BS	BS_4: Maximization of service offerings by gaining access to more data

Provision of multi-source data analytics/insights services based on data acquired from data owners	
Use Case Id	UC_D_4.7
Description	Data Brokers are also interested to shift away from the traditional models of just data provision and brokerage, and engage in the analytics trading business. Therefore, such users should be provided with services that allow the conduction of analyses on top of data they acquire from data owners and trade their outputs alongside with the data as they already do. Such services should allow the on-demand request of analyses by business clients, as well as the conduction of analytics on top of data coming from data owners, by providing the latter with the necessary compensation, based on contracts that should be signed between data brokers and data owners. The same services should be also available to Data Consumers to deliver analytics-as-a-service that can be used to complement their existing services and open new business pathways through the introduction of new intelligence-based business offerings.
Beneficiaries	Data Brokers, Data Consumers
Relevant BS	BS_4: Maximization of service offerings by gaining access to more data BS_5: Improvement of operations through increased outreach to external data and analytics

Definition of data asset matchmaking scenarios which enable overcoming specific data unavailabilities	
Use Case Id	UC_D_4.8
Description	Data availability plays an essential role in data analysis and insights generation and as practice has shown, many analytics operations and business scenarios suffer from data unavailability obstacles which do not allow the envisaged scenarios to scale out to their maximum potential. Data Consumers are therefore in need of services where they can specify specific data matchmaking scenarios and data requests that should be broadcasted in a network of data owners and brokers in order for these actors to identify whether their data can accommodate the needs of a specific data consumer and engage with the latter towards establishing a data sharing agreement.

Beneficiaries	Data Consumers
Relevant BS	BS_5: Improvement of operations through increased outreach to external data and analytics

Intuitive data discovery and collection	
Use Case Id	UC_D_4.9
Description	A great amount of effort of data consumers is spent on the discovery and the importing of data which are required for their business operations. These users should be provided with services which makes it easier and faster for data consumers to spot and retrieve data assets, reducing their overall effort spent in such operations and thus reducing their OPEX. Such services should allow for the execution of complex, yet understandable search queries over various data sources and be able to present to data consumers results in various dimensions and facets, that contain rich information regarding the included data assets, as well as snapshots of those assets (if available) to make it more apparent the included information to data consumers, supporting them in this manner to take informed decisions on the acquisition of a data asset, in a more reliable and faster manner. Moreover, the data consumers should be provided with the necessary service that allow for the easier, state-of-the-art and interoperability-friendly fetching of the data assets they have discovered, to limit the necessary investments that should be made on their side for importing the data into their systems.
Beneficiaries	Data Consumers
Relevant BS	BS_5: Improvement of operations through increased outreach to external data and analytics

4.2.2.2 Energy-relevant Use Case description

Accurate building energy performance simulation, considering fine-grained occupancy and comfort profiles of building occupants	
Use Case Id	UC_E_5.1
Description	The value proposition of the EPC of building energy renovations is based on the improvement of building energy performance generated by renovation measures. The ability to select the most cost-optimal renovation measures and to predict as much more accurate as possible estimation of building energy performance generated by the selected renovation measures at the design phase (upon which the EPC agreement is drawn) is essential to stipulate and de-risk EPC investment. Using quasi real time data of actual building operations in form of fine-grained occupancy and comfort profiles of building occupants into simulation loops of alternative renovation scenarios of targeted buildings will enhance generic

	routines conventionally implemented in commercial products/software used for predicting energy performance of buildings.
Beneficiaries	ESCOs, Construction companies, City Authorities
Relevant BS	BS_6: Reinforcement of the effectiveness and de-risking of the viability of Energy Performance Contracting through reliance on accurate occupancy-related schedules

Building Energy Passport configuration for tracking renovation actions and increasing transparency building assets and performance	
Use Case Id	UC_E_5.2
Description	To strengthen the uptake of the Energy Performance Contracting (EPC) for ESCOs and various beneficiaries (renovation projects managers, city decision makers) and increase the awareness of energy performance for building owner, occupants and new buyers, tracking renovation actions and increasing transparency over building assets and energy performance is essential to create evidence-based information trail by the creation of building energy passport. This will include the real and simulated energy performance of buildings before and after the implementation of renovation measures. Moreover, it will list the respective renovation measures with related KPIs.
Beneficiaries	ESCOs, Construction companies, Building/Facility Managers, Building Occupants /Consumers, City Authorities
Relevant BS	BS_6: Reinforcement of the effectiveness and de-risking of the viability of Energy Performance Contracting through reliance on accurate occupancy-related schedules

Simulation-based network performance assessment	
Use Case Id	UC_E_5.3
Description	In order to have a detailed knowledge of the structure and performance of the analysed network, it is necessary to study its behaviour in different situations. The situation of the grid is constantly changing, whether due to an increase or decrease in customer consumption, the installation of new generation or changes in the grid infrastructure. For this purpose, the different scenarios of demand and generation growth need to be analysed in order to plan new infrastructures. The behaviour of the electricity and heating networks in the defined scenarios needs to be simulated and evaluated in detail using appropriate simulation software and fine-grained (real-life) data and forecasts, which will point out specific weaknesses, reinforcement requirements and flexibility needs for a smooth operation and quality of service.
Beneficiaries	Network Operators
Relevant BS	BS_9: Avoidance of costly investments through evidence-based, data-driven sizing of energy networks

Optimized sizing of network assets	
Use Case Id	UC_E_5.4
Description	New types of consumption (new consumers) and generation (new power plants) make it necessary to increase the capacity of the grids with the economic cost that this entails. Appropriate management of current and future network elements allows optimisation of network performance and avoidance of most of the network upgrades that were initially necessary. The results obtained from iterative network simulations will allow to evaluate which network improvements are really necessary, reducing the total investment. Several scenarios need to be studied with the use of appropriate simulation tools to define the optimal sizing of the network assets from a technical point of view. As a result of this study, the points of the network that need to be reinforced to allow the planned new connections or new assets (and their size) that need to be installed (e.g. generation or storage) can be identified.
Beneficiaries	Network Operators
Relevant BS	BS_9: Avoidance of costly investments through evidence-based, data-driven sizing of energy networks

Energy Network-wide flexibility availability estimation	
Use Case Id	UC_E_5.5
Description	Network elements can change their consumption or generation profile to provide flexibility. Therefore, the behaviour of the elements must first be analysed to determine the degree to which each element can modify its consumption or generation (flexibility). Based on information from buildings and their assets that will be provided by the grid operators, grid operators can obtain the opportunity to gain better visibility over their network and analyse the flexibility that distributed assets can offer, so as to take this into account when planning the operation of their networks. To this end, they need appropriate tools for performing this analysis of flexibility while obtaining insights on short-term forecasts of flexibility. This analysis can be further extended with customer clustering analysis to look for similarities between customers and cluster them together. Based on the analysis of the customers of the network and using the clustering tool included in the Beyond project pipelines, the customers are clustered. Once the different clusters have been defined, the flexibility that each of them can offer to the network can be estimated at aggregated level and thus support informed planning of network operation and allow for the definition of appropriate flexibility requests to be sent to aggregators. New customers connecting to the network can be associated to one of

	the defined customer clusters to estimate the flexibility they can offer to the network.
Beneficiaries	Network Operators, Building/Facility Managers
Relevant BS	BS_10: Cost-effective planning of network operation, OPEX reduction and avoidance of peak loads and network congestion through accurate estimation and utilization of flexibility offered by building assets

Flexibility-based operational planning of energy networks	
Use Case Id	UC_E_5.6
Description	In order to avoid investments in distribution networks and to make electricity grids operate in an economically efficient way, the cheapest possible sources of flexibility can be implemented to ensure quality of service and security of operations. In this context, proper management of network demand-side flexibility is important not only in economic terms, but also in technical terms. Flexibility on the demand side of the network can help to avoid critical situations in the networks, so the amount of flexibility that will be needed has to be defined in advance. To this end network operators are in need of tools that will allow them to generate accurate short-term demand and generation forecasts and simulate the behaviour of the network in order to identify the parts of the network where demand side flexibility is needed. Appropriate algorithms will analyse the available flexibility of all network elements and how much should be provided to avoid peak loads, network congestion and voltage variations. Once the critical areas of the network are mapped, the network operator can develop a robust operational planning of the network based on the advanced analysis of demand-side flexibility and the correct dimensioning of the network assets as a whole. One of the advantages of keeping the network operating under normal conditions (avoiding critical situations such as congestion and/or voltage deviations) is that the network infrastructure is not affected as much, which reduces the need for maintenance and increases its lifetime.
Beneficiaries	Network Operators, Building/Facility Managers
Relevant BS	BS_10: Cost-effective planning of network operation, OPEX reduction and avoidance of peak loads and network congestion through accurate estimation and utilization of flexibility offered by building assets

Urban planning optimization and SECAP target-setting	
Use Case Id	UC_E_5.7
Description	In order to elaborate their Sustainable Energy and Climate Action Plan (SECAP) and make investment decisions that will enable them to meet the European Union's commitments in terms of reducing GHG emissions at a lower cost while improving the quality of life of the inhabitants, local authorities must have a precise vision of the

	energy consumption of their territory, of the equipment (type of boilers, hot water, etc.) and of the uses of the inhabitants (particularly in terms of transport) in order to identify the levers for action. Indeed, this mapping of the territory and its analysis is essential to any bottom-up approach to assessing the impact of investment decisions on the GHG emissions trajectory. However, today this mapping is essentially carried out using data obtained at relatively large grids (Commune, NUTS3) and from statistical models. The building data (building typology, load curve, heating vector) will allow to reinforce the energy modelling of the territory and thus to refine the investment decisions to be undertaken to reduce our carbon footprint in the long term.
Beneficiaries	City Authorities
Relevant BS	BS_16: More effective decision-making for urban planning and evidence-based realistic target setting for their transformation to smart and sustainable ecosystems, through advanced forecasting of demand in buildings

SECAP target monitoring and revision	
Use Case Id	UC_E_5.8
Description	When a local authority carries out a SECAP, it provides itself with a plan of actions to be carried out, over a relatively long period of time, to meet its greenhouse gas reduction commitments. This action plan is developed on the basis of an energy model of the territory carried out at the time of the study and based, generally, on older data. Thus, in order to ensure compliance with the GHG reduction trajectory and to adapt the action plan to any deviations observed, it is necessary to have a tool that is able to monitor the implementation of the actions included in the SECAP, to measure their real impact (difference between the simulation results and the observed emissions) and to propose amendments in order to remain on track.
Beneficiaries	City Authorities
Relevant BS	BS_16: More effective decision-making for urban planning and evidence-based realistic target setting for their transformation to smart and sustainable ecosystems, through advanced forecasting of demand in buildings

Real-time assessment of building energy performance in different spatio-temporal granularities	
Use Case Id	UC_E_6.1
Description	Traditional methods of building energy performance certification are mostly based on static data that do not reflect the dynamic elements of building operation and are not updated through time. The penetration of Energy Performance Contracts and the introduction of novel services for the building sector, require a more

	dynamic framework that will allow educated and evidence-based decision making on investments to be made, along with different investment incentives for different levels of energy performance certification levels over the building stock, through the utilization of more granular data coming from the buildings. To this end, tailored tools and services are required towards the building sector allowing for their real time energy certification and investment optimization through the utilization of enhanced Display Energy Certificates that will allow for the buildings' compliance with energy efficiency commitments. Such services shall rely in real-life data streams and appropriate analytics that will be utilized for monitoring in real-time the energy performance of facilities/ buildings (as a whole but also at individual systems level), analyse it against the needs and requirements of the occupants and visitors, define spatio-temporal outliers that significantly affect energy performance and support energy management decision-making for optimizing it.
Beneficiaries	ESCOs, Building/Facility Managers
Relevant BS	BS_7: New revenue creation through new services for real-time energy performance certification, complemented by Smart Readiness Certification services

Enriched building performance assessment including the on-the-fly calculation of Smart Readiness indicators	
Use Case Id	UC_E_6.2
Description	Buildings are continuously gaining in importance when it comes to the optimization of the energy system in whole and the provision of flexibility for improving the quality of power and participating in services offered to network operators. Though, in order to grasp this opportunity and be valid for participating in flexibility transactions, buildings need to achieve some minimum levels of smartness that can be certified through the use of the Smart Readiness Indicator Methodology. In this sense, business actors like aggregators and retailers need to have access to detailed information about buildings towards evaluating their smart readiness and assessing their capabilities for getting involved in flexibility transactions and control strategies that are associated with innovative automation concepts. To this end, they need appropriate tools and methods to support the continuous assessment and certification of the Smart Readiness status of buildings. Such detailed information about building systems and other devices available, will need to be processed and analyzed in order to enable the calculation of a variety of metrics that altogether contribute to the assessment of the smart readiness of the building and the presentation of individual analyses in appropriate graphical user interfaces (GUIs) that point out to the overall score, but also to the performance of the building in separate metrics that affect its

	smart readiness levels. The latter will point out to specific improvements that need to be performed (in terms of retrofitting) towards enhancing the smart readiness level of the building and making it more attractive for revenue creation through flexibility provision (or at least for the provision of innovative smart energy services for energy savings and wellbeing).
Beneficiaries	ESCOs, Building/Facility Managers
Relevant BS	BS_7: New revenue creation through new services for real-time energy performance certification, complemented by Smart Readiness Certification services

Energy Performance monitoring in real-time	
Use Case Id	UC_E_6.3
Description	Accurate quasi-real-time monitoring of energy performance of building energy components (such as generation, consumption, storage, HVAC components, air quality, etc.) and historical recordings are necessary information for optimizing the energy flow and verify the energy performance of buildings against EPC targets. There is a need for tools that enable the visualization of energy data flowing from building assets, along with forecasts of anticipated performance to enable the design of highly effective energy management strategies for energy performance improvement. This is of paramount importance to take corrective measures, if needed to improve the performance of contracts. The outcomes of the Use Case will be a set of KPIs, outlining, energy and reliability indicators to monitor energy performance of buildings.
Beneficiaries	ESCOs, Building/Facility Managers, Building Occupants
Relevant BS	BS_8: EPC optimization through real-time monitoring and improvement of energy performance of buildings, as well as, through predictive maintenance of building assets

Predictive maintenance of HVAC systems	
Use Case Id	UC_E_6.4
Description	To guarantee efficient operations, high performance of energy building systems and comfort of occupants, facility/building managers would benefit from intelligent support tools able to predict and suggest maintenance schedules in near real-time and enable proactive facility management decisions. `In this context they need fine-grained tools that will utilize information coming from HVAC systems, along with AI algorithms (applied over these data streams) to predict maintenance interventions facilitating maintenance strategy implementation, enabling long-term preservation of efficient operations, high performance of energy building systems and comfort of occupants. The AI may consider various data sets analysing them against historical performance benchmarks, occupant needs to detect

	performance discrepancies or discrepancy related occupant discomfort.
Beneficiaries	ESCOs, Building/Facility Managers
Relevant BS	BS_8: EPC optimization through real-time monitoring and improvement of energy performance of buildings, as well as, through predictive maintenance of building assets

Continuous optimization of building energy performance and self-consumption maximization through the utilization of the Digital Twin concept	
Use Case Id	UC_E_6.5
Description	In case of utilization or existence of RES, storage and other energy flexibility sources (EVs) in a building facility, facility/building managers would benefit from intelligent support tool to design control strategies to maximize self-consumption and to reduce energy costs, without compromising occupants' requirements for comfort, by means of proper management of energy flexibility assets. To this end Digital Twin Tools are needed that will utilize actual data streams (and associated forecasts) from buildings and their assets, simulate alternative control strategies and select the most efficient ones, which will be further enhanced with functionalities to assess and design control strategies for managing the energy flows of energy generation and storages against multi-objectives targets (energy, cost and comfort) and with flexibility analytics.
Beneficiaries	ESCOs, Building/Facility Managers
Relevant BS	BS_8: EPC optimization through real-time monitoring and improvement of energy performance of buildings, as well as, through predictive maintenance of building assets BS_11: Energy costs savings with preservation of well-being preferences through the deployment of personalized and advanced human-centric energy services incl. self-consumption

Personalized energy analytics and awareness of energy consumption characteristics	
Use Case Id	UC_E_6.6
Description	Reduction of energy costs and elimination of energy wastes, requires consumers to have an excellent understanding and valuable insights on their energy consumption patterns and characteristics. This requires appropriate tools and comprehensive dashboards that include simplified visualizations that will allow consumers to understand how and when they consume energy, where they stand in comparison with consumers of similar profiles and identify weak points of their energy performance. This will help them to better define appropriate actions towards energy savings in an informed and effective manner. In this sense, energy analytics provided to energy consumers need to be

	equipped with powerful personalization features, that will allow the consumer to accurately recognize the constituents of his/her energy behaviour, identify what can be improved and receive personalized guidance on how they can optimally control individual devices to reduce their energy consumption. This way they will be able to make informed (and guided) decisions to alter their energy behaviours and through a progressive interaction process with respective apps to sustainably adopt long-lasting energy-efficient ones.
Beneficiaries	Building occupants, Energy suppliers/retailers
Relevant BS	BS_11: Energy costs savings with preservation of well-being preferences through the deployment of personalized and advanced human-centric energy services incl. self-consumption BS_15: Increased profitability and long-term sustainability through the transformation of their business-as-usual to data and intelligence-driven Energy-as-a-Service offerings

Smart control functions including human-centric features for energy and non-energy services	
Use Case Id	UC_E_6.7
Description	The increasing digitalization of the building sector provides significant opportunities for the automation of their operation through the utilization of IoT devices and controllers. Automation, though, is not a no-regret option. In order for a solution to be acceptable by the building occupants, it needs to respect their comfort preferences and avoid disrupting their daily schedules by being highly intrusive. Independently of the scope that automation features are introduced (either for energy savings and demand response or for non-energy purposes like comfort preservation and security enhancement), they need to always safeguard the occupants' requirements for convenience and well-being and properly balance energy savings or flexibility provision with such requirements in a human-centric manner. In this building occupants are in need of intelligent solutions that enable the human-centric operation of their loads (mainly HVAC). Such solutions shall enable full and non-intrusive operation of their HVAC loads by preserving their thermal comfort, while offering additional features for remote control and scheduling, so as to give occupants the opportunity and the power to intervene and retain control over their loads. Human-centric features will also safeguard the interests of business actors like aggregators and retailers (providing Demand Response and Energy Efficiency services in an automated manner) by ensuring non-overriding of the strategies they deploy and increased acceptance of control actions from the side of building occupants, thus allowing them to realize their business functions (flexibility provision to network operators from aggregators/ compliance with energy efficiency obligations and

	imbalance avoidance on the side of retailers) through the deployment of highly effective control strategies with reduced risk of being rejected and leading to associated penalties.
Beneficiaries	Building occupants, Energy suppliers/retailers
Relevant BS	BS_13: Improved profitability through utilization of the unleashed flexibility potential of the building sector BS_15: Increased profitability and long-term sustainability through the transformation of their business-as-usual to data and intelligence-driven Energy-as-a-Service offerings

Consumer-Centric Demand Response Optimization (automation)	
Use Case Id	UC_E_6.8
Description	The optimization of flexibility delivered by building assets allows the creation of new direct revenue for building end-users, through provisioning the flexibility-based ancillary service to other market participants via aggregator intermediaries. To do so, building managers need to gain and maintain better insight into their current flexibility portfolio. The appropriate flexibility evaluation centred on the consumer behaviour ensures the utilization of maximum amount of flexibility that does not jeopardize the user comfort, nor does it threaten the proper functioning of the building assets. The consumer-centric demand response optimization targets building managers, creating new revenue streams by delivering flexibility services to third parties by means of an aggregator. The flexibility service user may be the network operator seeking to resolve and optimize the operational network condition, however depending on the local market environment, the flexibility service user can also be a balance group operator or another market participant. The delivery of flexibility to business actors requires appropriate automation tools that can easily interpret high-level flexibility requests into specific control commands over specific loads, so as to provide the required flexibility in a non-intrusive manner. Also, the calculation of context-aware flexibility profiles will ensure that demand response strategies are always defined in a consumer-centric manner, aiming at delivering the requested flexibility without compromising human comfort or daily schedules.
Beneficiaries	Building occupants, Building/Facility Managers, Aggregators
Relevant BS	BS_12: Creation of new revenues through flexibility provision for ancillary services

Flexibility Analytics and VPP Configuration	
Use Case Id	UC_E_6.9
Description	Flexibility optimization delivered by a portfolio of different building assets accompanied by Virtual Power Plant (VPP) configuration

	maximizes the revenue creation space of the demand response aggregators, respecting at the same time operational and contractual limits. Aggregators need to gain better insight into their end-users' flexibility portfolio to fully exploit the flexibility potential. Flexibility segmentation, classification and clustering provide appropriate matching of the available flexibility resources, while ensuring their smooth operation under evolving conditions, and enabling the optimal utilization of flexibility and optimized creation of revenue at the same time. By performing flexibility analytics, the aggregators increase their level of insight into the selected flexibility made available by building managers/consumers within the buildings' portfolio. The flexibility analytics and VPP configuration models shall be directed towards meeting the request of the flexibility users, such as network operators, and shall consider: (i) flexibility characteristics (capacity, duration, ramp up/down time, shifting, shedding etc.) in terms of suitability for specific services; (ii) contractual parameters (from contracts signed between consumers/prosumers and aggregators) referring to number of activations, remuneration amount, etc. (iii) selected flexibility made available by consumers/prosumers. The aggregators should be able to ensure optimal clustering of flexibility sources into VPP configuration, while monitoring the flexibility provisioned by building assets. Additionally, aggregators should be able to properly forecast their aggregate flexibility portfolio on a day-ahead or shorter term as VPP. The optimization of VPP considers shedding or shifting demand away from the peak hours. The real-time service provided by the aggregators allows provisioning of ancillary services and direct flexibility trading on the energy market. The VPP configuration includes monitoring to keep the flexibility portfolio up to date and reconfigure it as needed.
Beneficiaries	Building occupants, Building/Facility Managers, Aggregators, Network Operators
Relevant BS	BS_13: Improved profitability through utilization of the unleashed flexibility potential of the building sector

Retailer portfolio analytics for elasticity estimation and extraction of useful insights	
Use Case Id	UC_E_6.10
Description	The increase in the revenue streams through the diverse billing strategies applied in the energy contracts is a major priority for the business objectives for diverse stakeholders. Such efforts are paramountly expanding as consumers are aware of the services of such utilities. Thus, it is becoming clearer that for energy retailers reaching the next level in acquiring a holistic view and respective insights, will require an improved understanding of consumers'

	behaviour. It is widely proven that high demand peaks have an even higher energy generation cost, which has to be considered in the final electricity price set by the retailer. Thus, energy retailers are often tasked with developing effective global pricing strategies for customers characterized by different energy behaviour. The challenges of formulating customer-oriented pricing schedules are especially evident in global verticals for service offerings, where intensive customer contact, extensive customization requirements, and reliance on extrinsic cues for service quality make pricing particularly complex. Customer Segmentation is considered as a paramountly beneficial strategy for delivering utilities and services with different prices and aspects to the diverse types of customers. This is due to the fact that the pricing strategy is proven to increase the overall profit and revenue through sales-driven and demand-oriented customer acquisition and, as a consequence, expand Customer Loyalty and Lifetime Value (CLTV). Energy Retailers necessitate initiatives on the delivery of respective insights over highly populated building customers through identifying different discrete customer behaviour with Customer Segmentation. Based on these insights, the design of dynamic electricity pricing allocation can be implemented. In more detail, this customer segmentation can incorporate the flexibility of the customer demand and the customer elasticity in the price modifications/fluctuations in order to sort the price and energy imbalances between the Network Operator and the Energy Retailer. These tools utilize historic transactional customer behaviour in the Energy Retailer ecosystem, spatio-temporal patterns (seasonality, weekday vs weekend) and demographic information for each individual customer in order to significantly reduce demand variances and localize different types of trends and outliers of a particular behaviour and enable the valuable knowledge reception for the design and delivery of added-value services per customer or per a cluster of customers. The clustering criteria can be energy flexibility, elasticity, customer region, contracted power etc. Thus, Energy Retailers can benefit from the aforementioned customized services that can deliver a more satisfactory energy bill, directly to the end-user.
Beneficiaries	Energy suppliers/retailers
Relevant BS	BS_14: New revenues through provision of services to Network Operators (Implicit DR) and avoidance of unnecessary charges through imbalance management

Elasticity utilization in demand response and imbalance reduction strategies	
Use Case Id	UC_E_6.11
Description	Retailers need to gain better insight on the elasticity of their customers' demand so as to design and deploy better pricing strategies for demand response programs and increase their profit.

	That's because customers intentionally modify their electricity consumption patterns as a response to price fluctuation. Moreover, they may face extra costs to compensate for possible imbalances between the forecasted energy consumption of their portfolio and the actual supply from the network. This requires the right tools to analyse relevant data and present them in an intuitive way, in order to lead retailers to the right decisions about their portfolio management. In this context, retailers need to obtain knowledge about the elasticity of individual consumers/customers, as well as groups of them in varying energy prices. Such information will offer valuable input to retailers towards properly defining implicit demand response strategies (price-based) so as to hedge against anticipated imbalances and avoid relevant (extraordinary) charges, while giving them the opportunity to comply with Energy Efficiency Obligations that are imposed by regulation. Through advanced elasticity analytics and segmentation/ clustering of their customer portfolio, they will have the opportunity to launch dynamic pricing schemes, properly reflecting price fluctuations in overlay wholesale markets (in a way to optimize exposure to associated risks), while further extending them for hedging against forecasting errors based on actual data coming from their clientele. In that way, they will be able to communicate appropriate and effective pricing signals (implicit demand response signals) to single customers or clusters of them to optimize their business operations. In addition, through such analytics and optimization functions they will, in the future, gain the opportunity to get engaged in transactions with network operators and get involved in the provision of balancing services with focus on reducing their clientele demand in peak periods and, therefore, the energy generation costs. Also, based on the results of customers' forecasted demand and generation, market prices and the elasticity of both demand and price, retailers will be equipped with the tools to be prepared for the day-ahead bidding of the required amount of electricity, thus further reducing the risk of imbalances.
Beneficiaries	Energy suppliers/retailers, Building occupants, Network Operators
Relevant BS	BS_14: New revenues through provision of services to Network Operators (Implicit DR) and avoidance of unnecessary charges through imbalance management

Non-energy Services for Comfort, Well-being and Security	
Use Case Id	UC_E_6.12
Description	Modern societies are characterized by high urbanization. This reality, associated also with the fact that people spend most of their time in indoor environments introduces special requirements for ensuring that such environments safeguard the well-being of building occupants (ideally without increasing energy consumption in buildings). In such a context building occupants need solutions that

	will improve their well-being and optimize indoor comfort conditions when at home, while safeguarding security of themselves and their property. Such solutions shall properly balance energy performance with comfort and health aspects by properly analysing a wealth of data coming from smart devices and, subsequently, regulating their control to achieve the sweet spot between, often, conflicting energy and well-being requirements. This shall be achieved through human-centric automation over major comfort and health-related loads (HVAC). Moreover, such solutions shall ensure the satisfaction of security requirements of consumers through scheduling the operation of lighting devices when at or absent from home. Such new services can be provided by retailers as a means for differentiating their business offering and transforming their business model from commodity providers to Energy-as-a-Service providers, without profound benefits in profitability and future sustainability, that is currently hindered by competition and slashing of profits generated from energy sales. The provision of such added value services can be considered as a game-changer for retailers to introduce themselves into the service market and expand their offerings in domains that go beyond energy.
Beneficiaries	Energy suppliers/retailers, Building occupants
Relevant BS	BS_15: Increased profitability and long-term sustainability through the transformation of their business-as-usual to data and intelligence-driven Energy-as-a-Service offerings

5 Requirement Analysis

5.1 Methodology

In this section, the BEYOND list of business and end-user requirements will be finalized according to the description of the Use Cases and the results of the end-user survey conducted with the circulation of a relevant questionnaire.

"A requirement is a statement which translates or expresses a need and its associated constraints and conditions with the purpose to transform through their analysis the stakeholder, requirement-driven view of desired services into a technical view of a required product that could deliver those services." [1]

To this direction, a well-formed requirement needs to be "SMART": Specific – Measurable – Attainable – Relevant – Timely. The aim of the requirements elicitation process is to consolidate a set of requirements that:

- Ensure a common understanding between different stakeholders;
- Represent real-world needs for the whole electricity data value chain;
- Provide a concrete basis to guide the design and development activities.

The syntax of each requirement shall use a combination of the following syntax elements: Subject (typically the solution or the system) - Action - Object - Value - Constraint - Condition. Besides the main characteristics of a well-formed requirement, a number of linguistic parameters need to be adopted to streamline the style and increase the homogeneity of expression, as described in the following table:

TABLE 5-1: LINGUISTIC PARAMETERS IN THE REQUIREMENT FORMAT

Linguistic Parameters	Keyword
When a requirement is mandatory	"shall"
When a requirement defines desired / recommended features or preferences	"should"
When a requirement refers to a suggestion or allowance	"may"
Non-requirements (normal verbs, avoid "must" and "will")	-
Use positive statements and avoid negative requirements	-
Use active voice	-
Avoid: subjectivity, superlatives, vagueness, ambiguity, non-verifiable terms, comparison, loopholes, incompletion	-

5.2 Business requirements

In general, requirements can be categorised in many ways and the terminology is often used inconsistently. The business requirements need to state "what" is needed from BEYOND (as a whole) in terms of specific business (and functionality) needs.

The business requirements will be expressed with a list of generic functionalities of the BEYOND solution that can be derived by the description of the Use Cases. In that sense, each requirement is presented with its relevant Use Cases.

The requirements engineering process in BEYOND anticipated the following phases:

I. Iterative extraction of business requirements from the UC leaders (with support by Suite5 and Ubitech) based on the UC descriptions;
II. Discussion and assessment of the technical feasibility of the requirements by the technical partners through technical meetings;
III. Prioritization of the business requirements by the UC leaders once a complete list is available. This was performed with the indicator "1" when the requirement "shall" be satisfied, "2" when it "should" be satisfied and "3" when it "may" be satisfied;
IV. Numbering of each requirement.

We should note here, that in the second version of this document the business requirements are revised according also to what has been stated in D2.6 and the overall progress of all the business applications after resolving priorities with the relevant stakeholders.

Req_id	Description	Priority	Relevant WPs	Relevant UCs
Req_001	The BEYOND solution shall perform data validation operations on data owners' data assets, prior to being stored	1	WP3	UC_D_3.1
Req_002	The BEYOND solution shall perform data cleansing operations on data owners' data assets, prior to being stored	1	WP3	UC_D_3

				.1
Req_003	The BEYOND solution shall perform data completion operations on data owners' data assets, prior to being stored	1	WP3	UC_D_3.1
Req_004	The BEYOND solution shall harmonize and save all collected data assets under a common data model	1	WP3	UC_D_3.1
Req_005	The BEYOND solution shall provide a common data model considering existing energy standards and models	1	WP3	UC_D_3.1
Req_006	The BEYOND solution shall provide an intuitive user interface enabling data owners to semi-automatically map their data assets to the concepts of the common data model during the ingestion process	1	WP3	UC_D_3.1
Req_007	The BEYOND solution shall enable data owners during the data collection process, to manual edit the mappings of each concept of their data asset to the attributes of the BEYOND common data model	1	WP3	UC_D_3.1
Req_008	The BEYOND solution shall undertake all data transformation of a data asset's concepts (related to measurement units, datetime format and timezones, geographical coordinates, etc.) in accordance with the BEYOND common data model	1	WP3	UC_D

				_3.1
Req_009	The BEYOND solution shall enable data owners to define the data transformation rules that are to be performed in the concepts of their data asset	1	WP3	UC_D_3.1
Req_010	The BEYOND solution shall allow data owners to semantically enrich their data assets with additional information (i.e. code lists) and semantics	1	WP3	UC_D_3.2
Req_011	The BEYOND solution shall allow data owners to link their data assets to other data assets	1	WP3	UC_D_3.2
Req_012	The BEYOND solution shall allow data owners to query data that is in linked format	1	WP3	UC_D_3.2
Req_013	The BEYOND solution shall allow data owners to create composite data assets by merging existing data assets that are already stored in the system	3	WP3	UC_D_3.2

Req_014	The BEYOND solution should provide a preview of a composite data asset prior to creating it	3	WP3	UC_D_3.2
Req_015	The BEYOND solution shall enable the instant collection of data from the APIs exposed by the data owner's systems	1	WP3	UC_D_3.3
Req_016	The BEYOND solution shall enable the periodic collection of data from the APIs exposed by the data owner's systems	1	WP3	UC_D_3.3
Req_017	The BEYOND solution shall enable data owners to specify the retrieval schedule of data from the APIs exposed by their systems	1	WP3	UC_D_3.3
Req_018	The BEYOND solution shall enable data owners to specify the retrieval schedule of data from Open Data APIs	1	WP3	UC_D_3.3
Req_019	The BEYOND solution shall allow a data owner to set-up multiple and concurrent data collection jobs	1	WP3	UC_D_3

				.3
Req_020	The BEYOND solution shall notify the data owner on the result of each data collection execution	1	WP3	UC_D_3.3
Req_021	The BEYOND solution shall ensure the secure and safe transfer of shared data (end-to-end encryption) between the data producer and the data consumer	1	WP3	UC_D_3.4
Req_022	The BEYOND solution shall allow the data producer to define data anonymization rules	1	WP3	UC_D_3.4
Req_023	The BEYOND solution may ensure the integrity of the data transferred with the establishment of transparent rules (software based remote attestation)	3	WP3	UC_D_3.4
Req_024	The BEYOND solution shall allow data access to stakeholders based on their access details in their contract	1	WP3	UC_D_3.4
Req_025	The BEYOND solution may support data quality and data provenance of the exchanged data assets	3	WP3	UC_D

				_3.4
Req_026	The BEYOND solution shall allow the data provider to design and configure on-demand data access policies	1	WP3	UC_D_3.4
Req_027	The BEYOND solution may allow the data provider to design and provide guidelines for data pre-processing	3	WP3	UC_D_3.4
Req_028	The BEYOND solution should allow a data provider to select where the data he provides will be stored and processed (on-premises or on the cloud)	2	WP3	UC_D_3.4
Req_029	The BEYOND solution shall provide data owners with analytics services, to be utilised on their organizations' collected data	1	WP4	UC_D_4.1
Req_030	The BEYOND solution shall enable data owners to choose from a list of AI algorithms and apply them to their collected data	1	WP4	UC_D_4.1

Req_031	The BEYOND solution shall allow the users to select specific columns from a data asset and feed them into a AI algorithm	1	WP4	UC_D_4.1
Req_032	The BEYOND solution shall enable the users to configure the execution parameters of the available AI algorithms	1	WP4	UC_D_4.1
Req_033	The BEYOND solution shall enable data owners to run analytics to their data assets utilising a cloud-hosted environment	1	WP4	UC_D_4.1
Req_034	The BEYOND solution shall enable data owners to run analytics to their data assets utilising on-premises environment	1	WP4	UC_D_4.1
Req_035	The BEYOND solution shall ensure the security and privacy of the data assets utilised in the analytics services	1	WP4	UC_D_4.1
Req_036	The BEYOND solution shall enable the on-premises utilization of data assets to which authorized users have been granted access	1	WP4	UC_D_4

				.2
Req_037	The BEYOND solution shall enable data owners to share their own organization's data assets, with other BEYOND data owners (i.e. Organizations)	1	WP4	UC_D_4.2
Req_038	The BEYOND solution shall enable users to enrich their datasets by combining them with different external data assets to which they have been granted access and are owned by different data owners	1	WP4	UC_D_4.2
Req_039	The BEYOND solution shall enable the users to enforce their preferred access policies on the data they own	1	WP4	UC_D_4.2
Req_040	The BEYOND solution should enable the on-premises encryption of data assets, which are considered as private, and to which authorized users have been granted access	2	WP4	UC_D_4.2
Req_041	The BEYOND solution shall provide to the users an on-site secure data storage space	1	WP4	UC_D_4.2
Req_042	The BEYOND solution shall provide data owners and consumers with analytics services, which make also use of third party (external) data sources and analyses	1	WP4	UC_D

				_4.3
Req_043	The BEYOND solution shall enable data consumers to request a dataset available in BEYOND and owned by another user (organization)	1	WP4	UC_D_4.3
Req_044	The BEYOND solution shall allow data owners to approve or deny sharing their owned data asset(s), when requested by other users	1	WP4	UC_D_4.3
Req_045	The BEYOND solution shall enable data consumers to use data assets belonging to various data owners in their analytics, when a valid signed contract foresees it	1	WP4	UC_D_4.3
Req_046	The BEYOND solution shall enable its users to share/exchange their data assets with third parties, by generating data asset sharing contracts	1	WP4	UC_D_4.4
Req_047	The BEYOND solution may enable authorized representatives of organizations to choose whether a data asset sharing contract will be based on predefined templates or a new one to be created	3	WP4	UC_D_4.4

Req_048	The BEYOND solution shall allow users to define and edit the terms of a contract in which their organization is involved, prior to signing the data asset sharing contract	1	WP4	UC_D_4.4
Req_049	The BEYOND solution shall allow users to approve or reject changes on the terms of an asset contract in which their organization is involved, prior to signing the data asset sharing contract	1	WP4	UC_D_4.4
Req_050	The BEYOND solution may enable data users to replace their organization's private data assets under certain conditions, adhering always to the terms of the respective data asset sharing contract(s)	3	WP4	UC_D_4.4
Req_051	The BEYOND solution shall enable users to withdraw from a negotiation process over a data asset, prior to signing the data asset sharing contract	1	WP4	UC_D_4.4
Req_052	The BEYOND solution shall enable the authorized representatives of organizations involved in a transaction to sign the data sharing asset contract	1	WP4	UC_D_4.4
Req_053	The BEYOND solution shall save the data transaction operations and signed data sharing contracts in an immutable list	1	WP4	UC_D_4

				.4
Req_054	The BEYOND solution shall enable the authorized representatives of organizations involved in a data asset sharing contract to download the signed contract as a file	1	WP4	UC_D_4.4
Req_055	The BEYOND solution shall provide the prescribed remuneration mechanisms according to the signed data asset sharing contract	1	WP4	UC_D_4.4
Req_056	The BEYOND solution shall align the permissible actions over a data asset with the terms of the relevant signed contract through the BEYOND services, as long as those terms are relevant to the platform's features	1	WP4	UC_D_4.4
Req_057	The BEYOND solution shall provide data owners with a blockchain-powered data marketplace in order for them to trade their data in return for a predefined and agreed remuneration	1	WP4	UC_D_4.5
Req_058	The BEYOND solution shall ensure that all data trading services adhere to the terms defined in a relevant signed data asset sharing contract	1	WP4	UC_D_4.5
Req_059	The BEYOND solution may provide an appropriate remuneration mechanism based on the relevant signed data asset sharing contract	3	WP4	UC_D

				_4.5
Req_060	The BEYOND solution shall ensure the transparency of all data transactions, adhering to the applicable data access policies	1	WP4	UC_D_4.5
Req_061	The BEYOND solution shall guarantee the completion of the different transactions, adhering to the terms of the relevant signed data asset sharing contract	1	WP4	UC_D_4.5
Req_062	The BEYOND solution should save all the data transactions and the respective data asset sharing contracts in an immutable manner	2	WP4	UC_D_4.5
Req_063	The BEYOND solution may enable users to export/download all the data transactions related to their account as a file	3	WP4	UC_D_4.5
Req_064	The BEYOND solution shall enable the flow of remuneration between the wallets of the parties taking part in a data asset sharing contract	1	WP4	UC_D_4.5

Req_065	The BEYOND solution shall allow data brokers to come into contract with the various data asset owners through data asset sharing contracts	1	WP4	UC_D_4.6
Req_066	The BEYOND solution shall enable data brokers to access and trade data assets acquired from various data owners and external sources based on the terms of a signed data contract	1	WP4	UC_D_4.6
Req_067	The BEYOND solution shall semi-automatically execute data contracts between data owners and consumers in order to fully exploit their data asset sharing assets	1	WP4	UC_D_4.6
Req_068	The BEYOND solution shall provide data brokers and consumers with multi-source analytics services utilising data assets of various data owners and external sources	1	WP4	UC_D_4.7
Req_069	The BEYOND solution shall enable to data brokers and consumers to trade the results of the analytics services	1	WP4	UC_D_4.7
Req_070	The BEYOND solution shall provide data brokers and data consumers with on demand analytics services	1	WP4	UC_D_4

				.7
Req_071	The BEYOND solution shall provide data consumers with analytics as-a service	1	WP4	UC_D_4.7
Req_072	The BEYOND solution shall enable data consumers to browse through all the available assets that can be obtained by their organization	1	WP4	UC_D_4.8
Req_073	The BEYOND solution shall provide suggestions to data consumers regarding additional datasets based on their search queries	1	WP4	UC_D_4.8
Req_074	The BEYOND solution shall provide suggestions to data consumers regarding relevant or similar datasets, based on their search queries	1	WP4	UC_D_4.8
Req_075	The BEYOND solution should offer data consumers a data asset request service, to declare their interest for specific data assets	2	WP4	UC_D_4.8
Req_076	The BEYOND solution should provide to data consumers notifications of data requests placed over the BEYOND platform, so they can identify possible matchmaking opportunities	2	WP4	UC_D

				_4.8
Req_077	The BEYOND solution shall provide the data consumers with a search query interface	1	WP4	UC_D_4.9
Req_078	The BEYOND solution shall allow users to search for available external data assets based on the search queries parameters (filters) they prefer	1	WP4	UC_D_4.9
Req_079	The BEYOND solution shall allow users to search for available external data assets based on the assets' metadata	1	WP4	UC_D_4.9
Req_080	The BEYOND solution should allow users to search for data assets available on the BEYOND platform based on the assets' content	3	WP4	UC_D_4.9
Req_081	The BEYOND solution should provide suggestions to the data consumers of external organizations that own data assets relevant to their performed search query	2	WP4	UC_D_4.9

Req_082	The BEYOND solution shall provide the data consumers with a data asset collection interface	1	WP4	UC_D_4.9
Req_083	The BEYOND solution shall enable users to select the method of collection (e.g., through APIs, simple file upload, etc.) of the data asset they require	1	WP4	UC_D_4.9
Req_084	The BEYOND solution shall enable users to collect data assets of different formats (csv, json, xml)	1	WP4	UC_D_4.9
Req_085	The BEYOND solution shall enable users to configure the retrieval schedule for the data to be collected (e.g. immediately, daily, weekly, on specific date and time, etc)	1	WP4	UC_D_4.9
Req_086	The BEYOND solution shall enable simulation of different optimisation scenarios and parameters such as energy performance improvement needs, occupancy profiles, energy use scenarios, comfort profile of building occupants, available budget, etc.	1	WP5	UC_E_5.1
Req_087	The BEYOND solution should recommend the most cost-optimal renovation measures based on simulation results	2	WP5	UC_E_5

				.1
Req_088	The BEYOND solution should provide as accurate as possible an estimation of building energy performance generated by the selected renovation measures at the design phase based on accurate occupants' comfort profiles	2	WP5	UC_E_5.1
Req_089	The BEYOND solution should show the real & simulated energy performance of buildings before and after the implementation of renovation measures	2	WP5	UC_E_5.2
Req_090	The BEYOND solution shall provide a comparative analysis and visualisation of building energy performance before and after implementation of renovation	1	WP5	UC_E_5.2
Req_091	The BEYOND solution shall forecast demand in network in different temporal granularity	1	WP5	UC_E_5.3
Req_092	The BEYOND Solution shall forecast generation in network in different temporal granularity	1	WP5	UC_E_5.3
Req_093	The BEYOND solution shall provide a detailed network model including demand and generation forecasting	1	WP5	UC_E

				_5.3
Req_094	The BEYOND solution may enable the identification of the specific weakness of the network	3	WP5	UC_E_5.3
Req_095	The BEYOND solutions shall calculate a variety of network quality KPIs at different spatio-temporal granularity	1	WP5	UC_E_5.3
Req_096	The BEYOND solution may enable the characterization of weaknesses towards pointing out to the most suitable mitigation actions (infrastructure investment vs flexibility triggering)	3	WP5	UC_E_5.3
Req_097	The BEYOND solution shall forecast demand in network in the long term	1	WP5	UC_E_5.4
Req_098	The BEYOND solution shall forecast generation in network in the long term	1	WP5	UC_E_5.4

Req_099	The BEYOND solution shall be able to simulate different scenarios implementing several network upgrades	1	WP5	UC_E_5.4
Req_100	The BEYOND solution may provide an in-depth analysis of the weak points of the network, pointing out to specific reinforcement needs	3	WP5	UC_E_5.4
Req_101	The BEYOND solution may allow identify the points/ locations of the network that need to be reinforced	3	WP5	UC_E_5.4
Req_102	The BEYOND solution may recommend the most optimal network improvements	3	WP5	UC_E_5.4
Req_103	The BEYOND solution should enable the simulation of alternative network expansion scenarios	2	WP5	UC_E_5.4
Req_104	The BEYOND solution shall enable comparative analysis of alternative reinforcement/expansion scenarios based on selected KPIs	1	WP5	UC_E_5

				.4
Req_105	The BEYOND solution shall enable the calculation of network Quality of Service KPIs	1	WP5	UC_E_5.4
Req_106	The BEYOND solution shall analyse and cluster the customers of the network	1	WP5	UC_E_5.5
Req_107	The BEYOND solution shall identify the flexibility that can be offered by each customer group at aggregated level	1	WP5	UC_E_5.5
Req_108	The BEYOND solution should allow new customers to be associated with one of the defined customer groups	2	WP5	UC_E_5.5
Req_109	The BEYOND solution shall enable the identification of available flexibility at different spatial granularity	1	WP5	UC_E_5.5
Req_110	The BEYOND solution shall enable the identification of available flexibility at different temporal granularity	1	WP5	UC_E

				_5.5
Req_111	The BEYOND solution shall enable the forecasting of flexibility in the short-term	1	WP5	UC_E_5.5
Req_112	The BEYOND solution may provide analysis of the characteristics of available flexibility (duration, responsiveness, capacity)	3	WP5	UC_E_5.5
Req_113	The BEYOND solution shall forecast demand in network in the very-short term	1	WP5	UC_E_5.6
Req_114	The BEYOND solution shall forecast generation in network in the very-short term	1	WP5	UC_E_5.6
Req_115	The BEYOND solution shall be able to simulate different network operation scenarios taking into account the available flexibility in the network	1	WP5	UC_E_5.6

Req_116	The BEYOND solution shall allow the simulation for different time granularity depending on the forecasts	1	WP5	UC_E_5.6
Req_117	The BEYOND solution shall provide the most robust operational planning solution and flexibility triggering needs	1	WP5	UC_E_5.6
Req_118	The BEYOND solution shall be able to simulate different planning scenarios taking into account different growth in demand and generation	1	WP5	UC_E_5.6
Req_119	The BEYOND solution may forecast demand in selected areas of the city	3	WP5	UC_E_5.7
Req_120	The BEYOND solution may forecast generation in selected areas of the city	3	WP5	UC_E_5.7
Req_121	The BEYOND solution may consider flexibility forecasts in simulation of different strategies	3	WP5	UC_E_

				5.7
Req_122	The BEYOND solution shall allow for the design of alternative planning strategies	1	WP5	UC_E_5.7
Req_123	The BEYOND solution shall allow for comparing the impact achieved through the simulation of alternative actions and strategies	1	WP5	UC_E_5.7
Req_124	The BEYOND solution shall allow the calculation of a variety of Impact Indicators in relation to simulated strategies	1	WP5	UC_E_5.7
Req_125	The BEYOND solution shall allow the assessment of specific actions over the city's energy performance	1	WP5	UC_E_5.7
Req_126	The BEYOND solution should provide a consumption pattern of the territory concerned	2	WP5	UC_E_5.7
Req_127	The BEYOND solution should be able to simulate the impact of an energy action on consumption pattern	2	WP5	UC_

				E_5.7
Req_128	The BEYOND solution shall allow the monitoring of demand in selected areas	1	WP5	UC_E_5.8
Req_129	The BEYOND solution may allow the monitoring of generation in selected areas	3	WP5	UC_E_5.8
Req_130	The BEYOND solution shall allow the real-time assessment of the performance of specific areas of the city against key performance indicators	1	WP5	UC_E_5.8
Req_131	The BEYOND solution should provide a consumption pattern of the territory concerned	2	WP5	UC_E_5.8
Req_132	The BEYOND solution should be able to simulate the impact of an energy action on consumption pattern	2	WP5	UC_E_5.8

Req_133	The BEYOND solution should enable monitoring of the implementation of the energy action plan	2	WP5	UC_E_5.8
Req_134	The BEYOND solution shall support capture of real-life data streams and appropriate analytics for monitoring in real-time the energy certification and investment optimization	1	WP6	UC_E_6.1
Req_135	The BEYOND solution shall enable generation of the Display Energy Certificates that allows buildings' compliance against energy efficiency commitments	1	WP6	UC_E_6.1
Req_136	The BEYOND solution shall enable the visualization of real-life data streams and analyse it against need and requirements	1	WP6	UC_E_6.1
Req_137	The BEYOND solution shall provide, analyse and visualise a set of outliers that affect energy performance and support energy management decision making process	1	WP6	UC_E_6.1
Req_138	The BEYOND solution shall gather general information on the building and its technical building systems	1	WP6	UC_E_6

				.2UC_E_6.1
Req_139	The BEYOND solution shall identify the functionality level for each service running in the building	1	WP6	UC_E_6.2
Req_140	The BEYOND solution shall have visual presentation on calculation results	1	WP6	UC_E_6.2UC_E_6.1
Req_141	The BEYOND solution shall provide possibility for user defined weighting factors	1	WP6	UC_E_6.2UC_E

				_6.1
Req_142	The BEYOND solution shall make a list with all smart ready services and their functionality levels and provide possibility for users to include or exclude particular service	1	WP6	UC_E_6.2UC_E_6.1
Req_143	The BEYOND solution shall provide with further details on the various services including the provisional impact scores for each of the services levels	1	WP6	UC_E_6.2UC_E_6.1
Req_144	The BEYOND solution shall make sure to gather end-users' feedback on SRI assessment	1	WP6	UC_E_6.2UC

				_E_6.1
Req_145	The BEYOND solution should support capture of real-life data streams and provide analytics for monitoring in real-time the energy performance of facilities/ buildings	2	WP6	UC_E_6.3UC_E_6.1
Req_146	The BEYOND solution shall assess real-time building energy performance against different KPI (such as generation, consumption, storage, HVAC components, air quality) to ensure energy performance against EPC targets	1	WP6	UC_E_6.3
Req_147	The BEYOND solution shall enable the visualization of energy data flowing from building assets, along with forecasts of anticipated building energy performance	1	WP6	UC_E_6.3
Req_148	The BEYOND solution should support identification of different effective energy management strategies for energy performance improvement	2	WP6	UC_E_6.3

Req_149	The BEYOND solution shall provide, analyse and visualise a set of KPIs, outlining, energy and reliability indicators to monitor energy performance of building	1	WP6	UC_E_6.3
Req_150	The BEYOND solution should retrieve data from installed HVAC systems and compare HVAC system performance against configured HVAC system performance targets	2	WP6	UC_E_6.4
Req_151	The BEYOND solution should identify discrepancies between actual performance and configured HVAC system performance targets	2	WP6	UC_E_6.4
Req_152	The BEYOND solution may make sure that AI algorithms to learn from past HVAC system performance discrepancies, the causes of these discrepancies, and implemented corrective actions	3	WP6	UC_E_6.4
Req_153	The BEYOND solution may predict maintenance interventions and recommend proactive maintenance actions	3	WP6	UC_E_6.4
Req_154	The BEYOND solution shall provide a digital twin of the asset/building/space incorporating all available energy sources to the asset/building/space	1	WP6	UC_E_6

				.5
Req_155	The BEYOND solution should make use of optimisation and simulation models and tools to maximize self-consumption and to reduce energy costs, without compromising occupants' requirements for comfort, by means of proper management of energy flexibility assets	2	WP6	UC_E_6.5
Req_156	The BEYOND solution should utilize actual data streams (and associated forecasts) from buildings and their assets, simulate alternative control strategies under multi-objective targets (energy, cost, comfort, flexibility)	2	WP6	UC_E_6.5
Req_157	The BEYOND solution shall identify the optimal control strategy for building performance optimisation and self-consumption maximisation based on control strategy simulations	1	WP6	UC_E_6.5
Req_158	The BEYOND solution should enable transfer of the optimal control strategy based on simulations to the energy sources and systems of the asset/building/space to ensure maximisation of self-consumption, and reduction in energy costs, without compromising occupants' requirements for comfort	2	WP6	UC_E_6.5
Req_159	The BEYOND solution shall provide visualization of historical energy consumption data	1	WP6	UC_E_6.6
Req_160	The BEYOND solution shall provide visualization of historical energy consumption data on a daily basis (per hour)	1	WP6	UC_E

				_6.6
Req_161	The BEYOND solution shall provide visualization of historical energy consumption data on a weekly basis (per day)	1	WP6	UC_E_6.6
Req_162	The BEYOND solution shall provide visualization of historical energy consumption data on a monthly basis (per week and day)	1	WP6	UC_E_6.6
Req_163	The BEYOND solution shall provide visualization of historical energy consumption data on a yearly basis (per month)	1	WP6	UC_E_6.6
Req_164	The BEYOND solution shall provide visualization of historical energy cost data on a daily basis (per hour)	1	WP6	UC_E_6.6
Req_165	The BEYOND solution shall provide visualization of historical energy cost data on a weekly basis (per day)	1	WP6	UC_E_6.6

Req_166	The BEYOND solution shall provide visualization of historical energy cost data on a monthly basis (per week and day)	1	WP6	UC_E_6.6
Req_167	The BEYOND solution shall provide visualization of historical energy cost data on a yearly basis (per month)	1	WP6	UC_E_6.6
Req_168	The BEYOND solution shall provide a snapshot of energy consumption for the last hour	1	WP6	UC_E_6.6
Req_169	The BEYOND solution shall provide a snapshot of energy costs for the last hour	1	WP6	UC_E_6.6
Req_170	The BEYOND solution shall provide a snapshot of thermal comfort for the last hour	1	WP6	UC_E_6.6
Req_171	The BEYOND solution may provide historical energy consumption data analysis per device monitored	3	WP6	UC_E_6

				.6
Req_172	The BEYOND solution should provide a snapshot of indoor environment conditions in real-time	2	WP6	UC_E_6.6
Req_173	The BEYOND solution may provide historical energy cost analysis per device monitored	3	WP6	UC_E_6.6
Req_184	The BEYOND solution shall provide a snapshot of energy consumption for the last hour per device monitored	1	WP6	UC_E_6.6
Req_175	The BEYOND solution shall provide comparisons of total energy consumption with similar peers	1	WP6	UC_E_6.6
Req_176	The BEYOND solution may provide comparisons of energy consumption with similar peers per device monitored	3	WP6	UC_E_6.6
Req_177	The BEYOND solution shall enable the definition of similar peers for a specific end-user, based on location	1	WP6	UC_E

				_6.6
Req_178	The BEYOND solution shall enable the definition of similar peers for a specific end-user, based on household size	1	WP6	UC_E_6.6
Req_179	The BEYOND solution shall enable the definition of similar peers for a specific end-user, based on demographic data	1	WP6	UC_E_6.6
Req_180	The BEYOND solution shall enable the definition of similar peers for a specific end-user, based on dwelling/ building size	1	WP6	UC_E_6.6
Req_181	The BEYOND solution may enable the definition of energy consumption outliers at device level, in real-time	3	WP6	UC_E_6.6
Req_182	The BEYOND solution shall provide tailored advice for energy savings based on outlier detection, in real-time	1	WP6	UC_E_6.6

Req_183	The BEYOND solution may provide real-time notifications for energy savings	3	WP6	UC_E_6.6
Req_184	The BEYOND solution shall provide generic hints for energy behaviour change and energy savings	1	WP6	UC_E_6.6
Req_185	The BEYOND solution shall provide forecasts of energy consumption for the next 15 minutes to 1 hour	1	WP6	UC_E_6.6
Req_186	The BEYOND solution shall provide forecasts of energy consumption for the next day	1	WP6	UC_E_6.6
Req_187	The BEYOND solution shall provide forecasts of energy consumption for the next week	1	WP6	UC_E_6.6
Req_188	The BEYOND solution shall provide forecasts of energy costs for the next 15 minutes to 1 hour	1	WP6	UC_E_6

				.6
Req_189	The BEYOND solution shall provide forecasts of energy costs for the next day	1	WP6	UC_E_6.6
Req_190	The BEYOND solution may provide historical setpoint data for individual devices	3	WP6	UC_E_6.6
Req_191	The BEYOND solution shall provide forecasts of energy costs for the next week	1	WP6	UC_E_6.6
Req_192	The BEYOND solution should provide historical external temperature data on a daily/ weekly/ monthly/ yearly basis	2	WP6	UC_E_6.6
Req_193	The BEYOND solution shall provide comparisons of individual monthly energy consumption and cost data	1	WP6	UC_E_6.6
Req_194	The BEYOND solution shall provide comparisons of individual daily energy consumption and cost data	1	WP6	UC_E

				_6.6
Req_195	The BEYOND solution shall enable continuous monitoring of the status of HVAC devices	1	WP6	UC_E_6.7
Req_196	The BEYOND solution shall enable continuous monitoring of the status of lighting devices	1	WP6	UC_E_6.7
Req_197	The BEYOND solution shall enable continuous monitoring of the setpoint of HVAC devices	1	WP6	UC_E_6.7
Req_198	The BEYOND solution shall define control signals for loads for maximizing energy savings	1	WP6	UC_E_6.7
Req_199	The BEYOND solution shall define control signals for loads for providing flexibility requested by aggregators	1	WP6	UC_E_6.7

Req_200	The BEYOND solution shall define control signals for loads without causing discomfort to building occupants	1	WP6	UC_E_6.7
Req_201	The BEYOND solution shall continuously define automated control strategies every 15 minutes to 1 hour	1	WP6	UC_E_6.7
Req_202	The BEYOND solution should allow for remote control of specific controllable loads in real-time	2	WP6	UC_E_6.7
Req_203	The BEYOND solution may allow for the definition of control schedules on a daily basis	3	WP6	UC_E_6.7
Req_204	The BEYOND solution shall take into consideration technical constraints of flexibility assets	1	WP6	UC_E_6.8
Req_205	The BEYOND solution shall supplement the base technical constraints of the assets with additional operational constraints derived from the impact on user comfort	1	WP6	UC_E_6

				.8
Req_206	The BEYOND solution shall provide specific consumption profiles of flexibility assets	1	WP6	UC_E_6.8
Req_207	The BEYOND solution shall allow the selection of multiple specific flexibility assets	1	WP6	UC_E_6.8
Req_208	The BEYOND solution shall provide flexibility analytics per flexibility asset, taking into consideration its technical operational constraint and comfort-derived constraint imposed on this particular asset	1	WP6	UC_E_6.8
Req_209	The BEYOND solution shall provide flexibility analytics aggregated per selected flexibility assets taking into consideration technical and comfort constraints imposed on these particular assets	1	WP6	UC_E_6.8
Req_210	The BEYOND solution shall provide consumption profiles of aggregated flexibility assets	1	WP6	UC_E_6.8
Req_211	The BEYOND solution shall allow the identification of flexibility requests by third parties – besides flexibility providers and flexibility customers - e.g. network operators	1	WP6	UC_E

				_6.8
Req_212	The BEYOND solution shall provide insights of daily flexibility schedules delivered by aggregated flexibility assets	1	WP6	UC_E_6.8
Req_213	The BEYOND solution may allow benchmarking of aggregated flexibility assets daily loads vs. their historical daily consumption profiles	3	WP6	UC_E_6.8
Req_214	The BEYOND solution may allow customization of benchmark key performance indicators tailored to the users' needs	3	WP6	UC_E_6.8
Req_215	The BEYOND solution may allow benchmarking of aggregated flexibility assets daily loads vs. their historical daily flexibility profiles	3	WP6	UC_E_6.8
Req_216	The BEYOND solution shall provide flexibility segmentation of available flexibility sources	1	WP6	UC_E_6.9

Req_217	The BEYOND solution shall provide flexibility classification of available flexibility sources	1	WP6	UC_E_6.9
Req_218	The BEYOND solution shall provide flexibility clustering of available flexibility sources	1	WP6	UC_E_6.9
Req_219	The BEYOND solution shall provide optimized flexibility profiles to aggregators	1	WP6	UC_E_6.9
Req_220	The BEYOND solution may provide customization of criteria for flexibility optimization	3	WP6	UC_E_6.9
Req_221	The BEYOND solution shall provide the selection of flexibility sources	1	WP6	UC_E_6.9
Req_222	The BEYOND solution shall provide optimal clustering of flexibility sources to aggregators	1	WP6	UC_E_6

				.9
Req_223	The BEYOND solution shall provide day-ahead electricity market or/and flexibility market requests to aggregators	1	WP6	UC_E_6.9
Req_224	The BEYOND solution may provide real-time flexibility activation requests from third parties (i.e. DSOs, capacity market) to aggregators	3	WP6	UC_E_6.9
Req_225	The BEYOND solution shall provide optimal VPP configuration of flexibility assets towards day-ahead market requests to aggregators	1	WP6	UC_E_6.9
Req_226	The BEYOND solution may provide optimal VPP configuration of flexibility assets towards intra-day flexibility activation requests from third parties (i.e. DSOs, balancing capacity market) to aggregators	3	WP6	UC_E_6.9
Req_227	The BEYOND solution may provide intraday monitoring of energy or/and flexibility market requests to aggregators	3	WP6	UC_E_6.9
Req_228	The BEYOND solution may allow benchmarking of aggregated flexibility assets daily loads vs. their historical daily flexibility profiles offered to third parties	3	WP6	UC_E

				_6.9
Req_229	The BEYOND solution may allow customization of benchmark key performance indicators of flexibility asset daily loads tailored to the users' needs (e.g. maximum flexibility activated, maximum savings, average savings etc.)	3	WP6	UC_E_6.9
Req_230	The BEYOND solution may provide insights of energy prices of day-ahead electricity, flexibility prices on the flexibility market or contracted transaction prices with third parties (i.e. DSOs, balancing capacity agreement with TSOs)	3	WP6	UC_E_6.9
Req_231	The BEYOND solution shall provide customer segmentation of the retailers' portfolio according to criteria such as region, contracted power, consumption etc.	1	WP6	UC_E_6.10
Req_232	The BEYOND solution shall calculate the elasticity of each customer or cluster of customers of the retailers' portfolio, against the price modifications/fluctuations	1	WP6	UC_E_6.10
Req_233	The BEYOND solution shall provide personalised and customized energy billing services via various pricing algorithms (e.g., Time of Use, Real Time pricing)	1	WP6	UC_E_6.

				10
Req_234	The BEYOND solution should perform spatio-temporal consumption pattern analysis of the retailers' portfolio	2	WP6	UC_E_6.10
Req_235	The BEYOND solution may provide identification of behavioural trends and outliers per individual customer or clusters of them	3	WP6	UC_E_6.10
Req_236	The BEYOND solution shall implement implicit DR strategies (price-based) based on the elasticity of clustered customers to price fluctuations	1	WP6	UC_E_6.11
Req_237	The BEYOND solution shall provide day-ahead demand/generation forecasting at building-level for the prediction of portfolio imbalances	1	WP6	UC_E_6.11
Req_238	The BEYOND solution shall provide informative and optimized dynamic pricing schemes to single customers or clusters	1	WP6	UC_E_6.

				11
Req_239	The BEYOND solution may provide customer-oriented or cluster-oriented energy efficiency strategies based on the EU Energy Efficiency obligations	3	WP6	UC_E_6.11
Req_240	The BEYOND Solution shall allow for the selection of automated control mode for comfort and well-being	1	WP6	UC_E_6.12
Req_241	The BEYOND Solution, when in comfort mode, shall define automated control strategies that maximize comfort without increasing energy costs, based on detailed comfort profiles	1	WP6	UC_E_6.12
Req_242	The BEYOND Solution shall allow for the selection of automated control mode for security	1	WP6	UC_E_6.12
Req_243	The BEYOND Solution shall enable the definition of lights control schedules for security reasons	1	WP6	UC_E_6.

				12
Req_244	The BEYOND solution may provide notifications for indoor presence detection, when set in security mode	3	WP6	UC_E_6.12
Req_245	The BEYOND solution shall allow the selection of different control modes for a specific duration	1	WP6	UC_E_6.12
Req_246	The BEYOND solutions shall by default operate in automated control mode for energy efficiency	1	WP6	UC_E_6.12
Req_247	The BEYOND solution shall save all collected data assets under a common information model	1	WP3	UC_D_3.1

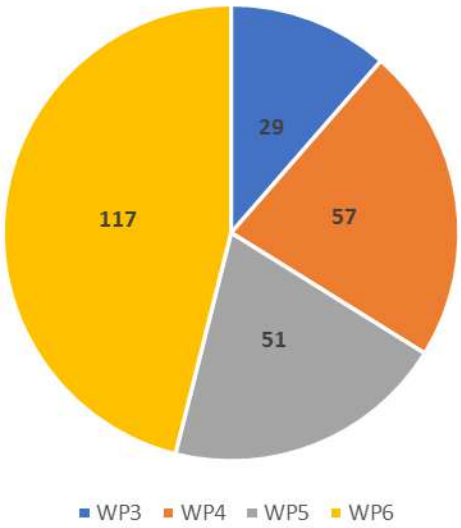

FIGURE 5-1: BUSINESS REQUIREMENTS DISTRIBUTION AMONG THE PROJECT WPS

5.3 User requirements

In our attempt to listen and appraise the end-user point of view, and mainly for the energy applications of WP5 and WP6, a questionnaire was circulated, and its results have been taken into account as user requirements. In order to enlarge the representative sample of the respondents, responsible partners have circulated the survey to a pool of proxy users (similar profiles to the ones expected to get involved in BEYOND project) from the clientele of our demo partners.

The questionnaire, which is attached in the ANNEX, includes various questions concerning personal anonymous information in order to shape the profile of the sample, as well as questions focusing in the end-users demand for monitoring energy consumption and KPIs, their preference on the most suitable way to approach and interact with the project proposed services.

5.3.1 End-User Survey Results

The results of the end-user questionnaire will be presented in this section in order to enable the extraction of the end-user requirements.

Concerning the profile information of the participants, they represent building occupants from 4 different countries (Greece, Spain, Finland and Serbia). The majority is in the ages of 30-65 (30-45: 43.9%, 45-65: 35.4%) with at least tertiary education (75.6%) having at least the basic computer literacy (basic: 24.4%, moderate: 40.2%, expert: 31.7%). The annual incomes of the participants varied to a wide range (10,000 – 20,000: 30.5%, 20,000 – 30,000: 24.4%, 30,000 – 40,000: 14.6%, more: 22%).

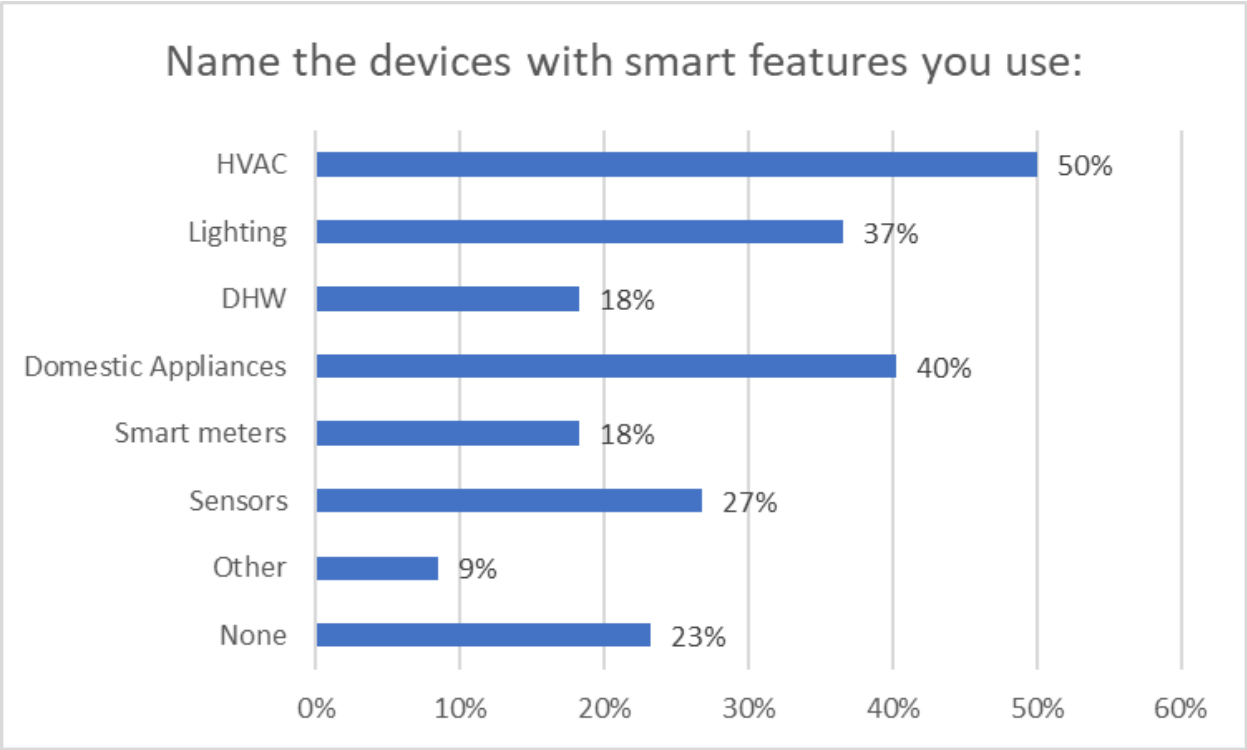

FIGURE 5-2: AN INDICATIVE QUESTION OF THE END-USER SURVEY REGARDING THE DEVICES WITH SMART FEATURES ALREADY BEING USED BY THE END-USERS

The questions referring to the characteristics of the building indicated that the number of adult occupants varied (1 adult: 19.5%, 2 adults: 34.2%, 3 adults: 23.2%, more: 23.2%), while the majority of the buildings/apartments was between 50 and 150 m^2 (50 – 100 m^2: 47.6%, 100 – 150 m^2: 34.2%) mostly for residential use (88%). The cases where the owner was the occupant was the 62.2% while the renters represented the 33%.

The participants seem to be willing to pay some money for installing some sensors for the monitoring of the indoor building conditions (up to 100€: 62.2%, up to 500€: 20.7%, no money for sensors: 12.2%). Moreover, half seemed to be familiar with Demand Response, while regarding the priority towards the establishment of the smart building, 45.1% mentioned the energy savings, 32.9% the comfort and convenience and 22% the smart energy management. This appears in their preference on the indicators they would like to monitor (total energy consumption: 72%, energy savings: 65.9%, comfort level: 57.3%, CO^2 emissions: 53.7%). The frequency of feedback provided on the energy consumption is mainly at real time (real time: 45.1%, hourly: 6.1%, daily: 15.9%, weekly: 20.7%, monthly: 11%). The majority (75.6%) would find useful a mobile interface for the monitoring of such indicators, while the Web or Tablet apps would be used by the 40% and 30% respectively.

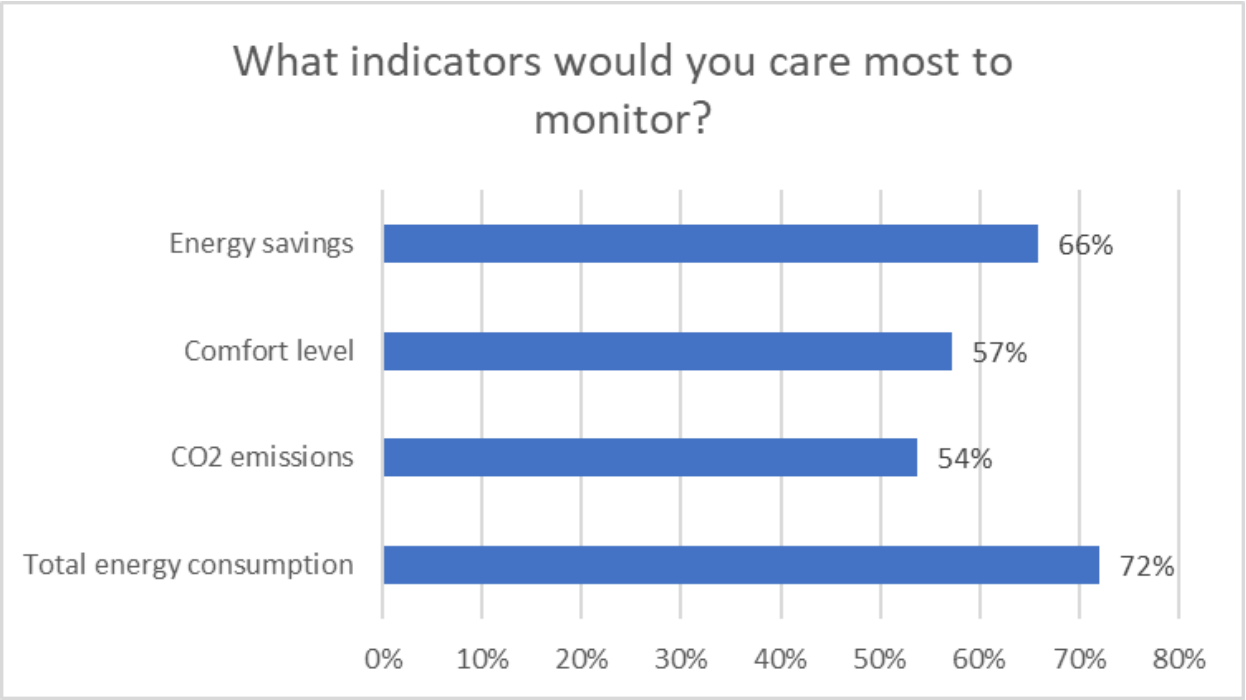

FIGURE 5-3: AN INDICATIVE QUESTION OF THE END-USER SURVEY REGARDING THE PREFERENCES OF THE END-USER ON THE VARIOUS USEFUL INDICATORS THAT CAN BE MONITORED

The majority would like to get insights about their energy usage compared to similar neighbouring profiles (yes: 73.2%, no: 9.8%, not sure: 17.1%). This monitoring would be preferred to be provided via a mobile application in most cases (68.3%), while the web and tablet applications would be utilized by 34.2% and 26.8% respectively. An even greater majority would like to monitor his energy usage compared to his past behaviour (92.7%).

Most of the participants find usefulness in monitoring various indicators concerning the indoor conditions and comfort in their premises and specifically indoor temperature (somewhat important: 70.7%, important: 24.4%), indoor air quality (somewhat important: 29.3%, very important: 61%), indoor humidity (somewhat important: 40.2%, very important: 36.6%) and luminance (somewhat important: 35.4%, very important: 29.3%). They again think that it is more sensible to view these indicators mainly via a mobile application (76.8%) and less via web or tablet applications (39% and 26.8% respectively).

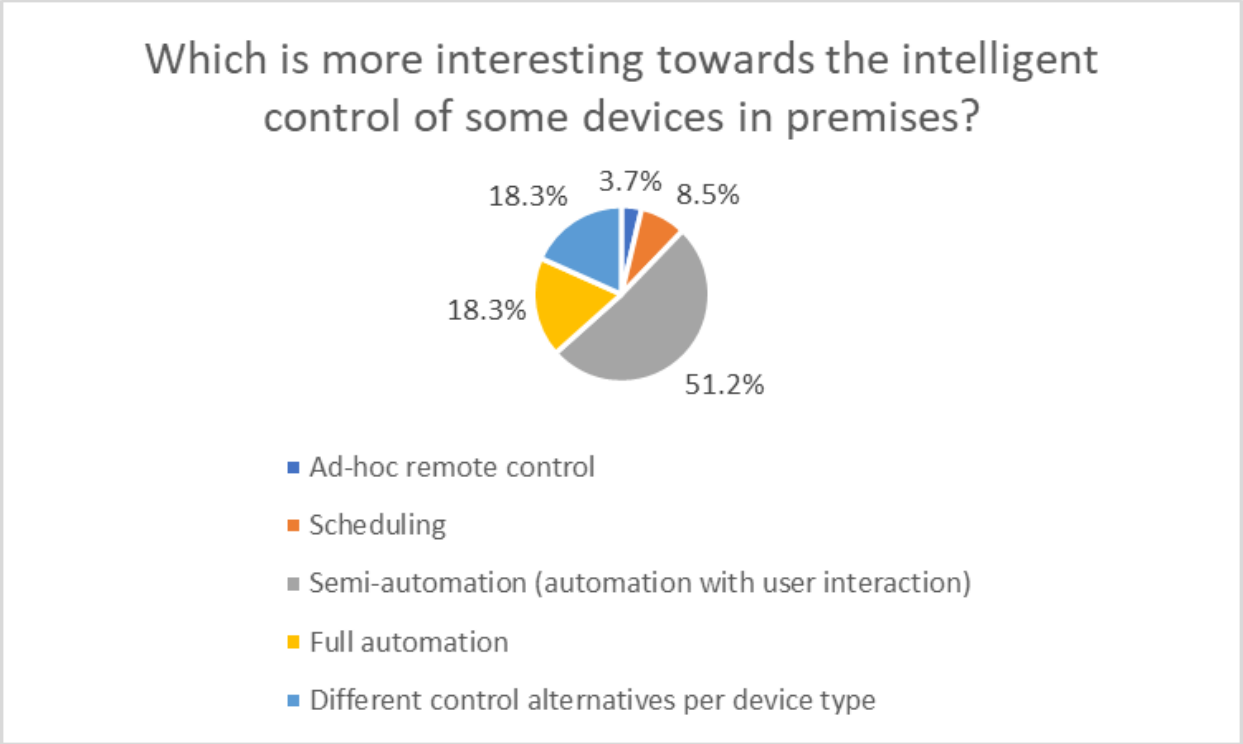

FIGURE 5-4: AN INDICATIVE QUESTION OF THE END-USER SURVEY REGARDING THE REQUESTED LEVEL OF AUTOMATION FOR THE BUILDING ENERGY SERVICES

A 79.2% of the participants would like to get updates on the maintenance requirements of their building devices while only 6% seem to not be interested in such a service. The mobile app is again the most preferable way to have access in it.

In case of a PV installation, almost all participants (except a 5%) would be interested to be informed about the PV generation and self-consumption (70.7% via a mobile app). Around 90% of the participants find some or more interest in being able to remotely control their home energy consumption. Almost all participants (95.1%) would accept the installation of Internet of Things devices, such as sensors and actuators, in order to acquire an idea about their levels of energy consumption, flexibility and comfort preferences (taking into account that privacy was respected). Most of them would not have a problem if the installation would last for more than a year.

Concerning the level of control/automation that they would accept for the increase in the comfort level in their premises, almost 80% would like such a service for electric heating/cooling and smart devices. For the 90%, it would be a motivation to increase their energy savings while only 2.4% can't see such a motivation. Such automations would enable the provision of flexibility services. Only 5% would not care about possible profit from such a perspective. Half of the participants are in favour of semi-automation (automation with user interaction), 18.3% would accept full automation

and another 18.3% would prefer different control alternatives per device. Ad-hoc remote control was not popular among the alternatives (3.7%).

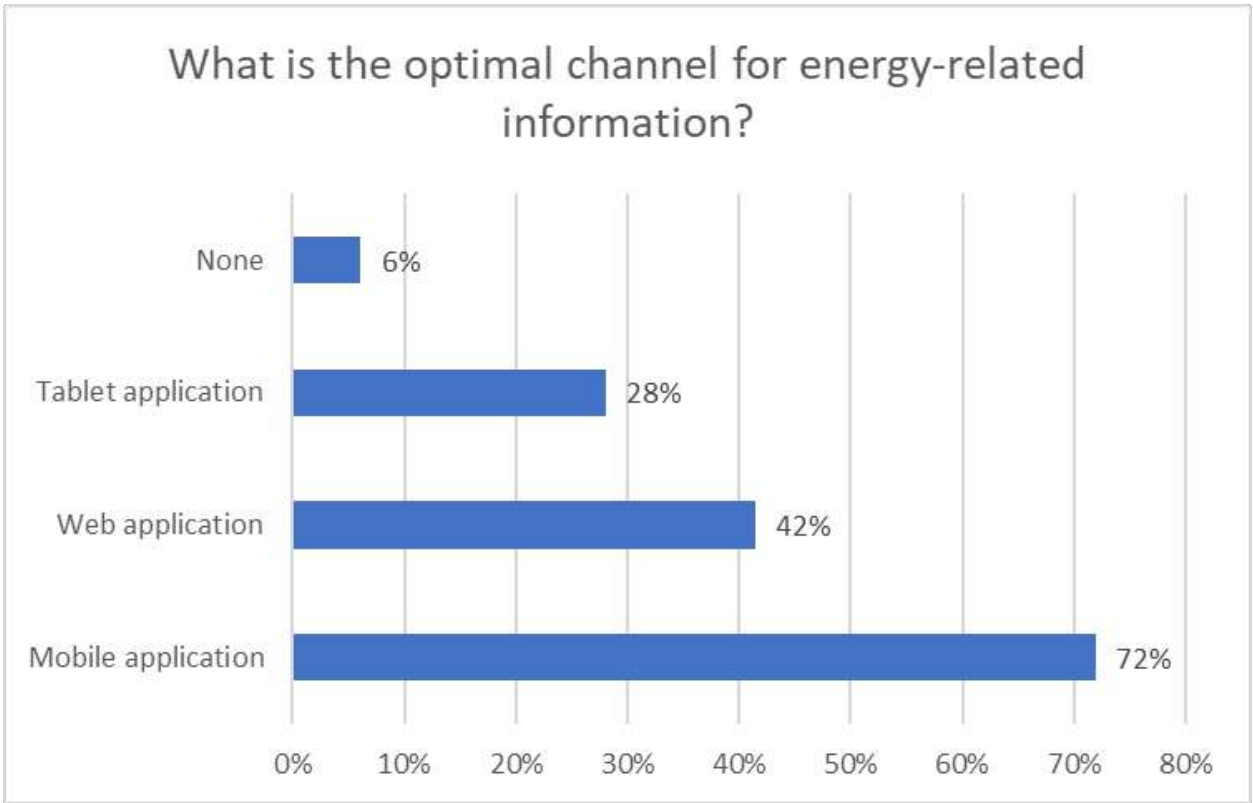

FIGURE 5-5: AN INDICATIVE QUESTION OF THE END-USER SURVEY REGARDING THE WAY THEY WOULD LIKE TO INTERACT WITH THE END-USER DASHBOARD

Only 2.4% of the participants would object on the creation of a profile with their behavioural preferences on comfort and indoor air-quality preservation. Moreover, 83% of the participants would take advice for energy cost reduction through renovations suggested by a tool based on their energy and comfort profile. A similar majority would like to be able to customize the control boundaries for the automated control of the devices.

Finally, only 11% have a contract with an ESCO regarding their energy services, while only 2.4% have a contract with an aggregator for DR services. It seems, though, that the reduced monthly bill would be a strong motivation for signing a contract with dynamic electricity pricing (yes: 59.8%, no: 17.1%, not sure: 23.2%).

It seems that there is great acceptance among respondents to implement a smart home solution to remotely control their energy use, under the premises of full respect of data privacy and security. The results are promising for the acceptance of the services by the building occupants, especially of younger ages, regardless of their country. They accept the installation of devices such as sensors and actuators for a period to determine their power consumption, flexibility and comfort preferences,

with the motivation of achieving economic savings. They agree to provide their personal data for the creation of behavioural profiles that could empower the optimization of their energy consumption with respect to their comfort levels. The great majority prefers the utilization of a mobile app for the monitoring and control of the energy usage and services.

5.3.2 User requirements list

According to the end-user survey results, the following list of user requirements could be extracted:

Req Id	End-User Requirement Title	Priority	Relevant WPs	Relevant UCs
EUReq_01	The BEYOND solution shall enable monitoring of HVAC operation	1	WP6	UC_E_6.4, UC_E_6.6, UC_E_6.7
EUReq_02	The BEYOND solution should enable monitoring of domestic appliances operation	2	WP6	UC_E_6.6
EUReq_03	The BEYOND solution may enable monitoring of lighting operation	3	WP6	UC_E_6.6
EUReq_04	The BEYOND solution may enable monitoring of DHW operation	3	WP6	UC_E_6.6
EUReq_05	The BEYOND solution shall enable monitoring of the building energy consumption	1	WP6	UC_E_6.6
EUReq_06	The BEYOND solution shall enable the collection of energy consumption data in order to provide advanced services such as implicit and explicit flexibility	1	WP6	UC_E_6.6
EUReq_07	The BEYOND solution shall ensure the data protection of the personal information collected	1	WP3	UC_D_3.4
EUReq_08	The BEYOND solution shall ensure the data privacy of the personal information collected	1	WP3	UC_D_3.4
EUReq_09	The BEYOND solution should ensure the control over the data collected	2	WP3	UC_D_3.4
EUReq_10	The BEYOND solution should provide services ensuring comfort and convenience	2	WP6	UC_E_6.5

EUReq_11	The BEYOND solution should provide services ensuring and maximizing energy savings	2	WP6	UC_E_6.5
EUReq_12	The BEYOND solution should provide smart energy management	2	WP6	UC_E_6.5
EUReq_13	The BEYOND solution should enable the monitoring of the building CO_2 emissions	2	WP6	UC_E_6.2
EUReq_14	The BEYOND solution should enable the monitoring of the building comfort levels	2	WP6	UC_E_6.2
EUReq_15	The BEYOND solution should enable the monitoring of the building energy savings	2	WP6	UC_E_6.2
EUReq_16	The BEYOND solution should provide a dashboard that would interact with the building occupant via a mobile application	2	WP6	UC_E_6.3, UC_E_6.6
EUReq_17	The BEYOND solution may provide a dashboard that would interact with the building occupant via a Web interface	3	WP6	UC_E_6.3, UC_E_6.6
EUReq_18	The BEYOND solution should enable the comparison of the building energy usage with neighbouring energy profiles	2	WP6	UC_E_6.10
EUReq_19	The BEYOND solution should enable the comparison of the building energy usage with past behaviour	2	WP6	UC_E_6.6
EUReq_20	The BEYOND solution should enable the monitoring of the indoor humidity	2	WP6	UC_E_6.6
EUReq_21	The BEYOND solution should enable the monitoring of the indoor temperature	2	WP6	UC_E_6.6
EUReq_22	The BEYOND solution should enable the monitoring of the indoor luminance	2	WP6	UC_E_6.6
EUReq_23	The BEYOND solution should enable the monitoring of the indoor CO_2 concentration	2	WP6	UC_E_6.6
EUReq_24	The BEYOND solution should provide alerts on the maintenance requirements of the building devices	2	WP6	UC_E_6.4, UC_E_6.7
EUReq_25	The BEYOND solution should provide insights concerning the building PV generation and self-consumption	2	WP6	UC_E_6.7
EUReq_26	The BEYOND solution should enable the remote controlling of various electric devices in the building	2	WP6	UC_E_6.7, UC_E_6.8
EUReq_27	The BEYOND solution should access data by sensors concerning at least a year's building energy operations	2	WP6	UC_E_6.7

EUReq_28	The BEYOND solution should enable the automation of electric heating and cooling in a building	2	WP6	UC_E_6.7
EUReq_29	The BEYOND solution should increase the automation level in the control of smart devices	2	WP6	UC_E_6.8
EUReq_30	The BEYOND solution should enable device automation to increase consumption flexibility	2	WP6	UC_E_6.7 , UC_E_6.8
EUReq_31	The BEYOND solution should enable semi-automation (automation with user interaction)	2	WP6	UC_E_6.7
EUReq_32	The BEYOND solution should learn from the occupant energy behaviour and make a behavioural profile	2	WP6	UC_E_6.7
EUReq_33	The BEYOND solution should provide recommendations for energy cost reduction through renovations	2	WP6	UC_E_6.1
EUReq_34	The BEYOND solution should enable the customization of the control boundaries for the automated control of the devices	2	WP6	UC_E_6.7
EUReq_35	The BEYOND solution should provide real-time information on the building energy consumption	2	WP6	UC_E_6.6
EUReq_36	The BEYOND solution may provide daily information on the building energy consumption	3	WP6	UC_E_6.6
EUReq_37	The BEYOND solution may provide weekly information on the building energy consumption	3	WP6	UC_E_6.6
EUReq_38	The BEYOND solution should enable the establishment of smart contracts considering dynamic electricity pricing	2	WP6	UC_E_6.11

5.4 Requirements limitations, risks and major changes arising from the technical advancements of Beyond applications

As all the applications of WP5 and WP6 are now reaching a more stable and mature state of implementation and deployment, it is a good time now to point out any risks or major changes to the initial set of requirements and functionalities promised in the initial version of the deliverable D2.1 and the deliverable regarding the technical requirements described in D2.6.

WP3:

No major changes have been identified relevant to the implementation of the technical outputs of WP3, as the requirements are still valid. Following discussions about the backlog, a change in the prioritisation of some requirements was performed, in order to focus more on 1st priority requirements that are more relevant for the applications offered by WP5 and WP6.

WP4:

No major changes have been identified relevant to the implementation of the technical outputs of WP4, as the requirements are still valid. Following discussions about the backlog, a change in the prioritisation of some requirements was performed, in order to focus more on 1st priority requirements that are more relevant for the applications offered by WP5 and WP6.

WP5:

The only limitation foreseen for **Task 5.1** and **Task 5.2** concerns the availability of data that can be provided by partners (FVH and BELIT/BEOELEK) that might have an impact on some implementation choices. In any case, if this limitation is confirmed, assumptions will be taken to meet functional requirements as closely as possible.

The limitation of **Task 5.3** is the availability of historical data on the power consumed and generated by the buildings connected to the pilot network. In addition, data characterising the customers of the buildings within the clusters is also needed.

Regarding **Task 5.4** (Renovation Optimisation Decision Support Tool), the availability of measured data on building energy consumption (heating, cooling, electricity) is necessary to provide the required services.

WP6:

Task 6.1: Regarding Building Digital Twins Environment for Energy Performance Optimization, Self-consumption Maximization and Predictive Maintenance toolbox, the availability of real-time building energy performance data is crucial to implement the respective functionalities.

Task 6.2: Regarding the Building Portfolio Analytics and Management Module, the most important risk so far is the lack of real customer data and pricing data from all the retailers that participate in the Beyond project. Regarding the part of the customer segmentation, we proceeded with a dataset provided by Mitilinaios, but we believe that the classification criteria used in our algorithms are very much

coupled to the Greek market and it might be the case that they cannot be generalized to accommodate for other markets too. So separate investigations are needed in order to identify those needs.

Regarding the estimation of customer elasticities, the data provided by Cuerva (10 customers) do not accommodate with them any pricing details so that we could relate consumptions with prices and calculate historical elasticities. We are now in the process of constructing some synthetic data with the risk of making assumptions that might not be valid in the real use case scenarios.

Task 6.4: Regarding the Energy Performance and Smart Readiness Certification Tool the main technical risks include not enough high-quality data, which is a critical issue that may prevent deployment quality of the energy performance tool. It is still a common practice that building's HVAC systems are equipped only with a minimum set of sensors that is required for basic monitoring and control of the system. But if the available data is not rich enough, the analytical outcomes delivered to the customer will have only a limited value. As a consequence, the new entrant to the market needs to focus only on carefully selected segments. Limited availability of data is another technical barrier, which actually means that adaptation of analytical models to the specific behavior of individual equipment may not be possible.

Task 6.5 Concerning Flexibility based VPP Configurator and DR Strategies Optimization Tool, the most important risk is the lack of real customer data and third-party requests from partners participating in the BEYOND project. Regarding VPP configuration engine and the related optimization algorithms the risk is to be set-up for specific use cases data provided by Cuerva, more data provided from other partners, more applicable the VPP configuration algorithms will be applicable to various cases. In other words, the principal risk is the lack of generalization of trained algorithms as they might overfit the performance to Cuerva's data. The mitigation strategy that will be employed is to use synthetic generated data and open data available from other sources.

6 Conclusions

The deliverable tries to analyse thoroughly the BEYOND ecosystem by digging into the possible benefits for the project-related stakeholders, clearly expressing their needs and possible profit. The engagement of the technical and business stakeholders, as well as the end-users, provided useful feedback on both the understanding of the business motivations and the conceptual description of the framework of the BEYOND solution.

The extracted list of requirements will provide the necessary guidelines for the determination of the technical specifications of the project solution regarding the specific components, their technical characteristics and their interaction with each other and with the stakeholders. In that sense, the shaping of the BEYOND architecture will take advantage of the present deliverable's agreed list of project requirements.

The findings of the end-user survey which was conducted for the purposes of the user requirements will support the socioeconomic analysis performed in T2.2. The acceptance of the end-users to provide data for the needs of having access to advanced services is an important motivation for the implementation of the BEYOND solutions.

Any limitations and risks identified in the first 18 months of the development of the energy business applications are also documented here.

Finally, the mapping of the Uses Cases and the requirements to implementation activities will be reflected in the activities of the technical WPs (WP3-WP6).

7 References

1. ISO/IEC/IEEE 29148:2011), https://standards.ieee.org/standard/29148-2011.html

8 Annexes

The template for the building occupant's questionnaire is provided in Annex. The questionnaire template is available in:
https://ec.europa.eu/eusurvey/runner/BEYONDendusersurvey

BEYOND end-user survey

Fields marked with * are mandatory.

The aim of the BEYOND project is to establish a highly effective, innovative and scalable technology framework (for Secure and Privacy-preserving data management, along with intelligence extraction through advanced analytics), accompanied by a bundle of applications for building occupants that will enable the realization of significant benefits in the form of both (i) optimized energy performance and reduction of associated energy costs and (ii) financial gains achieved from data monetization (data sharing negotiations and smart contracts) or trading of building flexibility in upstream energy and flexibility markets.

To this end, BEYOND will build on top of proven technological components of the consortium, currently available open standards and novel data-driven and data sharing approaches towards delivering innovative energy services and associated applications to building occupants, enabling:

1. **Significant energy costs savings for energy consumers**, through the deployment of highly effective energy performance optimization and demand side management strategies, mainly through automation of highly consuming devices (heating/ cooling, domestic hot water, lighting)
2. **Creation of new revenue streams for building occupants** by introducing their energy infrastructure as active assets in energy markets for the provision of respective services to grid operators
3. **Proper tackling of prosumer reluctance to participate in Demand Response and Energy Management Optimization** by establishing a human-centric DR optimization framework that provides personalized control functions and automation, in a non-intrusive manner and without compromising prosumers' comfort, indoor environment quality or daily operations/ schedules
4. **Wide promotion of self-consumption** at building level optimizing in real-time how local energy generation (photovoltaics) and consumption are balanced, again, under the principle of maintaining human comfort within acceptable boundaries

BEYOND will step on data inputs from building (heating, cooling, lighting systems and devices, generation and storage systems, EV installations, along with metering devices and IoT devices and sensors) and their inhabitants, that will be further processed in order to reinforce understanding and extract intelligence over building energy performance and the factors that affect it, thus allowing for the definition of appropriate control approaches over specific assets and devices towards delivering the aforementioned benefits

In this context, our team pays special attention in involving building occupants in the co-design of the innovative solutions and energy services we are aiming to deliver, since their role as data producers (smart meter and/ or personal data from IoT devices) and end-users of these solutions is considered vital for delivering results of high value and wide acceptance.

For this reason, we have prepared **a short (15 minute) survey** to better understand your specific needs, requirements and/or concerns around energy, technology and data-related issues and in this way, **help us**

1

develop **really user-centric and co-designed innovations that consider and can effectively adapt to your unique situation**, thus allowing you to enjoy a wealth of benefits under an **enhanced data privacy and protection framework.**

* Please indicate your country of residence:
  - Greece
  - Spain
  - Finland
  - Serbia

* Please indicate your age:
  - < 30
  - 30 - 44
  - 45 - 64
  - > 65

Please indicate your gender:
  - Male
  - Female

* Please indicate your educational level:
  - Primary or lower
  - Secondary
  - Tertiary or higher

* Please indicate your computer literacy level:
  - Beginner
  - Basic
  - Moderate
  - Expert

* Please indicate your annual income (in Euros):
  - < 10,000
  - 10,000 - 20,000
  - 20,000 - 30,000
  - 30,000 - 40,000
  - > 40,000

* Please indicate the number of adults in the dwelling:
  - 1
  - 2
  - 3
  - > 3

* Please indicate the size (floor area in m2) of your premises:

2

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200

* Please indicate the use of the property:
  - Residential use
  - Commercial use

* What is your relationship to your apartment/property?
  - Renting
  - Owning and using it
  - Owning, not using it (family relationship to person renting it)
  - Owned, not using it (not related to person renting it)

* What is your opinion about the building energy consumption management?
  - I am concerned and try to manage it
  - I am concerned but I don't know how to manage it
  - I don't see any reason to do so

* Do you currently use smart devices?
  - Yes
  - No
  - Very few
  - Not sure

Name the devices with smart features you use (you may check multiple answers):
- [ ] HVAC (Heating, Ventilation and Air-Conditioning)
- [ ] Lighting
- [ ] DHW (Domestic Hot Water)
- [ ] Domestic Appliances
- [ ] Smart meters
- [ ] Sensors
- [ ] Other

* Are you willing to install smart home equipment as a means to get a better understanding of your energy consumption?
  - Yes
  - No
  - Not sure

* Are you willing to share your data, in order to receive advanced services?
  - Yes
  - Yes, I already do so

- No
- Not sure

* When it comes to sharing of your data in order to receive advanced services, what is of outmost concern?
  - Data protection - Possible exposure of personal information in the event of data breach
  - Data control - No/little control over the data collected
  - Data privacy - Full respect of private information (not disclosed, GDPR compliance)

* How much are you willing to pay for sensors to be installed in your house in order to measure and improve your indoor conditions (e.g. room temperature, humidity, lumination, etc.), and finally to help you decide according to your needs?
  - nothing
  - no more than 100 Euros
  - no more than 500 Euros
  - more than 500 Euros

* Are you familiar with Demand Response?
  - Yes
  - No
  - Not sure

* What would be your main priority towards the establishment of a smart building?
  - Comfort and convenience
  - Energy savings
  - Smart energy management

* Which indicators would you care most to monitor?
  - Total energy consumption
  - CO_2 emissions
  - Comfort level
  - Energy savings
  - Other

* Overall, how would you like to monitor such indicators?
  - Via a Web interface
  - Via a Tablet interface
  - Via a Smartphone interface

* Would you like to get insights about your energy use compared to similar neighbouring energy profiles?
  - Yes
  - No
  - Not sure

* How would you like to monitor your position against the district/community level energy consumption (privacy of personal information will be respected)?

- ☐ Via a Web interface
- ☐ Via a Tablet interface
- ☐ Via a Smartphone interface

* Would you like to get insights about your energy use compared to your past behaviour (last week/month /year)?
  - ○ Yes
  - ○ No
  - ○ Not sure

* How would you like to monitor your comfort level in your premises?
  - ☐ Via a Web interface
  - ☐ Via a Tablet interface
  - ☐ Via a Smartphone interface

Please indicate how important the following aspects are, regarding your comfort:

	Unimportant	Somewhat unimportant	Neutral	Somewhat important	Very important
Indoor temperature	○	○	○	○	○
Indoor humidity	○	○	○	○	○
Indoor luminance	○	○	○	○	○
Indoor Air Quality (CO_2 concentration, etc.)	○	○	○	○	○

* Would you like to get updates about the maintenance requirements of your building devices?
  - ○ Yes
  - ○ No
  - ○ Not sure

* How would you like to get such updates?
  - ☐ Via a Web interface
  - ☐ Via a Tablet interface
  - ☐ Via a Smartphone interface

* Would you like to get insight about the indoor air quality levels in your premises?
  - ○ Yes
  - ○ No
  - ○ Not sure

* How would you like to monitor your premises indoor air quality levels?
  - ☐ Via a Web interface
  - ☐ Via a Tablet interface
  - ☐ Via a Smartphone interface

In case of PV installation, would you like to get insights about your local generation and self-consumption?

- Yes
- No
- Not sure

* How would you like to get such insights?

- Via a Web interface
- Via a Tablet interface
- Via a Smartphone interface

* Do you consider the deployment of a smart home solution to remotely control your energy use as an interesting feature?

- Yes
- No
- Not sure

* Would you accept the installation of low powered Internet of Things devices (such as sensors and actuators) for a period of time to determine your energy consumption, flexibility and comfort preferences, if privacy was respected?

- Yes
- No

Would you agree to have sensors installed at your property for more than a year?

- Yes
- No

What is the longest period you are willing to have such monitoring devices (e.g. sensors, actuators, etc.) installed in your property?

- 1 month
- 3 months
- 6 months
- 12 months

* Are you willing to accept some type of control/automation on the way to increase comfort levels in premises?

- Yes
- No
- Not sure

On which of the following devices would you allow such type of control/automation in order to increase your comfort levels in your premises?

	Yes	No	Not sure
* Electric heating			

• Electric cooling			
• Smart devices			

• Are you willing to accept some type of control/automation on the way to increase energy savings?

- Yes
- No
- Not sure

• Are you willing to accept some type of control/automation on the way to gain profit from providing energy flexibility services?

- Yes
- No
- Not sure

• Which of the alternative approaches seems more interesting towards the intelligent control of some devices in premises?

- Ad-hoc remote control
- Scheduling
- Semi-automation (Automation with user interaction)
- Full automation
- Different control alternatives per devise type.

• Would you like it if the automatic control mechanism in your premises would "learn" and make a profile of your behaviour preferences (comfort and indoor air quality preservation)?

- Yes
- No
- Not sure

• Would you take into account recommendations for energy cost reduction through renovations suggested by a tool based on your energy and comfort profile?

- Yes
- No
- Not sure

• What is the optimal channel for energy related information?

- Via a Web interface
- Via a Tablet interface
- Via a Smartphone interface

• Would you prefer to customize the control boundaries for the automated control of the devices?

- Yes
- No
- Not sure

* How often would you like to be given information on your energy consumption?

- Real time
- Hourly
- Daily
- Weekly
- Monthly
- Other

* Do you currently have a contract with an energy service company (ESCO) regarding your energy services.

- Yes
- No

Please specify:

* Do you currently have a contract with an Aggregator regarding any demand response services

- Yes
- No

Please specify:

* Would the seeking for a reduced monthly energy bill be a strong motivation for signing a contract with dynamic electricity pricing?

- Yes
- No
- Not sure