PHOENIX

WP2 – Requirements, Use case definition and Architecture Blueprint

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D2.1 Business, market & regulatory requirements

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Abstract:

This document shows the PHOENIX project key business and functional details that will further trigger the implementation of technical activities in the project. At first, and following the methodological approach as agreed among the partners, a preliminary PHOENIX related market and regulatory analysis is performed in order to screen the market and regulation environment. In addition, the use cases and business scenarios of the project are defined to screen the landscape for the technical activities to be performed in the project. Following this analysis, the requirements extraction phase takes place, including also the building occupants in this process through structured surveys that were circulated by the demo partners among their customers. By extracting the list of use cases and the associated requirements, an elicitation process takes place towards the extraction of the 1st version of the PHOENIX project MVP.

Keywords:

Use cases, requirements, market analysis, regulation, MVP

Revision History

The following table describes the main changes done in the document since created.

Revision	Date	Description	Author (Organization)
0.1	0/10/2020	ToC and allocation of work	S5
0.2	30/10/2020	Feedback from partners: market and regulation	All task partners
0.3	05/11/2020	Analysis of use cases and business scenarios	S5
0.4	25/11/2020	Feedback from partners: use cases and business scenarios, surveys	All task partners
0.5	05/12/2020	Analysis of requirements and presentation	S5
0.6	15/12/2020	Validation of requirements by Project partners	All task partners
0.8	20/12/2020	Document Ready for Review	UMU, MERIT
1.0	26/12/2020	First version of the document	S5
2.0	25/03/2021	New version with the spelling checks and the update in the last section stating where the requirements are going to be checked as the project progresses.	S5

Executive Summary

This document shows the PHOENIX project foundations that will further trigger the implementation of technical activities in the project. At first, and following the methodological approach as agreed among the partners, a preliminary PHOENIX related market analysis is performed in order to screen the market environment and prioritize the key features (in terms of market requirements) that should be considered at the design of the PHOENIX solution. The market analysis is further complemented by the review of the regulation at EU level and the target countries on the way to ensure that the final solution is in line with the regulatory guidelines and constrains.

In addition, and 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 PHOENIX framework. This business-centered analysis is further complemented by the active participation and involvement of building occupants (as key actors of the project) in the PHOENIX 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 PHOENIX services and solutions.

The feedback from the business stakeholders and the building occupants further leads to the extraction of a non-exhaustive 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 PHOENIX technology framework specifications.

Overall, the outcome of this work is the extraction of the list of business scenarios, use cases and requirements to set the basis for the PHOENIX MVP as also reported in this document.

Disclaimer

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Table of Contents

1. Introduction *9*

1.1 Scope of the Document **9**

1.2 Relevance to other deliverables **9**

1.3 Structure of the Document **10**

2. Methodological Framework and key target group definition *11*

2.1 Methodology **11**

2.2 PHOENIX Business Stakeholders **13**

3. PHOENIX Market Analysis *16*

3.1 IoT solutions, Smart Appliances, Building Gateways Market Analysis **16**

3.1.1 Market Overview & Key segments 16

3.1.1 Competition Analysis & Features Characterization 19

3.2 (Energy) Data Analytics Market Analysis **21**

3.2.1 Market Overview & Key segments 21

3.2.1 Competition Analysis & Features Characterization 22

3.3 Energy Efficiency & Maintenance Services Market Analysis **25**

3.3.1 Market Overview & Key segments 25

3.3.1 Competition Analysis & Features Characterization 27

3.4 Non - Energy Services Market Analysis **29**

3.4.1 Market Overview & Key segments 29

3.4.2 Competition Analysis & Features Characterization 31

3.5 Demand Side Flexibility Services Market Analysis **33**

3.5.1 Market Status & Trend 33

3.5.2 Competition Analysis & Feature Characterization 34

4. PHOENIX Regulatory Framework Analysis *37*

4.1 Overview 37

4.2 Greece - Regulatory Analysis 42

4.3 Sweden - Regulatory Analysis 44

4.4 Spain - Regulatory Analysis 46

4.5 Ireland - Regulatory Analysis 48

5. PHOENIX Business Scenarios and Use Cases Definition 52

5.1 PHOENIX Business Scenarios Definition 52

5.2 PHOENIX Use Cases Definition 53

6. PHOENIX End Users Feedback 60

6.1 Questionnaires and Focus Groups Discussions Methodology 60

6.2 Questionnaires Results 63

7. PHOENIX Requirements Extraction and MVP Definition 66

7.1 Requirements Extraction 66

7.2 PHOENIX Minimum Viable Product 71

8. Summary and conclusions 79

9. References 81

10. Annex I 84

Abbreviation	Description
DoA	Description of Action
DSOs	Distributed System Operator
BMS	Building Management System
IPR	Intellectual Property Rights
IoT	Internet of Things
ROI	Return on Investment
DHW	Domestic Hot Water
HVAC	Heating Ventilation Air Condition
CAGR	Compound Annual Growth Rate
BAS	Building Automation Solution
EaaS	Energy as A Service
ESCOs	Energy Service Company
CBM	Condition-Based Maintenance
AAL	Ambient Assisted Living
DR/RDR	Residential Demand Response
NECPs	National Energy and Climate Plans
GDPR	General Data Protection Regulation
SGTF	Smart Grid Task Force
EG	Expert Group
DBLs	Digital Building Logbook
RES	Renewable Energy Source
GHG	Greenhouse Gas
ESR	Effort Sharing Regulation
NZEB	Nearly Zero Energy Buildings
IAQ	Indoor Air Quality
EPC	Energy Performance Certificate
UI/UX	User Interface/ User Experience
MVP	Minimum Viable Product
ML	Machine Learning
EPBD	Energy Performance Building Directive
ICT	Information Communication Technologies
SRI	Smart Readiness Indicator

1. INTRODUCTION

1.1 Scope of the Document

The scope of this document is to define the PHOENIX project [1] business and functional priorities that will further trigger the implementation of technical activities in the project. At first, a preliminary market analysis is provided in order to screen the landscape in the market and prioritize the core features (in terms of market requirements) that should be also considered for the design of the PHOENIX solution.

In addition, and taking into account the feedback from the business actors of the project, the details about the project business scenarios and use-cases should be defined, to drive the whole design process for the PHOENIX framework. This business-related analysis which set the backbone for the whole PHOENIX solution is further complemented by the extraction of a non-exhaustive 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 PHOENIX technology framework specifications.

The list of the requirements is derived through the active participation and involvement of building occupants (as key actors of the project) and business stakeholders' in the PHOENIX co-creation and design process from the early beginning of the project. Questionnaires were circulated to the building occupants in an anonymous way while the key business actors of the consortium were contacted in order to provide their vision about the PHOENIX solution.

Last but not least, the market and business analysis is further complemented by the review of the regulation at EU level and the target countries on the way to ensure that the final solution is full in line with the regulatory guidelines and constrains. The outcome of this work is the extraction of the list of business scenarios, use cases and requirements to set the basis for the PHOENIX MVP as reported in this document.

1.2 Relevance to other deliverables

This document is aimed to define the project functional and business objectives; to create the necessary inputs for the PHOENIX technology framework specifications in T2.3. 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.

In addition, the preliminary market analysis performed in this task, will be further complemented by a more detailed analysis to be in T8.3: Business modelling, IPR management and exploitation planning. On the other hand, and towards the early enrolment of the business actors in the project activities, tight linkage of this task work with the work in T8.2 where the focus is on Stakeholders Engagement.

1.3 Structure of the Document

The document includes the following contents:

- Chapter 1, the introductory section is provided, highlighting the scope and objective of the deliverable
- Following, chapter 2, the definition of methodology for the work and the identification of business stakeholders is reported.
- Chapter 3, the results of the preliminary market analysis are provided.
- Chapter 4, the review of regulation at EU and national level is reported.
- Chapter 5, the list of business scenarios and use cases is reported.
- Chapter 6, we present the results from questionnaire analysis and focus group discussions with project stakeholders.
- The list of requirements is provided in Section 7 along with the PHOENIX MVP definition.

Finally, a summary and the main conclusions of the work are reported in the last chapter of the deliverable.

2. METHODOLOGICAL FRAMEWORK AND KEY TARGET GROUP DEFINITION

2.1 Methodology

A successful extraction of business and system requirements is never an easy task as it requires to have a good understanding of the market environment and get into the minds of the end users of the solution. At first, the review of the market and the regulation is required in order to properly define a system that is in line with the external environment priorities. Complementary to this, feedback from end users /stakeholders is requested on the way to design a solution that fully complies with their priorities and expectations adopting that way a user-centered methodological framework.

Our methodology is composed by four main steps in line with the design principles presented above.

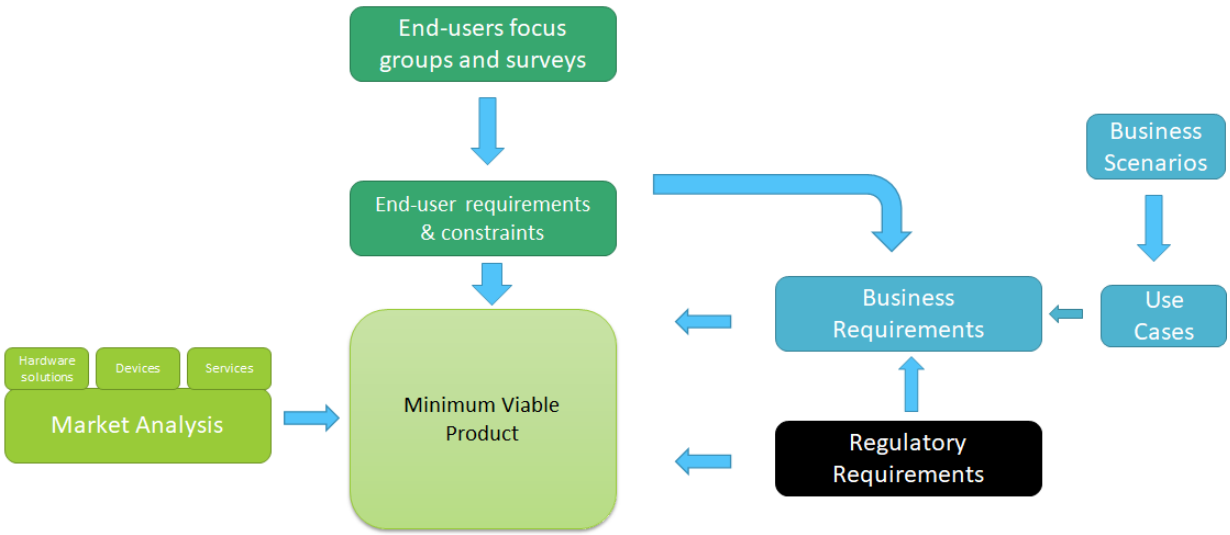

Figure 1 Requirements Extraction & PHOENIX MVP Methodological Framework

The different phases in the above figure are hereafter described:

Step 1: Analysis of the market and regulatory framework

As a first step, a clear understanding of the market environment is required on the way to design a solution that clearly take into account the competition and market status quo. The market analysis of end-to-end solutions and upgrades for existing systems and appliances will provide crucial

information for the exploitation of the different innovations that PHOENIX will provide. The extraction of key features that needs to be supported by an ICT solution along with the adoption of good practices is part of the work. In addition, the review of the national regulation is a mandatory first step as we need to provide a solution that is fully in line with the priorities set by the most recent and relevant regulation. The regulatory analysis will focus on standards and regulation, focusing on the European ones, to ensure that the project will comply with the most recent EU directives and regulations, that are envisioned by the package "Clean Energy for All Europeans" which were published and entered into force as part of the Clean Energy for All Europeans initiative. Special emphasis will be placed on the new EPBD and its Smart Readiness Indicator. A thorough review of the market and regulation is performed by the consortium partners and the results are presented in the document.

Step 2: Business scenarios and use cases definition

The major objective of this phase is to define the list of Business Scenarios and use cases to be examined in the project. The starting point for this analysis is the DoA where the High-level Business objectives of the project are defined. The refinement and final selection of business scenarios is based on the review of state of the art of technical advancements following consultation with the business stakeholders, partners of the consortium. Following the selection of business scenarios, the list of technical use cases is defined. The aim is to start with the high-level PHOENIX concepts, as defined in the DoA, and by taking into account the business needs on the way to extract the list of PHOENIX use cases.

Step 3: Business actors' enrolment on the co-creation process / Focus groups and questionnaires

Further to the definition of PHOENIX use cases, the different business actors of the solution should be enrolled on the way to express their needs and requirements for the final solution. This is a very important step at the design process as the final solution should first and foremost address their preferences. Towards this direction, a hybrid approach is considered for feedback gathering where questionnaires are circulated to the building occupants (as key actors of the project) and focus group discussions are organized with the business actors of the consortium on the way to address the needs of main system stakeholders.

Step 4: End users and Business Requirements Extraction and PHOENIX MVP definition

In this last step, we take into account questionnaires analysis and discussions results that are further transformed to PHOENIX end users and business requirements. These are further complemented by additional requirements mainly related to regulatory barriers in pilot regions of the project. The prioritization of end users' requirements is also a main task performed at this phase, setting the basis for PHOENIX MVP definition.

The next section focuses on the definition of the key PHOENIX stakeholders that will be further considered for the requirements extraction phase as reported in Step 3 of the methodology.

2.2 PHOENIX Business Stakeholders

As stated in the DoA, different types of business actors with specific roles are considered in the PHOENIX project. At the centre of the whole solution, we have the building occupants as the focus group for the user centric services provided by PHOENIX. In addition, a list of market stakeholders (retailers, ESCOs, Building Managers, Aggregators) is considered as the enablers of the different services provided to the building customers as presented in the following figure:

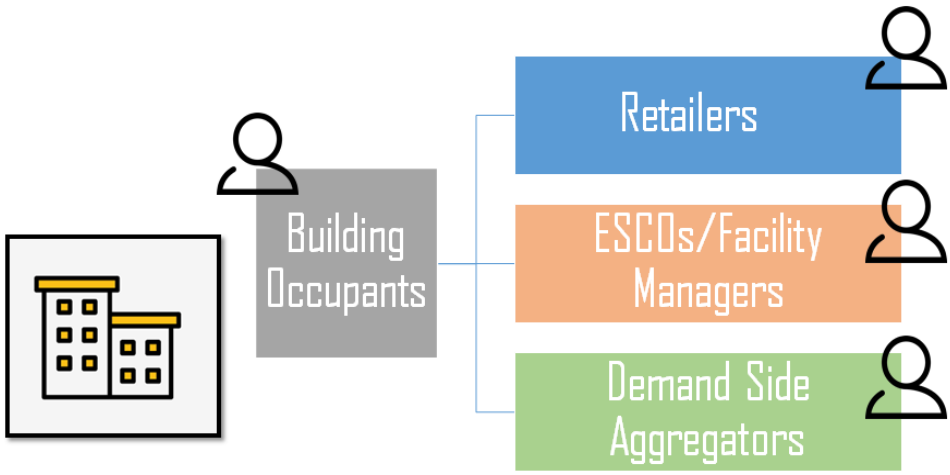

Figure 2 List of PHOENIX system stakeholders

A brief description of PHOENIX system stakeholders is provided.

Residential & Commercial Building Occupants

Building Occupants in residential and commercial buildings is an important focus group for the project activities and results. PHOENIX project considers the end consumers (both owners and

inhabitants) as the main enablers for the development of the proposed framework, as this group is expected to create the pool for the commercialization of the different hardware and software-based services to be delivered in the project.

Energy Retailers

Energy retailers are an important target group, since they become the distribution/reselling channel for the PHOENIX services. EU retailers must transition from their traditional role as commodity providers and make energy services as a profit centre. They must adapt to the new environment, towards providing energy services and flexible products to their customers.

ESCOs/ Building (Facility) Managers

At the same direction, ESCOs are an important target group as another type of market actor for reselling the PHOENIX services focusing mainly on the delivery of energy efficiency and building certification services to their customers under innovative contractual agreements. In addition, ESCOs may be considered as the key enablers of self-consumption business schemas, a model to be examined in the project.

Demand Side Flexibility Aggregators

Along with the delivery of energy savings and building performance services to the building occupants, a core aspect of the project is to increase the smartness of the building by incorporating their flexibility in innovative business models. Towards this direction, Demand Side Aggregators are considered as the enablers to manage their customer assets in an optimized way, trading their available flexibility in the market. Aggregators usually act as subcontractors of DSOs, for providing location and event-based grid management services (demand side management services for grid relief on specific locations and for specified time periods).

Along with the list of key business stakeholders presented above (and directly linked with the PHOENIX project activities), there are additional business actors that are indirectly linked with the activities performed in the project. These are hardware (building legacy systems/BMS systems) vendors, BMS system integrators, energy data analysts etc… which are not further analysed in the scope of this task but will be considered in the exploitation analysis to be performed in the project.

Following the definition of the business stakeholders (thus highlighting the main focus of the project), we proceed with the next steps of the work, namely the market and regulatory analysis further complemented by the definition of business scenarios and use cases.

3. PHOENIX MARKET ANALYSIS

The scope of this section is to report the results of the preliminary market analysis performed in the project. The main focus at this stage of the project is twofold: (a) to first select the most relevant market segments that are of interest for further analysis in the context of the project and (b) to proceed with per market segment identification of the key competitors on the way to extract the most relevant technology features that should be further considered at the design analysis of the PHOENIX project. The different steps of the analysis are further presented:

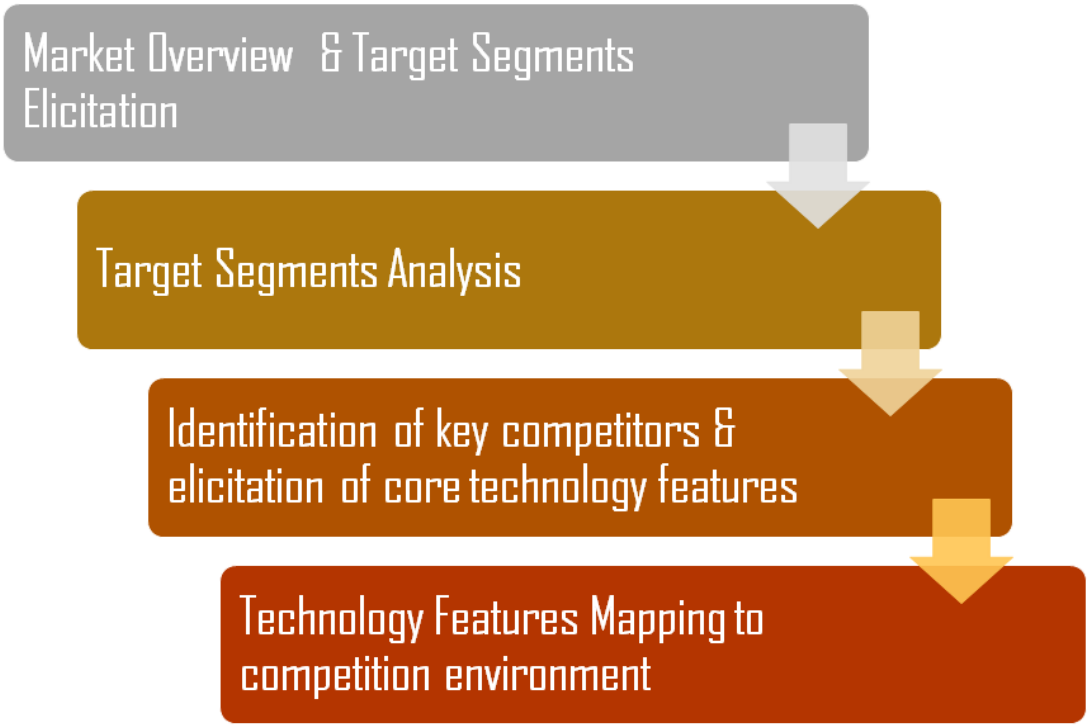

Figure 3 Market Analysis Methodology

By taking into account the DoA and the high-level objectives of the project, the key market segments were identified, presented in the following sections. We have to point out that this is the 1st preliminary market analysis performed in the project focusing on screening the potential market environment for the PHOENIX solution. A more thorough analysis will be performed on WP8 (T8.3: Business modelling, IPR management and exploitation planning) with the aim to link the developments of the project with potential exploitation opportunities.

3.1 IoT solutions, Smart Appliances, Building Gateways Market Analysis

3.1.1 Market Overview & Key segments

The proliferation of smart devices under the new paradigm of the Internet of Things (IoT) is standing as the key enabler for the provision of energy and non-energy services at the building environment. The now connected devices are from different families; intelligent devices may be included in the building to perform automatic envelope adaptation (structural changes such as shading, window opening or mechanical ventilation heat recovery) or more related to the occupant operation, such as white appliances or entertainment kits. Also, there is equipment to actively change the conditions of the building, such as the conditioning systems or the lighting. The existence of these new technologies in the market is a major market trend and focus of interest in the PHOENIX project.

In the past couple of years, market statistics reveal that more and more organizations are willing to experiment with IoT because of their higher expectations for Return on Investment (ROI) from their large-scale initiatives. Based on estimations of Forbes, the global IoT market will grow from $157B in 2016 to $457B by 2020 [2]. In the following figure shows the different segments of IoT market, where the sector of smart buildings and homes represents 14% of the global market.

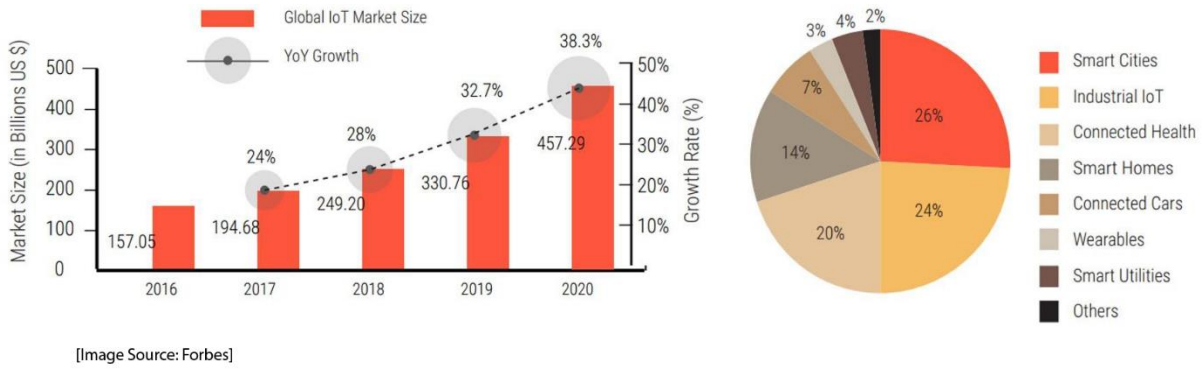

Figure 4 Global IoT Market Shared by Segments (Source: [2])

As the market field of IoT devices is very extended, a PHOENIX - targeted analysis to the most relevant market segments is provided in this section, focusing in the areas of Smart Appliances, and the Home/Building Gateways.

At the level of smart home devices (counting HVAC, lighting, DHW and smart white appliances, etc.) there will be an expending > 100B $ market size by 2027. While the main focus is for security and entertainment applications, there is a high interest also for the provision of energy related services. The main priority is still on integration of smart thermostat and lighting solution but there is an emerging trend for smart white appliance. In particular, the smart home appliances market size was estimated at 32.30 B $ in 2019 and is expected to reach 36.54 B $ in 2020 [3]. The market is likely to witness significant growth in the years to come on account of the growing geriatric

population, improved M2M communication systems, new product development, and improvements on the Internet of Things (IoT). The smart home appliances market is expected to grow at a compound annual growth rate of 14.1% from 2020 to 2027 to reach 92.72 B $ by 2027. Addressing the increased demand for integration of the different Smart Home IoT devices, there is a specific market segment focusing on Smart Home Hubs as the gateways to enable buildings smartization. The market analysis should differentiate between two main different segments: smart homes and commercial buildings. At first the Smart Home Hubs market at a broader term considering Smart Hubs, Smart Speakers, Appliances, Routers, and Smart TVs Enabling Communications in the Smart Home. The smart home hub market is largely driven by manufacturers equipping existing products with communicating technologies so that those products can act as the central platform for device interactions in the home. These moves create fewer barriers and provide a better user experience for consumers and enable vendors to own the customer experience around the smart home. Navigant Research expects global revenue for devices with hub capabilities to increase from $12.6 billion in 2019 to $72.9 billion in 2028 at a compound annual growth rate (CAGR) of 21.6%. Focusing the analysis on the smart home platforms and not counting added value services or hardware equipment that serve other roles, the global annual revenue is expected to grow from $3.2 billion in 2019 to $14.3 billion in 2028 at a compound annual growth rate (CAGR) of 18.1% [4].

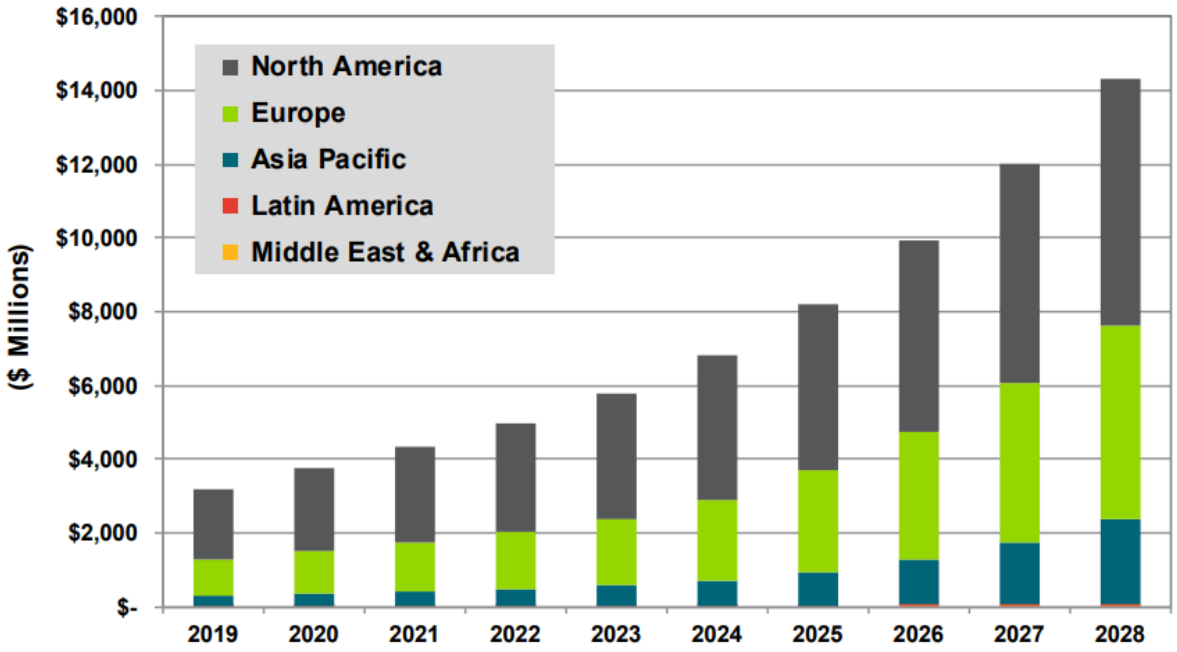

Figure 5 Market share of global smart home platforms [4]

On the other hand, at the commercial buildings we consider the integration of building automation solution (BAS). Traditional BAS control devices are increasingly embedded with computing and digital communications tools and therefore are more remote-accessible. However, they are competing with intelligent building solutions that use Internet of Things (IoT) and other innovative approaches for data collection, communications, and analytics. The opportunity to generate energy savings remains the foundation of BAS market demand but growing value exists in data ownership, advanced operations efficiency, and occupant engagement. Subsystem integration is also becoming more common with BASs, starting with the coordinated control and optimization of HVAC and lighting. This trend is creating a three-part market where traditional BASs lose share to a transitional (smart) market, with varying degrees of intelligent building penetration, and to an intelligent building market with full penetration. By 2029, global revenue for commercial BAS products is anticipated to reach more than $44.2 billion, growing at a compound annual growth rate (CAGR) of 3.2% from 2020 to 2029. Navigant report finds the traditional market ceding share primarily to the emerging transitional market, which is projected to grow at a CAGR of 15.9% from 2020 to 2029. The smaller, more advanced intelligent building market, is expected to grow at a CAGR of 17.6% from 2020 to 2029 [5].

3.1.1 Competition Analysis & Features Characterization

We presented above the results of the market analysis on the key segments of the IoT market, associated with the project activities. The scope of the project is to deliver a Smartness Hub for the seamless interactions with IoT devices, building management systems (BMS) and external data sources. Therefore, the competition analysis is focusing mainly at the level of home and building Gateways with the main competitors to be presented in the following tables.

Competitor	Description of product offering and State of Technology
Samsung SmartThings Hub -	Samsung SmartThings is versatile hub, supporting a broad range of devices thanks to both Zigbee and Z-Wave integration and an open approach. Protocol support for Z-Wave, Zigbee, and Bluetooth LE (future) decrease the likelihood of this controller becoming obsolete and the maturity in the market is even increasing supporting many integrations with different smart home devices.

HomeSeer – HomeTroller Zee S2 Home Controller	HomeSeer provides building automation software capable of running on Windows, Linux, and Macintosh computers. In order to provide this Zee S2 all-one-one lower-cost hardware and software solution. In addition to its included Z-Wave interface, the Zee S2 can control Insteon and X10 devices with an optional Insteon Power Lync Module.
Vera Control – VeraPlus Home Controller	The VeraPlus Home Controller boasts a mature interface supporting local processing of Z-Wave and Zigbee devices. The VeraEdge provides a flexible rule and notification set, and robust developer API. On paper, the VeraPlus commendably hits all the right bullet points. It is, however somewhat hard to pin down its user-base sweet-spot in today's market.
Nexia/Ingersoll Rand – BR100NX Bridge (7/10)	The Nexia BR100NX bridge is a Z-Wave only device that includes built-in battery back-up and provides an extensive alert and notification capability. Nexia's mature interface, developer API, and integration with a variety of industrial devices have made this a popular option for years. A subscription service is required with the bridge.
Amazon – Alexa Echo	Alexa Echo is a viable smart home system to run entire set up on, especially since the packing Zigbee connectivity into its smart speakers. Therefore, the Alexa is enabling integration with multiple smart home appliances supporting the different recipes/rules. With sensors, Alexa becomes a much more robust smart home system, letting create Routines that turn on the lights based on preferences and settings.
Google – Nest /Home Hub	Google Nest and Home are similar to the Amazon Echo device; however, Google Nest Hub does not support other protocolos like Zwave, Zigbee, Insteon, X10. For this reason, it is not the best choice to integrate different types of home devices and sensors.
Apple – HomeKit Hub	Apple's HomeKit falls between a software hub and traditional hub; there's a small box-like device needed if you want to control your devices while you're out of the house and that runs Automations. Apple's HomeKit has not Zigbee nor Z-Wave support, pretty much everything runs over Bluetooth and Wi-Fi, and thus requires separate home hubs to connect other types of devices.

Table 1 Smart Home Gateways – List of Market Solutions

From the aforementioned analysis, it is evident that the competition may split into 2 categories. The first category is the IT giants with the main focus to deliver a single home device and provide home automation services to their customers through the integration of IP based devices. The other group is the traditional smart home devices providers that in most of the cases provide the hub and some smart home equipment (or smart home compatible equipment) in order to enable the deployment of Smart Home IoT solutions. The key features that characterize the main smart home hub providers are presented in the following table (along with the mapping with the competitors as listed above)

Competitor / Feature	Samsung - SmartThings Hub	HomeSeer	Vera Control	Nexia	Alexa Echo	Google Home Hub	Apple – HomeKit Hub
Single Device vs Combo	Combo	Combo	Combo	Combo	Single	Single	Single
Multi-Protocol	+	+	+	+	(+)		
Device Integration Program	+				+	+	+
Cloud Data Handling	+		+	+	+	+	+
3rd Party API	+	+	+				
Applications Addon	+		+		+	+	+
Voice Assisted -Native					+	+	+

Table 2 Smart Home Gateways -Key feature analysis

3.2 (Energy) Data Analytics Market Analysis

3.2.1 Market Overview & Key segments

Data analytics is a field of huge expansion the last 2 decade and with mass applicability in different domains. It is thus evident that big data analytics is expected to play a crucial role in the energy sector towards reducing energy consumption and improving energy efficiency. These factors, along with other associated benefits, are expected to propel the demand for analytics in all human activities. The scarcity of fossil fuel is giving rise to alternate sources of energy such as solar, wave, and wind turbines, wherein consumption is increasing at a high pace. Thus, it has become imperative to use advanced tools that use data-based analytics to understand the behaviour or adaption of these sources of energy. In addition, the volatility in oil prices leads to high expenditure in energy-related projects, which creates demand for big data analytics. The energy sector demands high maintenance for machinery and equipment monitoring, owing to which big data analytics plays an important role.

According to Reportlinker.com [6] the big data analytics market in the energy sector is expected to grow at a Compound annual growth rate (CAGR) of 10.22%, during the forecast

period of 2020-2025. Gartner has also acknowledged the digital transformation in the energy and utilities domain, led by four disrupting forces - decarbonization, democratization, decentralization, and digitalization [7]. Successful companies must change the way they work by radically optimizing asset, network and business operations and re-envisioning the customer experience. Such optimizations are only possible with the proper data analytics tools in place.

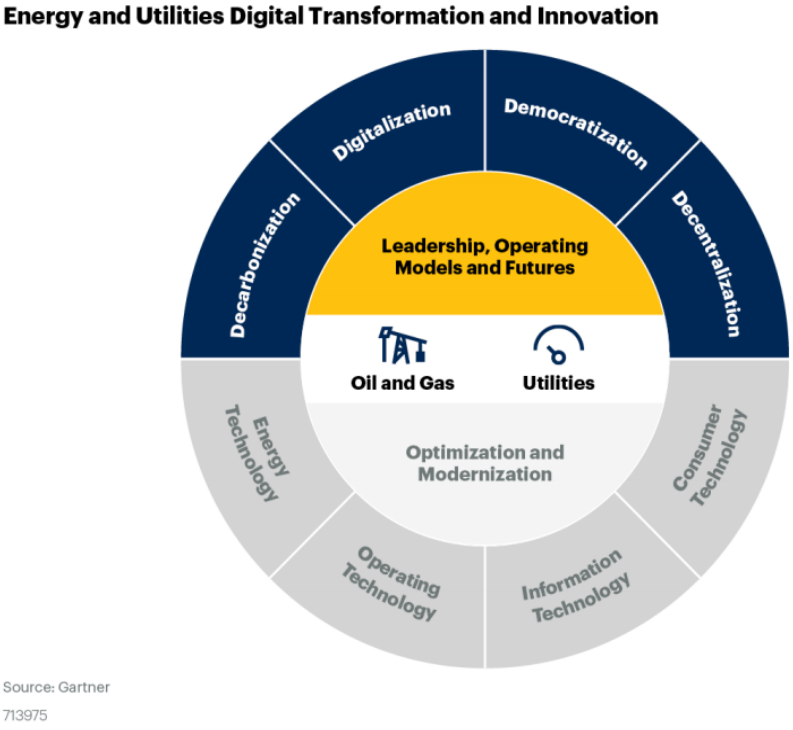

Figure 6 Gartner's digital transformation in the energy and utilities domain

In a recent report published by Guidehouse consultants, AI and Advanced Analytics [8] in the energy sector are further segmented to key categories spanning from: Generation Asset Analytics, Grid Operations Analytics, Grid Asset Analytics, Customer Operations Analytics, Demand Side Analytics, and Smart City Analytics. As it is evident, the focus in PHOENIX project is about delivering demand side/smart home/building level analytics spanning also the analysis at the generation side to address the need for the incorporation of the generation assets in the whole framework.

3.2.1 Competition Analysis & Features Characterization

In terms of energy data analytics market, many solutions come from companies with long experience in the energy domain but also from IT companies with vast experience on the provision

of analytics services at different domains. Also, small IT companies are emerging in the market to provide customized solutions based on end user needs. Most of the companies are providing a full series of analytics techniques applicable at the different application layers of the whole energy value chain. A non-exhaustive list of energy analytics services providers are presented in the following table.

Competitor	Description of product offering and State of Technology
EnergyIP – Siemens	EneryIP Analytics, which is part of the EnergyIP platform, provides data analytics for the energy management industry and incorporates the company's history and expertise Siemens in the area. Common use cases that are addressed includes distribution load analysis, customer load analysis, smart meter event analysis, power outage analysis, water and gas leakage detection. In addition, users can export data and import into their familiar tools such as Excel, Tableau, or Jupyter Notebook, etc., to run further data analysis.
IBM Maximo APM	IBM's Maximo APM for Energy and Utilities - a data management, visualization and analytics software solution that includes a broad range of pre-integrated analytic technologies. IBM Maximo APM for Energy and Utilities and IBM Data Model for Energy and Utilities are designed to work together to address key components of the new overall analytics landscape with the goal of reducing asset failures, improving asset utilization, optimizing network availability, decreasing loss of service and potentially reducing costs
SAP Cloud for Energy	SAP Cloud for Energy is a cloud solution for importing, validating, estimating and further processing time series and meter reading data with a seamless integration to SAP S/4HANA Utilities. Analytics is provided by the Energy Analysis application that runs on the Cloud for Energy platform. Use cases include aggregation, benchmarking, consumption pattern determination, peak load determination, as well as forecasting. There is also an API that enables the analytics results to be made available both for internal consumption (such as data scientists) and to external consumers.

Microsoft Power BI 4 Energy	Microsoft's Power BI solution for business analytics has different applications and customers in the energy domain. Its cloud scale analytics, which run on Microsoft Azure, offers ETL tools, storage solutions and machine learning models to accelerate data analysis.
Oracle 4 Utilities	Oracle provides numerous big data management and analytics services in the fields of field operation, asset management, meter operations, customer operations, etc. Special reference about Oracle Utilities Opower Energy Efficiency Cloud Service: Creating personalized, dynamic experiences that elevate customer satisfaction and boost program participation. Oracle Utilities Opower Peak Management Cloud Service: Managing peak demand through behavioural science, driving world-class results at a fraction of the cost as relevant to the scope of the project.
EcoStruxure Building Advisor service	Schneider Electric Building Analytics is an advanced life cycle managed service that delivers automated fault detection, diagnosis, and real-time performance monitoring for buildings. Information is captured from building systems and is sent to our cloud-based data storage. The advanced analytics engine uses artificial intelligence to process building data to continuously diagnose facility performance by identifying equipment and system faults, sequence of operation improvements, system trends, and energy usage.
BuildingIQ	The BuildingIQ 5i Platform of technology-enabled services learns and evolves with the needs of the building or portfolio of buildings. Main focus of the analytics is about energy visualizations and reports while also facilitating the operations and maintenance activities to be performed at the building environment.

Table 3 (Energy) Data Analytics – List of Market Solutions

We have to point out that while some solutions support standard data models, such as the Common Information Model and Building Information Model, and offer APIs for direct data access, users don't have direct access to the machine learning methods and models in use. Even though the reporting tools are somehow flexible and can be tailored to the different use cases, they are limited by the analytics tools available. In summary, energy data analytics solutions provided by leading

companies in the market are often offered as a "black box" solution, and while some level of customization is supported, they are not flexible when it comes to integrating new data sources of different types, or adding/combining different analytical methods and models. Therefore, a high-level characterization of the solutions is provided focusing mainly on the application domain.

Competitor / Feature	EnergyIP – Siemens	IBM Maximo APM	SAP Cloud for Energy	Microsoft Power BI 4 Energy	Oracle 4 Utilities	EcoStruxure Building Advisor service	BuildingIQ
IT Vendor		+	+	+	+		
Energy Vendor	+					+	+
Building/ Customer Analytics	+	+	+		+	+	+
Predictive Maintenance	+					+	+
Automation/ Optimization	+	+					+
Grid Level Analytics		+	+	+	+		

Figure 7 Energy Data Analytics - Feature analysis

3.3 Energy Efficiency & Maintenance Services Market Analysis

3.3.1 Market Overview & Key segments

The most emerging trend on the incorporation of digital services in the energy sector setting that way the prominent "Energy as a Service Market" framework (considering Energy Supply Services, Operational and Maintenance Services, and Energy Efficiency and Optimization Services). According to a report of MarketsandMarkets [9], the global energy as a service market is projected to reach 86.9 B $ by 2024 from an estimated 52.0 B $ in 2019, at a CAGR of 10.8%. This growth can be attributed to factors such as new revenue generation streams for utilities, increasing distributed energy resources, decreasing cost of renewable power generation and storage solutions, and availability of federal and state tax benefits for energy efficiency projects.

The energy supply services segment is expected to hold the largest market share by 2024. With the increasing prices, the consumers are looking to procure resilient energy supply to ensure that

they can operate without the grid. Also, with the growing focus on various energy supply sources such as renewable, fossil fuels, nuclear, biomass, and biofuels, energy as a service model mainly supports renewable energy as it lowers energy costs, reduces carbon footprint, ensures high energy efficiency, and is environment-friendly. At the same direction, significant expansion is expected also on the field of maintenance and energy efficiency services, driven by the regulation that promotes these concepts and relevant types of services.

Energy efficiency is big business and plays a large and valuable role in the sustainable development of the global economy. The penetration of P4P programmes the last 5 years are paving the way for the penetration of Energy as a Service (EaaS) with focus on energy performance. On the other hand, the EaaS model for efficiency improvements has not had much success historically in the residential sector. Residential customers are more likely than large commercial customers to default on a contract, which can discourage companies from seeking out clients. Other potential roadblocks to residential market penetration may have included greater difficulty in application. For example, tracking residential customer behaviour, especially in the past, may have been complicated by technological constraints on data availability and access, or by the high effort (and therefore low payback) associated with procuring individual customers. ESCOs can benefit from economies of scale in transaction costs when pursing business deals with large customers that use the same amount of electricity as hundreds or even thousands of individual households.

In the field of building maintenance, there are many technological advancements that drive the penetration of maintenance as a service programmes. At heart of maintenance for energy efficiency is predictive maintenance, as predictive analytics can be used to provide assessment for building equipment performance. The second category of maintenance strategy is condition-based maintenance (CBM). CBM techniques are performed by monitoring energy in real time with the help of IoT technologies. Any abnormal profile of energy consumption indicates that a fault on an equipment has occurred.

Overall, numerous possibilities exist for future EaaS models, many of which are becoming more feasible through technological advancement. Almost half of all residential electricity customers now use smart meters that track electricity usage electronically, which allows for the collection of useful data regarding consumer demand and, if applicable, home generation. Data analytics and advances in software and technology provide new opportunities for service companies to help customers save money beyond those available when the EaaS model originally evolved.

3.3.1 Competition Analysis & Features Characterization

As stated above, there are different segments under the umbrella of EaaS model. In the following, we are presenting some key technology players in the fields of Energy Efficiency & Maintenance as a Service, highlighting the key features of their solutions. As presented in previous section, there are conglomerate businesses in the domain but also small start-ups recently emerging in a quickly transforming market environment.

Competitor	Description of product offering and State of Technology
EnergyIP– Siemens	As stated above, Siemens is a traditional player in the market providing end to end solutions and thus targeting on the provision of energy efficiency services. At the core of the IP platform, Siemens provides energy efficiency analytics services, that are further combined with programs about Building performance monitoring - achievement against performance goals and set targets-, Building performance optimization, energy monitoring, building maintenance etc..
Schneider Electric- EcoStruxure Building Advisor	Through the analytics solution of the company (EcoStruxure Building Advisor) Schneider Electric provides key insights into building operations by constantly monitoring systems and identifying faults to proactively address building's inefficiencies. Through a threefold approach about: Continuous monitoring and performance trends to ensure your systems and equipment are operating as designed, Automated diagnostics to lower planned maintenance costs and focus on tasks based on business priorities, Verifying ROI on improvements.
Johnson Controls- OpenBlue	As a leader in energy efficiency services, the company is covering the full chai of solutions providing: energy efficiency auditing, energy management programs, energy performance contracting, energy retrofit programs and building maintenance solutions

Honeywell - Forge Energy Optimization	Honeywell Forge Energy Optimization is an autonomous building solution focused on decreasing energy consumption and decreasing a building's carbon footprint. Honeywell Forge Energy Optimization autonomously and continually optimizes a building's internal set points across hundreds of assets every 15 minutes to evaluate whether a building's HVAC system is running at peak efficiency. When Honeywell's solution finds a need to make an adjustment, it analyzes factors such as time of day, weather, occupancy levels, and dozens of other data points to determine the optimal settings per building and makes calculated decisions 96 times per 24-hour period for every building in a portfolio, 365 days a year across the system of assets. Honeywell is also a pioneer on building maintenance focusing mainly on the HVAC maintenance solution as the field of expertise for the company
Veolia- Hubgrade	Veolia develops energy services to reduce the energy consumption and CO2 emissions of buildings while preserving the comfort of their occupants. Based on an energy audit, the company develops an improvement plan including the installation of more energy-efficient equipment, tools for monitoring consumption and managing performance, as well as devices encouraging occupants to save energy. Hubgrade is a hypervision system and a building and infrastructure energy efficiency monitoring service developed by Veolia. Designed as a truly integrated management platform, Hubgrade collects data in real time which is analyzed to optimize work. This tool allows additional energy savings of up to 15 % to be made on energy efficiency in buildings compared to other energy efficiency services on the market.
Enertika	Enertika is a consulting company for energy efficiency. Enertika is focused on the development of projects to reduce energy consumption in which the required investments are repaid by the savings achieved through ESCo business model. Based in Spain, the company provides different types of energy solutions spanning from demand side management, energy auditing, energy efficiency, energy performance etc..
DEXMA Energy Intelligence Software	With data-driven Energy Intelligence, Dexma helps ESCOs, Utilities, OEMs, Energy Consultants & Green Corporates to optimise their Energy Transition and reach their Sustainability goals. The company provides different types of Energy Management services spanning from Benchmarking & Auditing, Real-Time Monitoring (Visualise energy data with intuitive, easy-to-use dashboards), On-Demand Control, Cost Allocation, Verified Savings, Easy Reporting etc.

ENGIE-Energy Efficiency Services	Acting more as an ESCO but with custom solutions for their customers, ENGIE is leader on the provision of energy efficiency and facility management services. The company is focusing on EPC contracts along with energy auditing and consultancy, to metering strategies and implementation to provide measurable energy-efficiency and facilities management initiatives on the way of cost reductions, carbon emissions cuts. Also, the company supports compliance schemes, including ESOS and ISO 50001 accreditation.

Table 4 Energy Efficiency and Maintenance Services– List of Market Solutions

Following the presentation of the different solutions targeting mainly the ESCO market, the key features are presenting in summary, screening that way the market requirements and needs about Energy Efficiency and Maintenance Services

Competitor / Feature	EnergyIP–Siemens	Schneider Electric-EcoStruxure Building Advisor	Johnson Controls-OpenBlue	Honeywell - Forge Energy Optimization	Veolia-Hubgrade	Enertika	DEXMA Energy Intelligence Software	ENGIE-Energy Efficiency Services
Building Equipment (Sensors etc..)	+	+	+	+				
ESCOs/EPC					+	+		+
ICT provider	+	+	+	+				
Maintenance Services	+	+	+	+	+			+
Energy Auditing	+	+	+	+	+	+	+	+
Energy Optimization	+	+	+	+	+	+	+	+
Energy Monitoring	+	+	+	+	+	+	+	+

Table 5 Energy Efficiency and Maintenance Services– key feature analysis

We have to point out that the field in the market is very wide operated both from big companies as presented above but also from small companies (and now also Utilities) at national level.

3.4 Non - Energy Services Market Analysis

3.4.1 Market Overview & Key segments

While the focus of the project is about delivering energy related applications, special interest should apply also about the delivery of non-energy services as a key enabler for the smartness of buildings. Home automation market at the broader term was valued at around $ 47.59 Billion in

2018, and is expected to grow at a significant rate in the expected time period to reach approximately $ 101.96 Billion in 2025, at a CAGR slightly above 15 % between 2018 and 2025 [10]. The demand is driven owing to the increasing adoption of Internet of Things. Shifting of customer focus from traditional houses to smart homes and change in luxurious and elegant lifestyle is also expected to support market growth.

Considering the market status, the majority of smart home devices are purchased for non-energy services applications, mainly security services as depicted in the following figure (Future Market Insights).

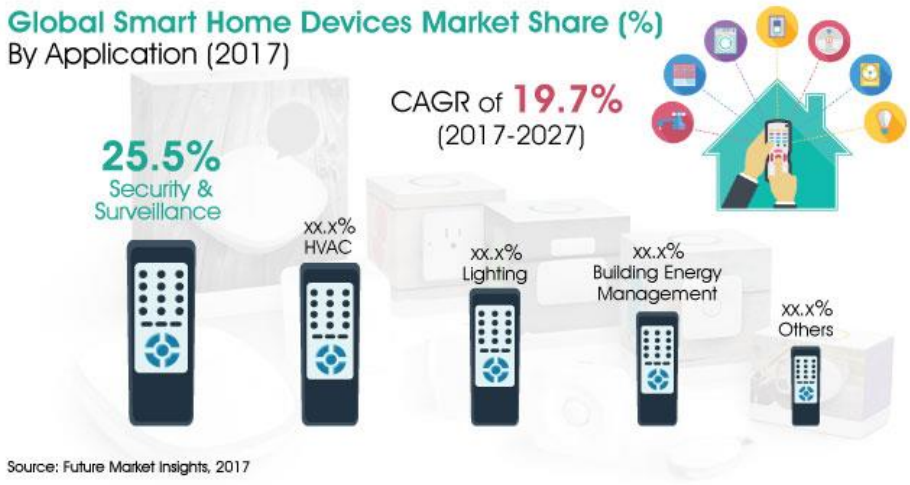

Figure 8 Market share of global smart home devices market share

Repeated studies have shown that consumers are interested in home security and safety propositions because they meet a clear need, linked to their desire to stay connected to the people, places and things that are important to them. For many in the industry, security and safety are often seen as the 'low hanging fruit' or entry strategy into the connected home market – and the means by which to capture value in the short to medium term.

On the other hand, a number of highly innovative proposition opportunities exist in the domain of home automation solutions, focusing also on users' comfort and convenience as the main focus of the project. Devices and solutions that automate tasks have a strong appeal for consumers; for instance, people prefer thermostats that adjust on their own to changing occupancy and outside temperatures and connected lights that automatically adjust to motion or occupancy. At the same direction, convenience is in demand with the expansion of voice-activated smart speakers for controlling thermostats, lights, or connected appliances. The global voice - activated solutions market size was valued at $ 9.12 billion in 2017 and poised to expand at a CAGR of 17.2% [11]

during the next 5-year period, highlighting that way the emerging need for comfort and convenience in the building environment.

In addition, there is a clear market need for ambient assisted living (AAL) technology – or telecare – in Europe and the Western world. This market has received attention for decades but remains small and immature as a result of multiple challenges, including an inverse correlation between needing care and being comfortable using technology, but more importantly determining who pays. According to a recent research, the global ambient assisted living market is expected to reach approximately $ 13.74 billion by 2027 growing at a 19.36% CAGR over the forecast period 2017-2027 ([12]).

3.4.2 Competition Analysis & Features Characterization

This competition analysis is then performed to highlight the most prominent commercial solutions in the field of non-energy services focusing mainly on home/building automation solution providers.

The phrase home automation (HA) is sometimes used interchangeably with energy services; however, as seen in the previous section energy services deal specifically with monitoring and controlling the building's energy consumption while automation services focusing mainly on the establishment of wellbeing and security in premises environment.

Considering the scope of the project, we will focus our attention on small and mid-range home automation service providers. The results of the competition analysis landscape are presented in the following table:

Competitor	Description of product offering and State of Technology
Loxone	Home automation and control system with energy management functions based on KNX, DMX, ModBus, RS232, RS485, EnOcean, Loxone Air protocols.
Zipato	Zipato is a full set home automation solution to control home from anywhere, automate all devices, see what's going on when you are away, and get instant alerts in case of any security or safety issue.
Control4	Control4 is a provider of automation and networking systems for homes and businesses, offering a personalized and unified smart home system to automate and control connected devices including lighting, audio, video, climate control, intercom, and security.
Fibaro	Fibaro is one of the newest, most complete and rich in functionality smart home solutions available on the market, offering a holistic smart home system to

	automate and control connected devices and providing added value services to the customers.
LightwaveRF	LightwaveRF is a home automation company which offers integrated light, heat, power and security solutions. It is based on a proprietary protocol providing both the hardware and the software for the delivery of home automation services.
Netatmo	Netatmo is a French company which manufactures smart home devices. It has launched a variety of products including various security cameras, personal weather sensors, and an internet-connected smoke detector and the associated applications.
homematic-ip	Homematic IP builds on the strengths of Homematic, implements IPv6 – the next Internet protocol generation – in each device and therefore offers a solution tailored to the Internet of Things (IoT). Homematic IP, can automate all areas based on user preferences: heating and climate control, light and shade, security and surveillance, weather and environment.

Table 6 Non-Energy Services – List of market solutions

Along with the presentation of the key competitors in the field, a feature characterization analysis. At first the pool of key features or service offerings from the different solutions are defined. Then a mapping of the features to the different solutions is provided in order to show the level of coverage. We have to point out that especially in the field of non-energy services there is not a single solution to address the full list of features as defined in the context of PHOENIX project.

Competitor / Feature	Loxone	Zipato	Control4	Fibaro	LightwaveRF	Netatmo	Homematic
Software & Hardware	+	(+)	(+)	+	+	+	
Multi-Protocol		+	+				
Remote control	+	+	+	+	+	+	+
Scheduling	+	+	+	+	+	+	+
Rule based automation	+	+	+				+
IAQ monitoring		+	+			+	+
Security Features	+	+	+	+	+	+	+
Notifications/ Recommendations		+	+	+			
Integration with 3rd parties		+	+	+		+	+

Table 7 Non-Energy Services key feature analysis

3.5 Demand Side Flexibility Services Market Analysis

3.5.1 Market Status & Trend

Demand response (DR) programs have been in for several decades but began to expand globally only after 2010. Nowadays the DR market is an evolving market with the new study conducted by Frost & Sullivan to forecast Europe demand response market to propel from the $0.9 billion market as is today to a $3.5 billion market by 2025. The residential, electric vehicles and data centre application segments are expected to dominate the market. Combined, the three sectors are expected to witness market share increase from 5% in 2017 to 15% by 2025 [13].

Given that most countries first implement DR programs that aggregate load reduction from large commercial and industrial (C&I) utility customers, the residential DR (RDR) market today is smaller than its C&I counterpart. However, utilities and grid operators have started recognizing that aggregated electric residential DR capacity (which is also the focus of PHOENIX project) can provide a substantial amount of load reduction or shift to both the capacity and open ancillary service energy markets.

In North America and Europe, regions with more legacy electric RDR programs and smart home and grid-connected technologies continue to proliferate and provide new sources of load reduction, and load shifting capabilities. These RDR program structures vary based on residential home energy needs and assets, such as the presence or absence of air conditioning (AC), water heating, and energy storage. Also, most of these programs are based on behaviour change or more singular smart home technologies, sourcing less load reduction capacity per site.

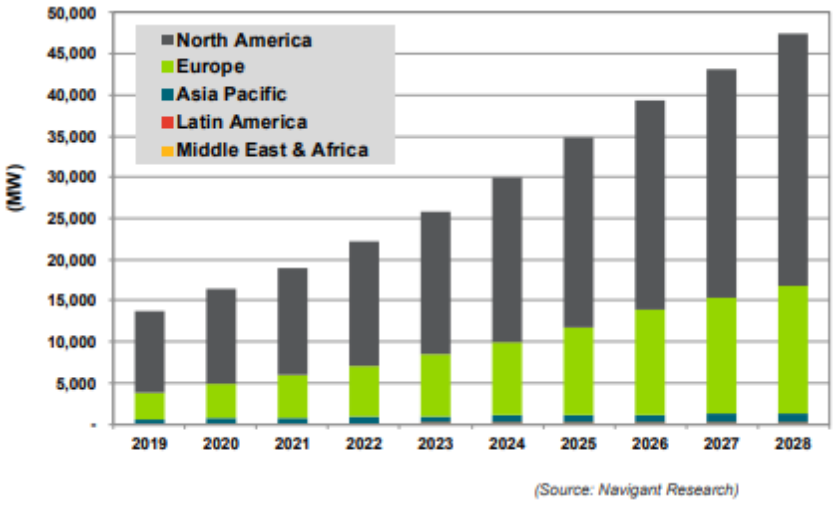

Figure 9 Residential Demand Response Market [14]

Based on recent surveys in RDR services market, by 2028 over 47.4 GW of RDR capacity will be available worldwide. In Europe, the total market size is expected to reach at ~ 15 GW at 2028 [14] showing the high potential for the penetration of DER services.

3.5.2 Competition Analysis & Feature Characterization

As demand response penetration is expanding around the world, there are many service providers focusing at the provision of DR related services. The focus on this section is about the analysis of the market for the residential DR service providers at EU level. The European countries that currently provide the most conducive framework for the further development of Demand Response have been identified as Switzerland, France, Belgium, Finland and Great Britain. Therefore, the analysis is focusing on the analysis of the market and service providers operating at these specific countries.

The main business actors in the field are presented in the following table:

Competitor	Description of product offering and State of Technology
Restore	Now part of Centrica, Restore was among the biggest DR service providers. REstore's Automated Demand Response (ADR) solution allows utilities to grow innovative downstream activities in Demand Side Management, deploying DR programmes across their customers to build and monetize clean virtual power plants "built" from the demand-side.
Tiko	Among the pioneers in the field of residential Demand Response in Europe. The tiko platform brings the power of a Virtual Power Plant and an award-winning Smart Home Energy Management system designed to connect Residential and SME assets. With its active VPP deployments, tiko is one of the biggest real-time HVAC system managers with focus on providing DR services in France and Switzerland.
Voltalis	Similar to Tiko is considered among the pioneers in residential DR services. Focusing on the management of domestic hot boilers in France, is providing a unique platform to integrate individuals and offer fine grained DR services to the market.
EnergyPool	One of the biggest DR service providers in Europe, responsible for the management of GW scale assets. The focus is mainly at the provision of C&I demand response services but with a high interest to expand the service offerings and provided residential based demand response services.

SEAM Group	SEAM Group is a major energy aggregator in Finland, contributing also for a better implementation of demand response programs offered by the system operators. SEAM identifies as the first Finnish company to provide energy optimization services, considering three types of demand response: shifting, curtailment, and adjustment. In this way, SEAM acts as a promoter entity for the demand response programs made available by the national system operator, increasing that way the available flexibility on the network
SONNEN	Sonnen is the biggest residential battery manufacturer in Europe. One of the main services provided by SONNEN is the provision of a platform that will facilitate the different battery owners to aggregate and actively participate in the markets through the provision of demand response services. The
Nuvve	Nuvve is another vertical aggregator focusing on the aggregation and management of EV charging points towards the provision of flexibility services to the grid. The main innovation is that Nuvve acts as the first EU Aggregator focusing on V2G functionality.

Table 8 DR Management Systems – List of List of market solutions

We presented above a non-exhaustive list of EU DR service providers. There are many other companies operating in Europe and testing DR services either at industrial or R&D level. In the following table, we present the list of features that characterize the DRMSs and a mapping of the different features to the service providers presented in the previous table.

Competitor / Feature	Restore	Tiko	Voltalis	EnergyPool	SEAM Group	SONNEN	Nuvve
Software & Hardware		+	+		+	+	+
Multiple Devices	+	+		+	+		
AI Analytics	+		+	+	+		
Energy Efficiency Services	+	+	+	+	+		
Active in the Market	+	+	+	+	+		
Explicit DR	+	+	+	+	+	+	+

Table 9 DRMSs - key feature analysis

The scope of the non-exhaustive market analysis is twofold: (a) to identify the trends at the different market segments that are examined in the PHOENIX project and (b) to define the key

features at the different solutions available in the market, information that will further drive our work towards the definition of the PHOENIX MVP.

4. PHOENIX REGULATORY FRAMEWORK ANALYSIS

4.1 Overview

The scope of this section is to provide an analysis of the regulatory framework and guidelines related to the scope and objectives of the PHOENIX project. The analysis is taking into account at first the Clean energy for all Europeans' package; a set of legislative acts on the energy performance of buildings (EPBD), renewable energy, energy efficiency, governance and electricity market design along with the newly established Green Energy Deal which is now under discussion. In addition, regulations related to data exchange, storage and protection (i.e., GDPR) as well as guidelines regarding algorithms development and digital services are studied in detail.
Apart from the brief analysis of the relevant regulation, the analysis identifies potential synergies with PHOENIX project in order PHOENIX to be completely aligned with EU's regulations.

Clean Energy Package for All Europeans

In 2019 the EU completed a comprehensive update of its energy policy framework to facilitate the transition away from fossil fuels towards cleaner energy and to deliver on the EU's Paris Agreement commitments for reducing greenhouse gas emissions. The agreement on this new energy rulebook – called the Clean energy for all Europeans package - marked a significant step towards the implementation of the energy union strategy, published in 2015 and is considered as the basis for the energy regulation in Europe.
The new rules aim to bring considerable benefits from an environmental perspective, and from an economic perspective considering the consumers at the centre of the energy transition. This is a key point also reflected in PHOENIX project where the focus is at delivering energy services for the end customers, the consumers.
Details about the most relevant points of the regulation are presented in the following.

Energy Performance in Buildings Directive (EPBD)[15]

At first, and with high relevance with PHOENIX project is the new Energy Performance in Buildings Directive. The EPBD aims to improve energy efficiency of buildings and to take further actions in order to create the necessary conditions to scale up renovations and reap the significant saving potential of the building sector; of high importance as the energy consumption in buildings comprise over 40% of the total EU stock. More specifically the list of actions promoted by the new EPBD are [16]:

- A path towards a low and zero-emission building stock in the EU by 2050 by implementing national roadmaps to decarbonise buildings
- Smarter buildings - encouraging more automation and control systems to make them operate more efficiently
- A smart readiness indicator that will measure a building's capacity to use new technologies and electronic systems to adapt to the needs of the consumer, optimize its operation and interact with the grid
- Combat energy poverty [17] and reduce the household energy bills through renovation and improved energy performance of older buildings
- E-mobility in buildings - supporting the rollout of e-mobility infrastructure such as e-charging points in buildings
- More money and support to renovate – by mobilising public and private financing and investment for renovation activities, and strengthening long-term building renovation strategies

All these points are thoroughly considered in the context of PHOENIX project where the focus is at the demonstration of new technologies and services that will increase the level of smartness in buildings.

In addition, the Commission has established a set of standards and accompanying technical reports to support the EPBD called the energy performance of buildings standards (EPB standards).

Energy Efficiency Directive [19]

Under the 2012/27/EU Directive [18], all EU countries were required to use energy more efficiently at all stages of the energy chain, including energy generation, transmission, distribution and end-use consumption while a number of important measures had been adopted to improve energy efficiency in Europe such as the preparation of national energy efficiency action plans (NEEAPs) every three years and the planned rollout of close to 200 million smart meters for electricity and 45 million for gas by 2020. In 2018, the new amending Directive on Energy Efficiency (2018/2002) was agreed in order to update the policy framework to 2030 and beyond. Apart from the key element of the amended that was the adaptation of the headline energy efficiency target for 2030 of at least 32.5%, stronger rules on metering and billing of thermal energy as well monitoring efficiency levels addressing also health issues, lower air pollution, and improve people's quality of life. These aspects are of high focus in PHOENIX project where the

aim is to ensure significant energy savings while also promoting the establishment of a healthy and convenient building environment.

Electricity Market Regulation [19]

The Energy Union aims to provide final customers – household and business – with safe, secure, sustainable, competitive and affordable energy. This Regulation establishes rules to ensure the functioning of the internal market for electricity and includes requirements related to the development of renewable forms of energy and environmental policy. The end customers should be able to participate in market-based energy schemas (participate actively, individually or through communities, in all markets, either by generating electricity and then consuming, sharing or selling it, or by providing storage services) and better control their costs (through the evolution of dynamic pricing schemas that better reflect the cost of energy) tackling that way the growing issue of energy poverty (allowing them to be rewarded for participating in innovative schemas like shifting consumption to times when energy is widely available and cheap). These concepts as defined for future electricity market at European level are of high relevance with the activities performed in PHOENIX project towards the definition of the right tools services that facilitate consumers and prosumers active participation in innovative market schemas, like participating in demand response programmes, dynamic/ flexible tariff schemas, self-consumption management etc…

Not directly linked with the activities performed in the project, but as core part of the regulation of the Clean Energy Package is the Governance of the Energy Union [20] which brings together policies on energy efficiency, renewables and governance of climate and energy targets by requesting that Member States develop National Energy and Climate Plans (NECPs) and long-term low emission strategies. It also contains the process for adopting and monitoring national energy objectives on renewable energy deployment and energy efficiency, as Member State contributions to EU level binding targets in these areas (e.g., reduction of 40% of greenhouse gas emissions, a minimum of 32 % renewables in the EU energy mix etc.). This is a fundamental step of the EU regulation towards setting the midterm objectives at EU level and at the national countries.

Finally, the Renewable Energy Directive [22] that among others allow households, communities and business to become clean energy producers with the recast on 2018/2001/EU to enter into force and set a new binding renewable energy target for the EU for 2030 of at least 32%, with a clause for a possible upwards revision by 2023

General Data Protection Regulation (GDPR) [23]

Along with the Clean Energy Package for All Europeans (with focus on EPBD) which is of high relevance for the project actions, we refer also to the General Data Protection Regulation as the new legislation about data protection which finds applicability in energy domain and the data-driven activities performed in the PHOENIX project.

The data collected from smart meters, smart systems and devices etc… could be classified as confidential or private, as it is information collected from consumers/prosumers and subsequently are consider of personal nature, and their processing can be based on various purposes such as the improvement of energy efficiency, metering accuracy, customer information, grid stability etc. Hence, the data collected by smart metering systems might be subject to different restrictions of processing and transmission that must be thoroughly considered in the context of the project. Apart from the generic GDPR regulation, we refer also to the guidelines defined by the SGTF – EG2 [24] where the details about GDPR implementation at the smart grid domain and applications (considering also the key measurements and criteria that have to be considered at the development of information systems in the energy domain) are specified.

Complementary to the GDPR regulation we present also the Free flow of non-personal data in the European Union Regulation. This Regulation aims to ensure the free flow of data other than personal data within the Union by laying down rules relating to data localization requirements, the availability of data to competent authorities and the porting of data for professional users. The GDPR already provides for the free movement of personal data within the Union, next to its primary goal of protecting personal data. Together with the GDPR, this Regulation will therefore ensure a comprehensive and coherent approach to the free movement of all data in the EU.

Related to the data protection, the EU guidelines on ethics in artificial intelligence are addressed to all AI stakeholders designing, developing, deploying, implementing, using or being affected by AI in the EU, including companies, researchers, public services, government agencies, institutions, civil society organizations, individuals, workers and consumers. The ethics principles applied in the context of PHOENIX project (as in any EU project responsible on handling personal data) are of high importance addressed in a dedicated WP – WP9 of the project.

European Green Deal [25]

This is the new legislation attempt at EU level to succeed the work defined with the Clean Energy package regulation towards making Europe climate neutral in 2050. The European Green Deal is a set of policy initiatives by the European Commission with the overarching aim of 55% CO2

emissions reduction in order to assure climate neutrality. Reaching this target will require action by all sectors of our economy, including

- investing in environmentally-friendly technologies
- supporting industry to innovate
- rolling out cleaner, cheaper and healthier forms of private and public transport
- decarbonising the energy sector
- ensuring buildings are more energy efficient
- working with international partners to improve global environmental standards

Of high relevance with the PHOENIX project activities, the promotion of renovation and efficiency on energy buildings through the "Renovation Wave for Europe" [26] schema. More than 220 million building units, representing 85% of the EU's building stock, were built before 2001 and it is estimated that 85-95% of the buildings that exist today will still be standing in 2050. Not surprisingly, most of those existing buildings are not energy-efficient as they rely on fossil fuels for heating and use old technologies. Thus, EU triggers a Renovation Wave for Europe, breaking down long-standing barriers to energy and resource-efficient renovation, supporting fresh investment over a sustained period starting from public and less efficient buildings, spurring digitalization and creating employment and growth opportunities across the renovation supply chain.

In close direction to the new regulation, the Commission adopts new rules to address energy poverty ((EU)2020/1563) [27] providing as additional recommendations on top of the electricity markets directive.

In parallel to the strategy, the Commission adopted new rules for the smart readiness of buildings in two relevant regulations:

- C(2020) 6929 [28]: Implementing regulation detailing the technical modalities for the effective implementation of an optional common Union scheme for rating the smart readiness of buildings
- C(2020) 6930 [29]: Delegated Regulation supplementing Directive (EU) 2010/31/EU of the European Parliament and of the Council by establishing an optional common European Union scheme for rating the smart readiness of building

Also, as part of the most recent regulation in the field of smart buildings, to highlight the most recent work at EU level about building digital logbooks. In October 2020 [30], EC presented the Report of the study on the development of a European Union framework for buildings' digital logbook with focus on supporting the widespread use of DBLs across Europe. The EC document

encourages data transparency and increased data availability to a broad range of market players, including property owners, tenants, investors, financial institutions and public administrations. In addition, the DBL contribute to a number of high-profile policy initiatives including the strategy "A Europe fit for the digital age", the "European Green Deal" and its Renovation Wave, the new Circular Economy Action Plan and the forthcoming Strategy for a Sustainable Built Environment. Several European countries have developed and implemented DBL-type initiatives over the last years and share a common objective to increase data availability and transparency to a broad range of market players. The existing DBLs however differ in terms of focus (e.g. on energy efficiency or materials), data handling and digital solutions employed. While paper-based logbooks do exist, it is widely accepted that to reap the most benefits of such tool digital features are required. A common European approach covering the entire lifecycle and comprising all relevant building information could increase learning and enable synergies, interoperability, data consistency and information exchange.

Along with the EU regulation analysis as presented above, the national regulation at the target countries is presented in the following section in brief.

4.2 Greece - Regulatory Analysis

In accordance to the EU legislation, the Greek regulation has been recently transforming to address the new topics in the in the field of energy performance at buildings. The starting point for this work in the last decade is the Law 4122/2013 [31] "Transposition of the EPBD directive 2010/31/EU into the Greek legislation" with the EPBD recast 2010/31/EU to be transferred to national Greek legislation. This law includes many provisions regarding the reduction of energy consumption in the building sector and the improvement of the energy efficiency of buildings. It was planned to improve the energy efficiency of buildings, with the aim of serving as a key tool in policy-making for the energy upgrading of buildings.

In existing buildings or building units that are radically renovated, their energy efficiency is upgraded, to the extent that this is technically, operationally and economically feasible, in order to meet the minimum energy efficiency requirements, set out in KENAK [32]. KENAK was established in 2010 to describe the minimum specifications for the design of buildings through an integrated design approach among the key-players taking into account proper building space layout and orientation; arranging interior spaces depending on their use and the comfort requirements; integrating natural ventilation techniques; integrating at least one passive solar system; configuring the surrounding space, designing and locating the building's openings for different orientations

depending on direct solar gains, daylight and ventilation requirements providing proper solar protection; exploiting daylight for securing visual comfort. Failure to comply with any of the above should be supported by proper technical justification.

The minimum specifications for the building services, include heat recovery by at least 50% in central air-handling-units with fresh air supply greater than 60%, proper thermal insulation of all heat and cold distribution pipes or ducts, use of outdoor temperature compensation systems, hot water recirculation with variable speed pumps, coverage of the SHW load by 60% from RES, energy efficient lighting with proper central control in non-residential buildings, thermostatic control in different thermal zones, independent heating and cooling with heat meters, power factor correction in non-residential buildings. In tight connection with KENAK is the "The Hellenic Technical Guidelines" (TOTEE) outlining the calculation procedures and standardized forms for performing building energy audits, preparing the EPC and performing the HVAC inspections.

Following years of recession, the country started restructuring the regulation in the field at 2018. Law 4513/2018 [33] "Energy communities and other Provisions" set the legislative framework for the establishment of Energy Communities (ECs) in Greece. The aim was to promote innovation in energy, social economy and energy solidarity as well as to increase efficiency in energy consumption in local communities. ECs are incorporated as civil law partnerships by individuals, law entities and municipal authorities and may deal with production, self-consumption storage and sale of electricity or heating/ cooling deriving from RES. ECs are in principle non-profit organizations, but under certain circumstances they may distribute profit in their members. Though the main transformation that is relevant to PHOENIX project activities took place at the end of 2019. In December 2019 was presented the new National Plan for Energy and Climate (NPEC) [34] in accordance with the EU Agenda 2030 as well as with the recently adopted Clean Energy Package. More specifically, the NECP has set the following objectives for 2030:

- Initially with regard to climate change and emissions, a much higher core objective for reducing greenhouse gas (GHG) emissions by more than 42% compared to emissions in 1990 and more than 56% compared to emissions in 2005, exceeding this way even the core EU targets
- With regard to renewable energy sources (RES), a much higher objective concerning the share in gross final energy consumption, as there is now an objective for a minimum share of 35%, compared to 31% in the initial NECP draft

- There is a quantitative objective for final energy consumption in 2030 to be lower than that recorded in 2017. Therefore, the NECP's objective is fully compatible with the relevant EU indicator
- A key objective for the NECP is the highly ambitious programme for sharply and definitively reducing the share of lignite in power generation, i.e. the so-called lignite phase-out, by implementing a relevant front-loaded programme in the following decade and putting a complete end to the use of lignite for power generation in Greece by 2028.

To attain the above objectives, the NECP sets out and details the individual policy priorities for the following period and the corresponding policy measures that are being planned for implementing the priorities and attaining the objectives of the NECP.

In the field of data protection (an aspect of interest for the PHOENIX project), Greek Parliament adopted Law 4624/2019 [35] "Harmonization of Greek legislation with the provisions of GDPR, Incorporation of Directive 2016/680 for the processing of personal data by public authorities with respect to criminal offences", which frames the provisions of the GDPR in Greece and has come into effect as of August 2019. Law 4624/2019 has made use of the majority of the derogations provided for in the GDPR by setting forth specific rules on the processing of employees' personal data, "sensitive" personal data and personal data in the sectors of health, insurance and media. In addition, the law introduces significant limitations on the usage of the data of the individuals, whereas it provides for exemptions that release controllers from their obligation to communicate personal data breaches to the affected individuals. Another important part of the law is the different treatment on the lawfulness of and restrictions on the processing of personal data depending on whether the controller is classified as a public or a private entity.

4.3 Sweden - Regulatory Analysis

In Sweden the EPBD legislation is worked into the "Regulation on energy declarations BED" [36], and in "Energy management - section 9 BBR" [37]. The most recent version of "Regulation on energy declarations", BED is named "Konsoliderad version av BED, BFS 2007:4 med ändringar till och med BFS 2018:11" and the last update took place in 2018 incorporating the most recent mandates of EPBD. In the report [38], it is stated that buildings, (with some exemptions), has to be inspected and an energy declaration must be made. The energy declaration is summarized according to a grading system ranked from A-G where A is the most energy efficient and G is the least, harmonised with the rest of the energy labels existing in other member states. Also, there is a new consolidated version of BBR, "BFS 2011:6 med ändringar till och med BFS 2020:4" [39]

incorporating in Section 9 regulations and general advice regarding energy management as promoted by the recent EPBD legislation.

The National Board of Housing, Building and Planning analyses how the revised EPBD affects the ongoing regulatory work, what it means and how they can handle the changes in the directive. In line with this, the National Board of Housing, Building and Planning consults with external actors to jointly find the best solution for how they should proceed in the work and how the revised EPBD should be handled in the Swedish regulations.

In the 2021-2030 era, the final NECP for Sweden is available specifying the details for the energy transition in Sweden the following years. The Swedish integrated National Energy and Climate Plan (NECP) is largely based on the Energy Bill and the existing climate framework. It describes a wide range of existing policies for reducing greenhouse gas emissions, as part of an overall framework to promote the transformation of the Swedish economy to become sustainable and climate neutral by 2045. The Swedish energy and climate goals for 2030 and beyond are:

- By 2045, Sweden must have net zero emissions, of which at least 85 percent of the reduction of emissions must take place in Sweden.
- Greenhouse gas emissions should be 63 percent lower in 2030 compared to 1990 (applies to activities not covered by the EU Emissions Trading Scheme).
- Emissions for domestic transport excluding domestic flights will be 70 percent lower in 2030 compared with 2010.
- Energy use will be 50 percent more efficient in 2030 compared to 2005 (through reduced energy intensity).
- Electricity production must be 100 percent renewable by 2040 (but it is not a stop date that prohibits nuclear power).

At the same direction, in March 2020 the third national strategy for energy efficiency renovation was decided [40], to provide support for the building stock to have a high degree of energy efficiency and facilitate existing buildings to be converted into so-called near-zero energy buildings in a cost-effective way. The strategy will also contribute to the EU's long-term goals of energy efficiency and greenhouse gas emissions reduction and become part of Member States' national energy and climate plans. The document contains indicative milestones to contribute to the achievement of the EU energy efficiency target. One of the areas is the fossil share of energy use in the building stock that should be 1% in 2030 and 0% in 2040.

In the field of data protection, the EU GDPR (General Data Protection Regulation) has been valid in Sweden since May 2018 and under the Law (2018:218) 'Data Protection Act' [41] as

complemented by the Ordinance on Supplementary Provisions to the GDPR (2018:219). "Datainspektionen" is the Sweden's national supervisory authority responsible to check compliance with data protection laws and regulations. The checks that it makes primarily concern the GDPR, the Camera Surveillance Act, the Credit Information Act, the Patient Data Act and the Debt Recovery Act, but it is also the supervisory authority for a large number of other statutes.
Giving advice and disseminating knowledge is also an important part of the Swedish Data Protection Authority's work. It does this for the people who process personal data in society, the data controllers and the people whose data is processed – the data subjects. Checks on compliance are mainly by means of inspection.

4.4 Spain - Regulatory Analysis

As stated above, the EU has committed itself to a clean energy transition, which will contribute to fulfilling the goals of the Paris Agreement on climate change and provide clean energy to all. To deliver on this commitment, the EU has set binding climate and energy targets for 2030 which in Spain are reflected in the 10-year National Energy and Climate Plan (NECP), setting out how to reach its national targets. The key targets and contributions foreseen in the draft National Energy and Climate Plan are:

- The Spanish draft integrated National Energy and Climate Plan (NECP) lays the foundation for a carbon neutral economy by 2050 in line with Green Deal objective. While covering all dimensions, the draft NECP is particularly comprehensive on targets and contributions as well as policies and measures on decarbonization (including renewable energy) and the energy efficiency dimensions.

- Spain's 2030 target for greenhouse gas (GHG) emissions not covered by the EU Emissions Trading System (non-ETS), is -26% compared to 2005, as set in the Effort Sharing Regulation (ESR)

- The planned national ambition level of 42% of energy from renewable sources in gross final energy consumption in 2030. The draft plan describes comprehensive measures to promote renewable electricity, heating and cooling and transport.

- Regarding energy efficiency, the 2030 primary energy consumption target represents a 39.6% reduction compared to the baseline projections.

- On energy security, the objective to reduce energy dependency to 59% by 2030.

- An increase of the interconnection level will be pivotal to improve the integration of Spain and the Iberian Peninsula into the Energy Union, as well as to accompany and steer the development of renewable energy sources in the region. Spain aims for an interconnection level of 15% in 2030

The legislation on energy efficiency in buildings in Spain has undergone important modifications until now, being the Royal Decree (RD) 47/2007 [42] on Energy Certification in Buildings a fundamental part of it. This was the first RD on energy efficiency, and it laid the foundations for all the laws that would come later. This RD was repealed by RD 235/2013 [43], which carried out the transposition required by the Energy Performance in Buildings Directive (EPBD) 2010/31/EU. This law modified the regulations on energy efficiency certificates considering the accumulated experience after applying the RD 47/2007 in the previous five years before the new RD was approved. Based on the recast legislation all new buildings, administrative and public buildings and existing buildings when they are sold or rent, need to have an Energy Certificate.

In addition, the Technical Building Code, Royal Decree 314/2006 [44], the regulation for thermal installations, Royal Decree 1027/2007, and their later modifications describe the minimum specifications for the design of buildings through an integrated design approach among the key-players taking into account proper building space layout and orientation may be considered for the PHOENIX project. This legislative framework sets the maximum expected consumption, the requirements of the thermal envelope, the need for thermal and photovoltaics solar systems according to the type of building and the efficiency parameters for the lighting system with proper central control in non-residential buildings and use of daylight illuminance. The minimum specifications for the HVAC installations include mainly efficiency requirements for thermal production units, heat recovery and free-cooling in mechanical ventilation systems and thermal insulation for pipes and ducts.

In the field of energy markets and with high relevance to the CEP, the current national policy framework has yet to apply the European Regulation (EU) 2019/943 that will allow small/medium users to participate actively in the energy market as prosumers and develops the figure of energy communities. Nevertheless, it is expected that the national regulation will be developed in short period of time, so figures as the aggregator or demand response programs could be available for all users and energy actors. For the most important legislation in this regard, it is important the

Law 24/2013 [45] which regulates the electrical sector. This law collects information about the providing of supply, including off-grid installations, or the electricity exchange between different territories. The law also covers the section for economic and financial sustainability of the electrical system, in which the different tariffs and other price-related issues are contemplated.

Last but not least, one important milestone in Spain was the RD 244/2019 [46], which facilitates renewable installation for self-consumption. This new legislation allows the citizens to inject on the electricity grid their electrical surplus, and multi-property renewable plants where all participants can take advantage of the produced energy.

The Spanish Data Protection Agency is the independent Public Authority in charge of the Data Protection and was established with the Organic Law 5/1992. The Spanish Data Protection Legislation has incorporated the European Directive 95/46/EC (General Data Protection Regulation). This Directive sets new rules for the protection of personal data in the member states of the European Union. In order to adapt and develop certain matters contained in the European Regulation and the new coming GDPR, the Spanish Parliament has approved the Organic Law 3/2018 [47] of 5 December on the Protection of Personal Data and the Guarantee of Digital Rights. The Organic Law 3/2018 aims the address the GDPR regulation requirements and place them in the national regulation to address data privacy needs.

4.5 Ireland - Regulatory Analysis

The regulation in the field of energy performance of buildings in Ireland last for most than one decade. Ireland's legislation on the energy performance of buildings was amended for the purpose of giving effect to Directive 2010/31/EU of the European Parliament and of the Council on 19 May 2010 Stratutory Instrument (S.I.) number 243/2012. The regulations in S.I. 243/2012 [48] defines that a person who commissions the construction of a new building other than a dwelling shall ensure that, before construction starts, the technical, environmental and economic feasibility of installing high efficiency alternative energy systems is considered and a person who commissions the construction of a new dwelling shall ensure that a reasonable proportion of the energy consumption to meet the energy performance of the dwelling is provided by energy from renewable sources in accordance with the Building Regulations (Part L Amendment) Regulations 2011 (S.I. No. 259 of 2011[49]).

Furthermore, any building (with exemptions to protected structures and temporary buildings) in Ireland must attain a Building Energy Rating (BER). This is a grading system ranked from A-G with A rated buildings being the most energy efficient and G rated being the least, in accordance with energy building performance certification in EU member states. From the 1 November 2019, new building standards were applied to all new residential dwellings (houses and apartments). New dwellings will typically require a Building Energy Rating (BER) of A2. New dwellings with this high level of energy performance are called Nearly Zero Energy Buildings (NZEB). NZEB homes will be 70% more energy efficient and emit 70% less carbon dioxide than those built under 2005 Building Regulations standards.

S.I. 426 of 2014 [50] was defined to give the legislation for which the public and private sectors are to follow to pursue the targets and actions contained in the NEEAP (as mandated by Article 24 of the EU Energy Efficiency Directive which required Member States to submit a National Energy Efficiency Action Plan (NEEAP) every three years). Public bodies shall fulfil their exemplary role in accordance with requirements published by the SEAI and including through the maintenance and construction of energy efficient buildings pursuant to measures adopted under Regulation 9, their energy management practices, energy efficient procurement under Regulation 10, the use of energy audits under Regulation 11, the use of financial instruments for energy savings, the use of energy services and other cost effective actions relevant to the Regulations of S.I. 426.

In the field of energy market, all electricity in Ireland is traded via the wholesale electricity market, the Single Electricity Market (SEM [51]). While electricity as a commodity is something that we need in our daily lives, and for which there is a demand for, it can't be easily stored. The SEM was set up in 2007. Due to a greater generation of renewable sources across Ireland and o the way to meet the target model the SEM became the I-SEM in 2018. A key principle of the I-SEM market is the flexibility that it offers and integration with European markets. This includes those who take part, the different ways in which these market participants can trade in the market over different time periods to meet their needs and the incentives in place. By mid-2021 customers will be able to avail a feed in tariff for renewable generation in accordance with the requirement of the Renewable Energy Directive.

Ireland is currently behind on its targets as defined at EU level. However, the Climate Action Plan [52] of 2019 sets out 180 actions to get Ireland back on track. Measures from the Climate Action Plan will feed into Ireland's National Energy and Climate Plan. Projections of Ireland's targets for 2021 to 2030 indicate that a strong surge in demand for electricity, at a rate faster than the

introduction of renewables, will mean Ireland's ETS sector emissions will continue to increase up to 2025, after which point policies contributing to fuel switching in power generation will contribute towards stronger emissions reduction to the end of the decade. While annual emission limits for the period 2021 to 2030 will guide Ireland towards the 2030 target, the main binding target will be for cumulative emissions.

The Government supports the adoption of a net zero target by 2050 at EU level in line with EU Green Deal. The Climate Action Plan puts in place a decarbonization pathway to 2030 which would be consistent with the adoption of a net zero target in Ireland by 2050. The Plan also commits to evaluating in detail the changes which would be necessary in Ireland to achieve this target. In 2014 Ireland adopted a National Policy Position for an 80% reduction in CO2eq. emissions by 2050 compared to 1990 levels for the electricity generation, built environment, and transport sectors. It also outlines an approach to carbon neutrality in the agriculture and land-use sector, including forestry, which does not compromise on national capacity for sustainable food production. Some more targets Ireland has committed to for 2050 in association with European Green Deal are a target of 55% renewable power, delivery of the full BusConnects [53] programme for all of Ireland's cities, retrofit plans for 450,000 homes, at least 500,000 electrical vehicles on the road by 2030 with additional charging infrastructure to cater for planned growth.

In the field of data protection, the Data Protection Act of 2018 [54] is the act to monitor data usage in Ireland. Every regulation made under this Act, other than under section 51, 60 or 73, shall be laid before each House of the Oireachtas as soon as may be after it is made. On the day the Act was established the Data Protection Commission was established and put in charge of data protection regulation. The Commission shall monitor the lawfulness of processing of personal data in accordance with: (a) Regulation (EU) No 603/2013 of the European Parliament and of the Council of 26 June 20135 on the establishment of 'Eurodac' for the comparison of fingerprints for the effective application of Regulation (EU) No 604/2013 establishing the criteria and mechanisms for determining the Member State responsible for examining an application for international protection lodged in one of the Member States by a third-country national or a stateless person and on requests for comparison with Eurodac data by Member States' law enforcement authorities and Europol for law enforcement purposes, and amending Regulation (EU) No 1077/2011 establishing a European Agency for the operational management of large-scale IT systems in the area of freedom, security and justice (recast), and (b) Regulation (EU) No 604/2013 of the European Parliament and of the Council of 26 June 20136 establishing the criteria and mechanisms for

determining the Member State responsible for examining an application for international protection lodged in one of the Member States by a third-country national or a stateless person (recast).

5. PHOENIX BUSINESS SCENARIOS AND USE CASES DEFINITION

In this chapter, the business perspective of the project as derived from the business stakeholders of the project is presented. At first, a high-level definition of Business Scenarios (BS) is performed, in order to screen the landscape for the PHOENIX business framework.

By screening the business principles of the project, the detailed analysis of the PHOENIX use cases is then provided, highlighting the key functionalities that needs to be supported by the final solution. Overall, we have to point out that the analysis is performed taking into account:

- The main objectives of PHOENIX project, as detailed in the DoA;
- The preliminary results from the market analysis
- The feedback received from the PHOENIX project partners as the business actors with expertise in the field further fine-tuned after consultation with pilot partners towards the definition of scenarios of interest.

5.1 PHOENIX Business Scenarios Definition

At first, the high-level business scenarios are derived taking into account the DoA and following consultation with the business stakeholders of the project. As stated in the DoA, among the key objectives of the project is to

"*create building knowledge and upgrade the smartness of existing buildings on the way to:*

- *Provide cost-effective services for building end-users to maximize the energy efficiency and overall performance to make sure that the new paradigm of smart homes and buildings helps on the improvement of the living and operational conditions.*
- *Enable real-time communication of buildings with energy stakeholders to optimise the grid operation by promoting the implementation of new services to suit the needs of the different electricity stakeholders. This will enable new business models and new revenue streams that will create an added value capable of sustaining them in energy market."*

It is evident that two main business scenarios are derived from the high-level project objectives, as presented in the following:

Prosumers to enjoy the value and benefit of innovative energy and non-energy services by increasing the smartness of their building premises

Smart buildings, through their software and hardware technologies, provide a vast range of opportunities for new services and applications for the building occupants. The EU has recently defined the SRI to place building occupants at the centre of energy transition and promote the development of smart services in buildings which will empower consumers to become active energy market players and benefit from energy costs savings, while ensuring preservation of high comfort and indoor environmental quality.

More specifically, one of the key business targets is to deliver to the building occupants smart cost-effective services on the way to optimize their energy saving, occupants' satisfaction by preserving their comfort, convenience and wellbeing, their overall performance of the buildings and their grid interactions.

Traditional (retailers) and new (ESCOs and Aggregators) energy business stakeholders to increase their profitability and improve their business sustainability through the provision of added value energy services to their customers

At the business side and with the goal "to set a clear business perspective for the provision of energy services to the customers" the aim is to establish a more flexible energy relationship between the building stock and the energy providers. Towards this direction, the traditional & new business actors should be given the means and tools to (a) analyse the level of smartness of their portfolio and (b) exploit at the maximum level the available demand flexibility in innovative business schemas (flexibility, dynamic pricing etc…) as emerge in the deregulated electricity markets.

In this sense, a key business objective is the provision of new business schemas and services to intermediaries and third parties that will facilitate consumers' involvement into energy markets by acting on their behalf and making the most out of consumers' flexibility value in terms of energy bills minimization and revenues maximization.

By defining the high-level business objectives of the project through business scenarios definition, we proceed with the analysis and report of the associated use cases in the next section.

5.2 PHOENIX Use Cases Definition

Following the definition of the business objectives for the project, the list of use cases is then extracted. These use cases focus at describing the different functionalities that needs to be supported by the PHOENIX framework in order to meet the aforementioned objectives.

- Adapt & Play integration of domestic appliances, legacy equipment and building systems
- Building knowledge enhancement to upgrade the smartness of buildings
- Services for building occupants to maximize their energy efficiency and increase overall building performance
- Provision of Comfort, Convenience and Wellbeing services to building occupants
- Portfolio flexibility analysis and configuration to optimize grid operation
- Flexible billing services and smart contracts for the retailer customers
- Advanced energy services to promote self-consumption optimization

The detailed description of the project use cases is provided in the following, following a standard template for use cases representation (simplified version of IEC 62559 use case template).

Title	**Adapt & Play integration of domestic appliances, legacy equipment and building systems**
Description	The optimal management of energy systems in the building environment requires that various types of smart systems and components to be installed and the integration of these technologies and building communications solutions. However, these systems are in most of the cases legacy equipment and technology building systems with diverse communication technologies and heterogeneous protocols that hinder the realization of the smart building concept. In that way, a key objective towards increasing building smartness is to upgrade and seamlessly connect all these disconnected legacy systems and devices through the integration of diverse IoT devices (i.e., gateways and smart controllers) and communication systems in the building under a unified, adapt-&-play device management layer. The homogenization of heterogeneous building systems through the deployment of IoT gateways and smart controllers is a complicated task as we should always take also into account aspects related to the high amount of equipment in the building environment, the building upgrade needs, the business viability of the different solutions etc... Therefore, a smart advisor guide that will provide suggestions about the technologies to upgrade the existing systems and appliances will pave the way for the in-practice realization of a adapt-&-play device management framework.
Triggering event	End users' interest to increase the level of smartness of their building environment End users' interest to participate in innovative energy services as defined by the business actors
Preconditions	Legacy systems and devices with capability of getting upgraded IoT systems and gateways installed in building premises
Postconditions	IoT systems and gateways integrated under the adapt-&-play device management framework
Actors Involved	Building occupants

Table 10 PHOENIX – UC01 Description

Title	Building knowledge enhancement to upgrade the smartness of buildings
Description	With recent advances in the field of Internet of Things (IoT), buildings are becoming more and more intelligent. However, the upgrade of these equipment is only half of the work needed to increase the smartness of existing buildings. The data generated by the sensor and building interfaces could not be exploited without the support of data analytic tools and artificial intelligence. Therefore, intelligent data management and analysis techniques are needed in order to extract knowledge from the raw the data - key information patterns within a multidimensional domain – which will further allow the realization of the smart buildings concept. In the field of data management, an enhanced knowledge layer that take into account the multitude of heterogeneous data models in the field and establish a unified data handling framework to enable the multi-party data exchange between distributed contextual data storage, data analytics tools and smart services is required. In the field of data analytics, the exploitation of ML based techniques for baseline energy analytics techniques - spanning from demand and generation forecasting, user comfort profiling etc.… - should be delivered to enable the extraction of useful knowledge that will further facilitate the implementation of energy business services.
Triggering event	IoT systems and gateways connected and reporting data for further analysis Energy business applications request for access on knowledge as extracted from the raw data in the building environment
Preconditions	IoT systems and gateways available in place reporting data to the analytics platform
Postconditions	Data analytics toolbox for extracting of energy domain knowledge that may be useful for the business functions to be delivered by the different business actors
Actors Involved	Retailers, ESCOs/Facility Managers, Aggregators

Table 11 PHOENIX – UC02 Description

Title	Services for building occupants to maximize their energy efficiency and increase overall building performance
Description	Traditional Building Energy Performance certification is a well know building performance evaluation schema constrained to offer a typical and static rating of the energy performance of the building, thus lacking to address the dynamic updates (e.g. installation of smart systems, energy management services etc.…) performed at the building environment. This is a main constrain of the current building performance mechanisms especially in the era of electricity digitization where access on up-to-date information is a key request from the building occupants; building occupants should be aware and informed about any building upgrades, maintenance activities and the respective impact in terms of energy performance (savings). To that end, appropriate tools and services should be provided to allow the extraction of dynamically updated energy performance certificates based on real-time measurements, further incorporating drill-in features to better understand energy behaviour related to different spaces and systems. In line with the EU regulation, the tools should support the continuous assessment and certification of the smart readiness status of the building according to recently established by EPBD Smart Readiness Indicator (SRI) methodology.

	Complementary to building performance assessment, the end users of the buildings should be provided with appropriate applications to get access on real time and easy to digest information about their energy behaviour, as a means to increase their engagement about building performance and subsequently get motivated towards actions that will increase energy (and cost) savings.
Triggering event	Building occupants interest about their energy performance and the potential for energy savings
Preconditions	IoT systems and gateways available in place reporting data as well as a set of data analytics tools
Postconditions	Building occupants knowledge about energy performance, energy savings potential and future maintenance actions
Actors involved	Building Occupants

Table 12 PHOENIX – UC03 Description

Title	**Provision of Comfort, Convenience and Wellbeing services to building occupants**
Description	One of the main obstacles that hinder the penetration of smart systems and technologies at the building environment is that the delivery of smart energy services does not come with no cost for the end users. There are often complains that full smartization and automation of a building may pose significant barriers on end users' convenience at their daily routines and patterns. In such a context, and apart from the obvious needs for reducing their energy and the associated costs, the end customers are also of interest about solutions that will fully preserve their daily preferences and comfort needs, improve their well-being and ensure indoor hygienic conditions. Any building smartization attempt shall take into account not only energy performance but also comfort and health aspects properly balancing the typically conflicting energy and well-being requirements. Moreover, such solutions shall ensure the satisfaction of the requirements of consumers in a fully adaptive manner, considering at any time the actual and dynamically updating contextual conditions in premises along with the continuous interaction of the users with the building systems.
Triggering event	Building occupants interest for comfort and convenience services
Preconditions	IoT systems and gateways available in place reporting data as well as a set of data analytics tools
Postconditions	Building Occupants access on comfort and convenience preserving services, IAQ conditions fully preserved in the building environment
Actors involved	Building Occupants

Table 13 PHOENIX – UC04 Description

Title	**Portfolio flexibility analysis and configuration to optimize grid operation**

Description	The active participation of buildings on the provision of flexibility related services to network operators in a robust and reliable manner is considered is a key priority towards increasing building smartness and the reason why buildings should not just be digitalized, but also become active systems, enabled by the smart solutions present in buildings which have flexible consumption patterns. Buildings have flexibility potential that represent precious decentralized energy resources for the energy sector. These resources can be harnessed to use energy when it is most cost-effective, while reducing consumption at moments when the electricity system is under pressure. Nevertheless, this transformation poses significant challenges especially in the case of small residential flexibility sources due to: (1) the need for large volume data processing and aggregation of flexible sources to achieve minimum required flexibility volumes, (2) involvement of a variety of loads with different response capabilities (activation time, duration, nominal power), (3) geographic distribution at different locations and (4) high probability of stochasticity on usage profile, (5) lack of consumer interest in active participation. Therefore, appropriate tools and services needs to be developed to fully understand the building dynamics and the flexibility characteristics of their energy systems on the way to address evolving requirements from network operators about the provision of ancillary services from buildings.
Triggering event	Aggregators interest to participate in flexibility markets Building Occupants interest to get engaged in flexible market schemas in order to get financial benefit
Preconditions	IoT systems and gateways available in place reporting data as well as a set of data analytics tools, Flexibility markets available, enabling participation of small customers
Postconditions	Aggregators potential participation in flexibility markets
Actors involved	Aggregators, Building Occupants

Table 14 PHOENIX – UC05 Description

Title	**Flexible billing services and smart contracts for the retailer customers**
Description	In the deregulated market environment, traditional retailers need to transform themselves into smart energy service providers, balancing the demand of their portfolio customers for flexible pricing services but also serving their need to optimize their positioning in energy trading operations. Towards this direction, the definition and deployment of building flexible rate plans, contracts management, and offer promotions as applied by communication networks' operators should be considered also by the electricity retailers. This requires an increased understanding of portfolio energy consumption patterns, access to more accurate demand forecast, identification of energy wastes and flexibility opportunities towards the extraction of valuable knowledge. With this knowledge in hand, retailers will be able to formulate smart billing strategies at specific time intervals to regulate their demand and make it adjust to their forecasted values, thus allowing the direct reflection of evolving energy market conditions into the tariffs applied.
Triggering event	Retailers interest to provide innovative pricing schemas at the contracts to their customers Building Occupants interest to get engaged in flexible contracts/billing schemas

Preconditions	IoT systems and gateways available in place reporting data as well as a set of data analytics tools
Postconditions	Retailers access on tools to structure smart billing services and contract types
Actors involved	Retailers, Aggregators, Building Occupants

Table 15 PHOENIX – UC06 Description

Title	**Advanced energy services to enable self-consumption optimization**
Description	The full integration and interaction of buildings with the energy system is foreseen as the most cost-effective way to achieve climate neutrality and guarantee system benefits. The proliferation of micro-generation renewable energies, the availability of domestic storage and the popularization of Electric Vehicles (also potentially used as storage) can be an opportunity for the energy stakeholders to gain a certain level of flexibility and further offer added value services to their customers. On the basis of accurate predictions about the current and future (short time window) production of energy, time of use pricing and the storage capacity of the building, intelligent support tools should be delivered to the electricity actors to properly design flexible control strategies and interacting mechanism with the dynamic entities of the portfolio network (buildings) in order to be able to maximize the level of self-consumption (contributing also to peak demand saving) of their customers and therefore the reduction of electricity costs for both parties.
Triggering event	ESCOs to provide self-consumption optimization and peak demand shaving services to their customers Building Occupants interest to get engaged in self-consumption optimization schemas
Preconditions	IoT systems and gateways available in place reporting data as well as a set of data analytics tools Generation and Storage devices in place to enable self-consumption
Postconditions	ESCOs access on self-consumption optimization and peak demand shaving services
Actors involved	ESCOs/ Facility Managers, Building Occupants

Table 16 PHOENIX – UC07 Description

Once again to point out that the definition of the different use cases was extracted following consultation with the business stakeholders of the project, providing their feedback on the detailed description of each case scenario. There is a clear linkage of the different use cases with the business scenarios, on the way to provide functionalities and services to the key PHOENIX

stakeholders in order to meet their business needs and expectations. As a next step of the work, the early definition of the business and user requirements of the project is reported in the next section.

6. PHOENIX END USERS FEEDBACK

6.1 Questionnaires and Focus Groups Discussions Methodology

By defining the list of business scenarios and use cases of the project, the next step is the extraction of business and user requirements. It is evident that the active participation of end users and business stakeholders is required towards the extraction of these requirements.

In order to extract PHOENIX end users' needs we follow a twofold methodological approach: (a) at first, we have to consider the feedback from building occupants as a focus group of the project. Towards this direction a questionnaire is circulated among the building occupants (main system stakeholders) that are to be enrolled at the demonstration activities of the project to get their direct feedback about their needs and requirements

(b) then, feedback from business stakeholders is required; focus groups discussions with consortium members are conducted to concretely contribute to the definition of business needs.

The definition of these two contact groups is in line with the early establishment of the engagement activities in M2 of the project. SAGOE, though not directly involved in this task, participated as the coordinator of PHOENIX engagement activities acting as the contact point to the demo partners, actively engaging their members to establish the occupant's close groups at the early beginning.

Overall, the small groups of people/stakeholders involved at the very early stage of the project are further presented

- PHOENIX pilot stakeholders: business representatives from the retailers/utilities involved in the project
- PHOENIX technology stakeholders: business representatives from the tech companies involved in the project
- PHOENIX pilot customers: A small but representative number of residentials/commercial building occupants participating in early project activities towards the identification of PHOENIX framework requirements

The next schema depicts the structure of the work among partners involved in the process towards engaging building occupants for their early feedback in the project.

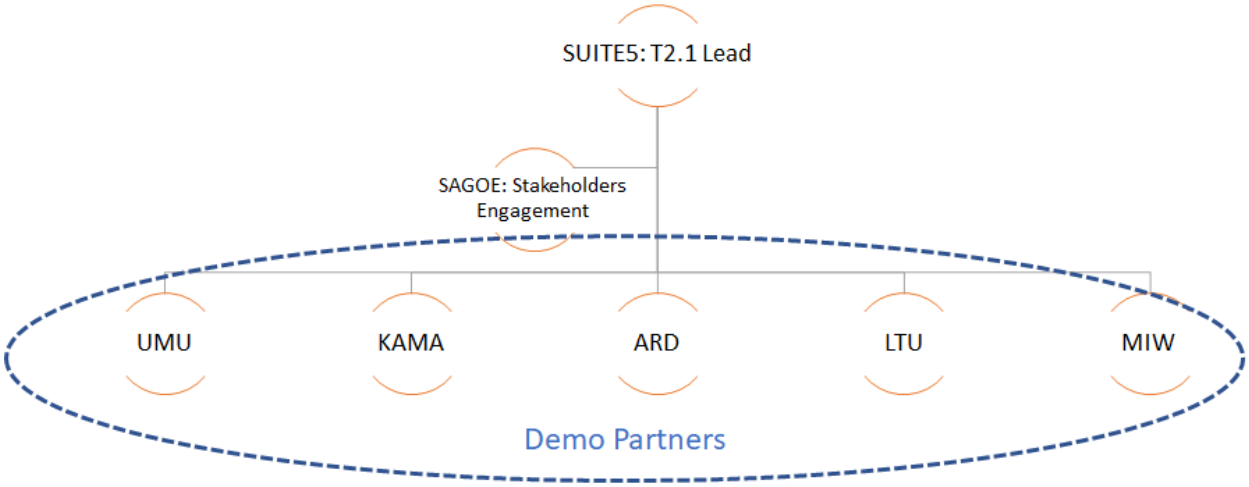

Figure 10 PHOENIX Building Occupants Engagement Methodology

For the questionnaire survey, and in order to address the requirement for a GDPR compliant process, the consortium decided to use the EU Survey tool[1]. This is a tool promoted by E.C. and provides added value features that were used by the PHOENIX consortium, namely: (a) auto translations of the questionnaire to meet the requirement for questionnaire template localization and (b) personalized tokens creation on the way to ensure that personalized feedback on the questionnaire is provided in a fully anonymized way, (c) continuous updates of the questionnaire, (d) share questionnaire template to 3rd parties, (e) direct analysis of summary results.

The template for the questionnaire is provided in Annex I.

[1] https://ec.europa.eu/eusurvey/home/welcome

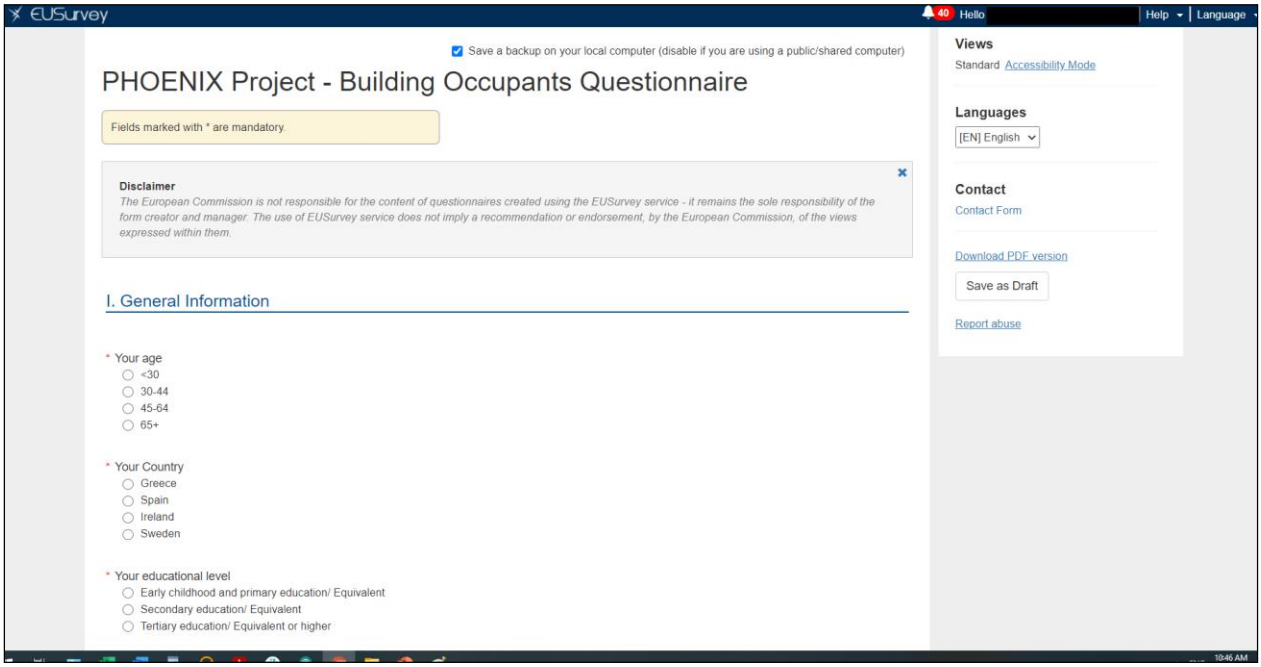

Figure 11 PHOENIX Building Occupants Questionnaire

The questionnaire is split in 3 different sections, namely:

- Intro section and user demographics: as this is the first building occupants related engagement activity performed in the project, the 1st section aims to extract some demographic information about the profile of the users and further inform them about the activities to be performed in the project
- General building and consumption information: this is the second section of the questionnaire towards understanding the familiarity of the end users with building smartness and performance certification
- Energy and non-energy applications for building occupants: the last and most important part of the questionnaire focusing on understanding the needs and expectations of building occupants from the different services to be delivered in the project. The analysis of this section will drive the extraction of building occupants' requirements in the following section.

In addition, focus group discussions with the PHOENIX consortium members were established. Business stakeholders' feedback was mainly related to the interconnection of the different hardware systems in the project along with the functionalities to be provided by the stakeholder applications to be developed in the project.

The next section presents the summary of results from questionnaires analysis.

6.2 Questionnaires Results

The results from the questionnaire survey are presented in this section. The analysis is presented for the different sections of the questionnaire.

In the first section, a short profile information for survey participants is provided. The questionnaire was circulated among the different demo parties of the project with a balanced participation of more than 50 building occupants from the different targeted countries (Spain, Sweden, Ireland and Greece). The majority of them are in the age group 30 - 44 (45 %, <30: 15%, 45-64: 28%) with Tertiary education (86 %), moderate computer literacy (61 %, expert: 22 %, basic: 11 %). A disperse annual income profile is extracted: 10,000 - 20,000 (26%), 20,000 - 30,000 (30%), 30,000 - 40,000 (12.96 %), > 40,000 (21%) mainly due to the variation at the different countries. Considering the Household/ office zone composition, a typical set up is with 2-3 persons in place (52%, 4- 6 persons: 28%) at a dwelling /space size of 50-100 m2 (35 %) or 100-150 m2 (38%).

Related to generic consumption information, most of the participants are concerned about energy issues (consumption and energy efficiency) with 48 % to do some attempts to manage their consumption and 26 % without any knowledge on how to manage their consumption. A 24 % of the participants are already in the process of controlling their energy consumption. A 35 % of the participants use smart devices and systems from which {multiple answers: 13%: HVAC, 22%: Lighting, 24% DHW, 7 % smart domestic appliances, 7% smart meters, 20% other, 13% environment sensors}. As expected, the majority (>95%) of the participants are keen to install smart energy systems (smart metering devices, sensors) in their home/office environment as a means to get a better understanding about your energy consumption and further enable your participation in energy efficiency programs, as most of the people have sufficient (30 %) or limited (58%) knowledge about them. As identified in the questionnaire, the main bottleneck for end user's participation in smart energy management programs is (multiple answers): 67% limited knowledge but also limited economic benefit (24%), lack of incentives (45 %), limited penetration of energy programs (25%) and end users' disturbance (18%). While most of the participants have some knowledge about smart energy systems, the majority of them (78 %) are not aware about the new EPC framework supported by E.U. and named Smart Readiness Indicator (SRI).

By drilling into the details about end users' expectations from the delivery of the energy and non-energy applications for building occupants, the priority is balanced between: Comfort &

Convenience: 29.63 %, Energy Savings: 44.44 %, Smart Energy Management: 25.93 %. Building occupants are interested to get insights about different energy and non-energy metrics: (multiple answers): Total Energy Consumption: 62.96 %, CO2 Emissions: 33.33 % Historical Consumption: 27.78 %, Comfort Level: 35.19%, Energy Consumption Savings: 46.30 %, Energy Consumption Waste: 25.93 %, Environmental Conditions: 27.78 %. Also, information about consumption of similar peers (neighbours, prosumer clusters etc.) show high interest (63 %); much higher the interest about energy use compared to past behaviour (last week, last month etc...): 93 %. High interest for information about comfort levels (89%) and IAQ monitoring (91 %) in the COVID era. Practical information about updates for maintenance of building devices (80 %) is an interesting feature, or local generation and self-consumption insights (82 %) in case of Solar Panels installation. Drilling into the details about features of interest, there is a balanced interest about energy waste knowledge (40.74 % at total level, 48.15 % details at device level), while insights about the smart readiness level of the building: A single indicator for the whole building: 42.59 %, Smartness per device type: 16.67 %, Smartness per user priority (comfort, savings, smart energy management): 40.74 %.

Above 95% of survey participants are interested for smart home solutions to control energy use, with high demand to increase convenience and ease of control (High: 31.48 %, Very High: 44.44 % by applying control or automation solutions), to increase comfort levels in premises (High: 40.75 %, Very High: 42.60 % by applying control or automation solutions), establish a healthy and wellbeing environment in premises (High: 29.63 %, Very High: 57.41 % by applying control or automation solutions), increase energy savings (High: 22.22 %, Very High: 66.67 % by applying control or automation solutions), gain profit from participating in new business services (High: 20.37 %, Very High: 37.04 % by applying control or automation solutions).

From the different control alternatives, the end users showing interest towards the intelligent control of some devices in premises (multiple answers): Remote control: 55.56 %, Scheduling: 18.52 %, Semi Automation (Automation with user interaction): 44.44 %, Full Automation: 25.93 %, Different control alternatives per device type: 0.37 %. A level of customization of control boundaries (62.96 %) is a mandatory requirement; also, users are interested to experiment *with an automatic control mechanism on the systems or devices within working area that will actually "learn" from control actions and try to control HVAC and lights without affecting typical comfort preferences* but with the option to disable this feature (75 %).

Apart from the functionalities to be offered by the project, high interest about the visualization of the information about smart energy systems and building performance (> 82% consider important or very important). The information should be accessible by different means (Web Portal: 50.00 %, Tablet: 12.96 %, Smartphone App: 72.22 %) and an interest for customization of time period for data visualization (> 60%), considering also the diversity on the feedback from building occupants about the updates on energy and environmental data {Real time: 22.22%, Hourly: 7.41 %, Daily: 24.07 %, Weekly: 40.74 %, Monthly: 46.30 %} or smartness of the building reporting{ KPIs about SRI, energy reporting, comfort levels}:{Real time: 27.78 %, Daily: 22.22 %, Weekly: 48.15 %, Monthly: 38.89 %}.

This thorough analysis of results from questionnaire survey highlights the key priorities of the building occupants and will further facilitate the extraction of end users' requirements and presentation in the next section. The full summary report of the survey is accessible via: https://ec.europa.eu/eusurvey/publication/851e025c-c9e6-d3a3-a80f-8ca8e50137df

7. PHOENIX REQUIREMENTS EXTRACTION AND MVP DEFINITION

In this section, the PHOENIX end user and business requirements are defined. The requirements have been derived following project discussions with the business and technical actors and further analysis of the questionnaire surveys with building occupants, described in Chapter 6. In addition, the analysis takes into account market and regulatory drivers and barriers to set the knowledge for the extraction of the list of business and user requirements. Moreover, and following requirements identification and further elicitation, the 1st version of the PHOENIX Minimum Viable Product (MVP) is reported.

7.1 Requirements Extraction

The scope of this section is to present the list of requirements as extracted following discussion with business and technology actors and the analysis of the questionnaire surveys. We have to point out that the scope of this section is to focus only on business needs while details about the technical implementation (technical requirements) will be extracted as part of the work in D2.3 as part of the work in T2.3.

At first, we present the list of requirements as defined after consultation with the business stakeholders of the project, taking also into account the market analysis reported above. Mapping with the relevant UCs is also provided.

Req. ID	Description	Relevant UC
BD.01	Consumption information from smart metering devices should be available	_01
BD.02	Energy generation information from generation systems should be available	_01
BD.03	Consumption data from specific load types including HVAC, lighting, DHW and ventilation loads should be available	_01
BD.04	Consumption and operational data from EV charging points should be available	_01
BD.05	Information about the status of energy storage systems should be accessible	_01
BD.06	Indoor environmental conditions monitoring including temperature, humidity should be available	_01
BD.07	Building occupancy related information should be available	_01
BD.08	Indoor air quality conditions monitoring including CO2 should be available	_01
BD.09	Device operation data - device status for specific load types including HVAC (status, mode, and set point), lighting (status, set point) and plugs (status)	_01
BD.10	Control over specific load types (HVAC, Lights etc..) should be enabled by the applications	_01
BD.11	Sensing and operation data should be accessible in high frequency (20 - minutes or lower)	_01
BD.12	Long history of sensing, consumption and operation data should be available	_01

BD.13	Building static configuration parameters (e.g., size of the building, age, dynamic envelope etc..) should be available	_01
BD.14	Demographics information (e.g., number of persons per space, gender etc.) should be considered in the analysis	_01
BD.15	Outdoor environmental conditions should be available for further analysis	_01
BD.16	Weather forecast data should be available for the energy services provision	_01
BD.17	Energy Price data should be available and further analysed by the different applications	_01
BD.18	PHOENIX should support integration with IoT gateways	_01
BD.19	PHOENIX should support integration with smart sensors and controllers	_01
BD.20	PHOENIX should support integration with BMS systems	_01
BD.21	PHOENIX should provide a guide to facilitate building occupants for the selection of best fitted hardware solutions	_01
BD.22	PHOENIX should guide building occupants about technological upgrades that should satisfy their needs	_01
BD.23	PHOENIX should guide building occupants about technological upgrades relevant to the equipment available in place	_01
BD.24	PHOENIX should prioritize the installation of costless smart hardware solutions	_01
BD.25	PHOENIX should prioritize the installation of energy preserving or efficient smart hardware solutions	_01
BD.26	PHOENIX should support seamless integration of 3rd party data entities to the data management framework	_01
BD.27	PHOENIX should support 3rd party integration following state of the art information and communication standards	_01
BD.28	A central data repository should store building context data to be further available for further processing and analytics	_01
BD.29	PHOENIX should provide a data discovery and provisioning framework to support integration of 3rd party hardware systems	_01
BD.30	PHOENIX data layer should store all data types required for SRI based KPIs calculations	_01
BD.31	PHOENIX data layer shall store the raw data with the appropriate data and metadata annotations to facilitate access by 3rd party applications	_01
BD.32	PHOENIX data layer shall store following standardized information models	_01
BD.33	PHOENIX shall support the extraction of now-casts and forecasts for customer behaviour analysis	_02
BD.34	User preferences/ behavioural profiles should be extracted and continually updated in a dynamic manner	_02
BD.35	PHOENIX shall support the extraction of different types of users' comfort [visual, thermal] profiles	_02
BD.36	PHOENIX shall support the extraction of user profiles should take into account the actual environmental conditions (temperature, humidity & luminance) in premises	_02
BD.37	PHOENIX shall support the extraction of user profiles taking into account building occupants' interaction in context conditions	_02
BD.38	PHOENIX shall support the extraction of IAQ profiles on the basis of IAQ monitoring conditions and health related limitations in premises	_02
BD.39	PHOENIX shall support the correlation of environmental conditions with building demographics (e.g., business processes, daily routines etc..)	_02

BD.40	PHOENIX shall support the extraction of occupancy profiles in the case occupancy related information is available	_02
BD.41	PHOENIX shall support the extraction of energy consumption forecasts at building level	_02
BD.42	PHOENIX should be able to monitor the energy use of each energy carrier	_02
BD.43	PHOENIX shall support the extraction of energy generation forecasts at generation asset level	_02
BD.44	PHOENIX shall support the extraction of energy storage schedules (day - ahead) at asset level	_02
BD.45	PHOENIX shall apply data driven techniques for the extraction of energy related forecasts	_02
BD.46	PHOENIX should provide services for preventive maintenance for the building systems	_03
BD.47	PHOENIX should provide services for responsive maintenance for the building systems	_03
BD.48	PHOENIX should support reporting and alerting about failure/lack of communication events of building systems	_03
BD.49	PHOENIX should support the calculation of the different KPIs related to building performance	_03
BD.50	PHOENIX should support the calculation of SRI score as defined in the regulation	_03
BD.51	PHOENIX should support the calculation of EPC score as defined in national regulation	_03
BD.52	PHOENIX should support the dynamic calculation of SRI score on the basis of actual data	_03
BD.53	PHOENIX should have the necessary tools to automatically obtain the current EPC	_03
BD.54	PHOENIX should support the dynamic calculation of EPC score on the basis of actual data	_03
BD.55	PHOENIX should support the retailers to define smart contracts for energy for their customers	_06
BD.56	PHOENIX should support the retailers to define different billing alternatives and smart plans for their customers	_06
BD.57	PHOENIX should support the retailers to offer promotions to their customers	_06
BD.58	PHOENIX should support the retailers on the contract's management process	_06
BD.59	PHOENIX may support the utilities to define smart flexibility contracts with their customers	_06
BD.60	PHOENIX should support the implementation of flexibility related demand adjustments based on grid needs	_05
BD.61	PHOENIX should support the implementation of direct load control programs	_05
BD.62	PHOENIX should support the implementation of demand response interventions to reduce peak demand	_05
BD.63	PHOENIX should support the extraction of flexibility nowcasts and forecasts	_05
BD.64	PHOENIX should support the provision of flexibility related performance reports to Aggregators	_05
BD.65	PHOENIX should provide services to ESCOs to ensure maximum self-consumption as a Service	_07

BD.66	PHOENIX should provide self-consumption optimization with battery system in place	_07
BD.67	PHOENIX should provide self-consumption optimization without battery system in place	_07
BD.68	PHOENIX should provide self-consumption optimization forecasts to the ESCOs.	_07
BD.69	PHOENIX should provide self-consumption optimization reports/KPIs to ESCOs	_07

Table 17 PHOENIX Business Requirements

In addition to business-driven requirements, the building occupants related requirements as extracted from the questionnaire surveys are presented in the following table. Mapping with the relevant UCs is also provided.

Req. ID	Description	Relevant UC
BO.01	PHOENIX should provide services to building occupants to promote energy savings	_03
BO.02	PHOENIX should provide services to building occupants to ensure comfort preservation	_04
BO.03	PHOENIX should provide services to building occupants to promote the establishment of a health environment	_04
BO.04	PHOENIX should provide services to building occupants to promote the establishment of a convenient environment	_04
BO.05	PHOENIX should provide services to building occupants to enable participation in smart energy programmes	_05, _06
BO.06	PHOENIX should provide services to building occupants to ensure prompt remuneration for the provided services	_05, _06
BO.07	PHOENIX should provide services to building occupants to increase awareness about energy efficiency and smart programs	_03
BO.08	PHOENIX should provide services to building occupants that will minimize end user's interaction- limited disturbance	_03, _05, _06, _07
BO.09	PHOENIX should provide information to building occupants about total energy consumption	_01, _03
BO.10	PHOENIX should provide information to building occupants about CO2 impact	_01, _03
BO.11	PHOENIX should provide information to building occupants about historical consumption	_01, _03
BO.12	PHOENIX should provide information to building occupants about comfort levels and environmental conditions	_01, _04
BO.13	PHOENIX should provide information to building occupants about energy savings and waste	_01, _03
BO.14	PHOENIX should provide information to building occupants about consumption of similar peers	_01, _03
BO.15	PHOENIX should provide to building occupants comparative information about past performance	_01, _03
BO.16	PHOENIX should provide to building occupants information about IAQ conditions in premises	_01, _04
BO.17	PHOENIX should provide to building occupants information about local generation and the level of self-consumption	_01, _07

BO.18	PHOENIX should provide to building occupants information about total energy waste	_01, _03
BO.19	PHOENIX should provide to building occupants information about energy waste per device type	_01, _03
BO.20	PHOENIX should support the dynamic calculation of SRI score	_01, _03
BO.21	PHOENIX should provide to building occupants the option for remote control of smart devices	_01
BO.22	PHOENIX may provide to building occupants the option for scheduling the operation of devices	_01, _03, _04
BO.23	PHOENIX may provide to building occupants the option for semi automation - automation with user interaction	_01, _03, _04
BO.24	PHOENIX should provide to building occupants the option to override automated control actions	_01, _03, _04
BO.25	PHOENIX should provide to building occupants updates of energy and environmental information in real time	_01, _03, _04
BO.26	PHOENIX should provide to building occupants updates of energy and environmental information at daily level	_01, _03, _04
BO.27	PHOENIX should provide to building occupants updates of energy and environmental information at week level	_01, _03, _04
BO.28	PHOENIX should provide to building occupants updates of energy and environmental information at month level	_01, _03, _04
BO.29	PHOENIX should provide to building occupants updates of building performance KPIs in real time	_01, _03
BO.30	PHOENIX should provide to building occupants updates of building performance KPIs at week level	_01, _03
BO.31	PHOENIX should provide to building occupants updates of building performance KPIs at month level	_01, _03

Table 18 PHOENIX Occupants Requirements

Along with the functional requirements, a non-exhaustive list of non-functional business-related requirements is extracted following consultation with business and technology actors, building occupants and the review of the regulatory framework, further presented in the following table:

Req. ID	Description
NF.01	PHOENIX shall support integration of 3rd party energy systems in an adapt and play manner
NF.02	PHOENIX shall support integration of smart energy hardware systems in a user-friendly way
NF.03	PHOENIX shall support guidance about potential technologies for interventions in a user-friendly way
NF.04	PHOENIX should ensure that the data will be stored in a privacy preserving repository at building gateway level
NF.05	PHOENIX should ensure that the gateway is designed on a way to block unauthorized access on building data
NF.06	A role-based access control framework over the data should be supported by the applications developed
NF.07	PHOENIX should ensure that all potential security risks has been analysed and appropriate mitigation techniques apply
NF.08	PHOENIX should ensure that all potential privacy risks has been analysed and appropriate mitigation techniques apply

NF.09	PHOENIX should consider the coverage of GDPR requirements when required, considering the applicability of the regulation in all demo countries
NF.10	PHOENIX application should support an authentication mechanism to ensure classified access on the different apps based on the user role
NF.11	The overall development and deployment of the solutions should ensure the scalability and expandability
NF.12	It is important to provide reliable applications for the building occupants
NF.13	The development of user-friendly applications (UX) is a key requirement from building occupants
NF.14	The look and feel of the applications are very important (UI) for the building occupants and thus the applications should be visually appealing
NF.15	The building occupants should have access on the different apps via different means (mobile devices, web etc..)
NF.16	The system should by design aid users to understand the different features provided by the applications
NF.17	Application localization should be supported by the different applications for the building occupants
NF.18	The system should ensure transparency on the flexible contract and billing schemas to be examined in the project
NF.19	The system should consider the national regulation for energy performance on the customization of the different business applications
NF.20	The system should consider the national regulation about energy markets operation on the customization of the different business applications

Table 19 PHOENIX Non-Functional Requirements

As stated above, the requirements analysis is targeting mainly the business part of the PHOENIX project. Additional requirements, focusing on the technical implementation will be extracted as part of the work in T2.3 along with the definition of the PHOENIX reference architecture.

7.2 PHOENIX Minimum Viable Product

In preparation of the design and development phases of the project, the PHOENIX consortium has initiated the definition of a Minimum Viable Product (MVP) in order to ensure that the platform is designed and viewed as a product with enough features to satisfy early customers, minimizing the risk of failure and improving the value generated. As stated in the bibliography, the design of a product should not focus on the functionality rather to provide just enough core features to effectively deploy the product. The main principles of the MVP are:

- Functionality - the set of features to deliver clear value to the user,
- Design - the design of the MVP to be up to the highest industry standard,
- Reliability - production quality standard to be achieved by rigorous testing,
- Usability - the MVP to be easy to use and intuitive

aspects that have already been considered at the requirements extraction phase.

In contrast to the usual practices that view the MVP as a critical asset in the prototyping phase, the MVP in PHOENIX is instrumental to guide the design and development activities throughout the project implementation and represents the platform release that will be delivered in the end of the project. In this context, it needs to be noted that even if the MVP pinpoints the minimum set of features that are necessary for a product to be deployed and validated, it does not dictate the PHOENIX consortium to seize their work based on this early elicitation; MVP will be only the primer to collect early feedback and appropriately steer the design and development activities.
Towards this direction, and following the definition of business goals, user stories and actions, and the preliminary list of features (as key points of the MVP methodology), the present section aims at assessing the added value of the features in order to perform a preliminary prioritization of the different requirements.

At first, a preliminary requirements elicitation process took place and we removed from the evaluation process the fundamental requirements related mainly with data availability. Therefore, the business-related requirements were considered for the validation process. The consortium has then decided to place the evaluation on the basis of two core criteria:

- The expected urgency in terms of technical need from the business partners
- The expected impact in terms of business priority for the end users of the tool

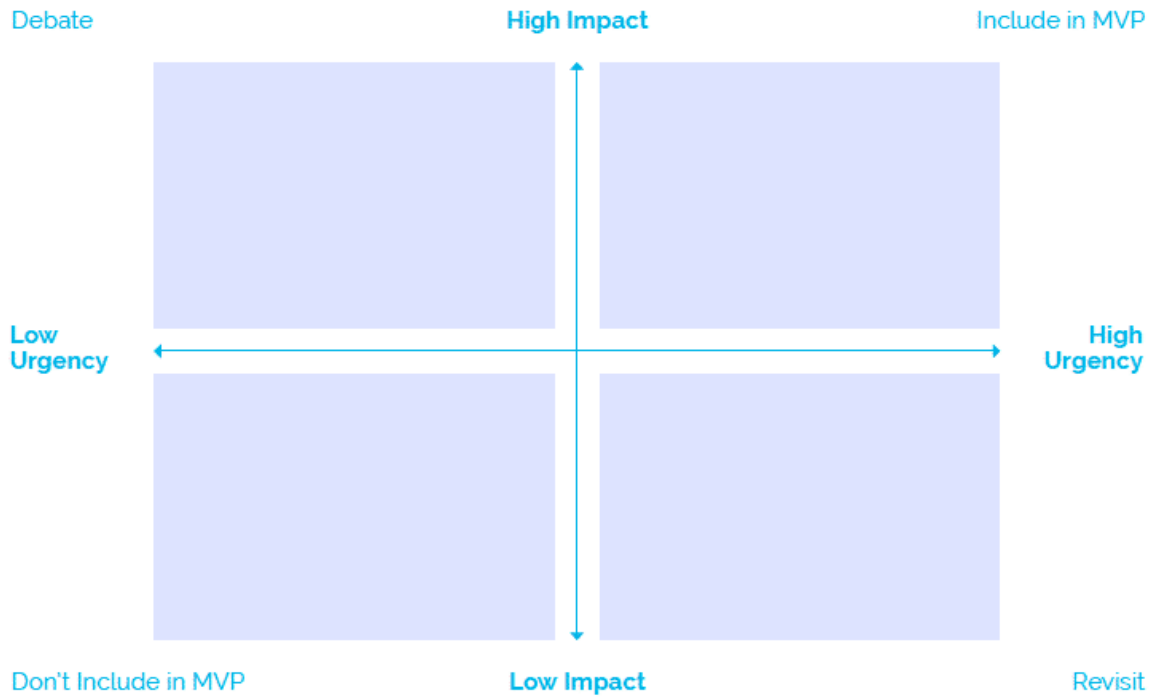

Figure 12 PHOENIX Feature Assessment Template

For the evaluation process, a 5-star Likert scale methodology was considered for the validation of the different requirements in these two core criteria as presented also on the methodological template in Figure 12.

A questionnaire form was circulated among the partners of the consortium to provide their validation feedback on the list of the core business requirements of the project. Since this deliverable represents the initial release of the MVP definition activities, such an assessment is initially conducted within the consortium.

Based on the feedback provided by the consortium members, the key remarks are presented:

- The full list of project requirements is of interest for the consortium (on average > 2.5 in all requirements)
- Towards the definition of the project MVP, an elicitation process further applies and we have selected the subset of requirements where both urgency and expected impact is above 3.5.

The detailed results of the evaluation process are presented in the following figure.

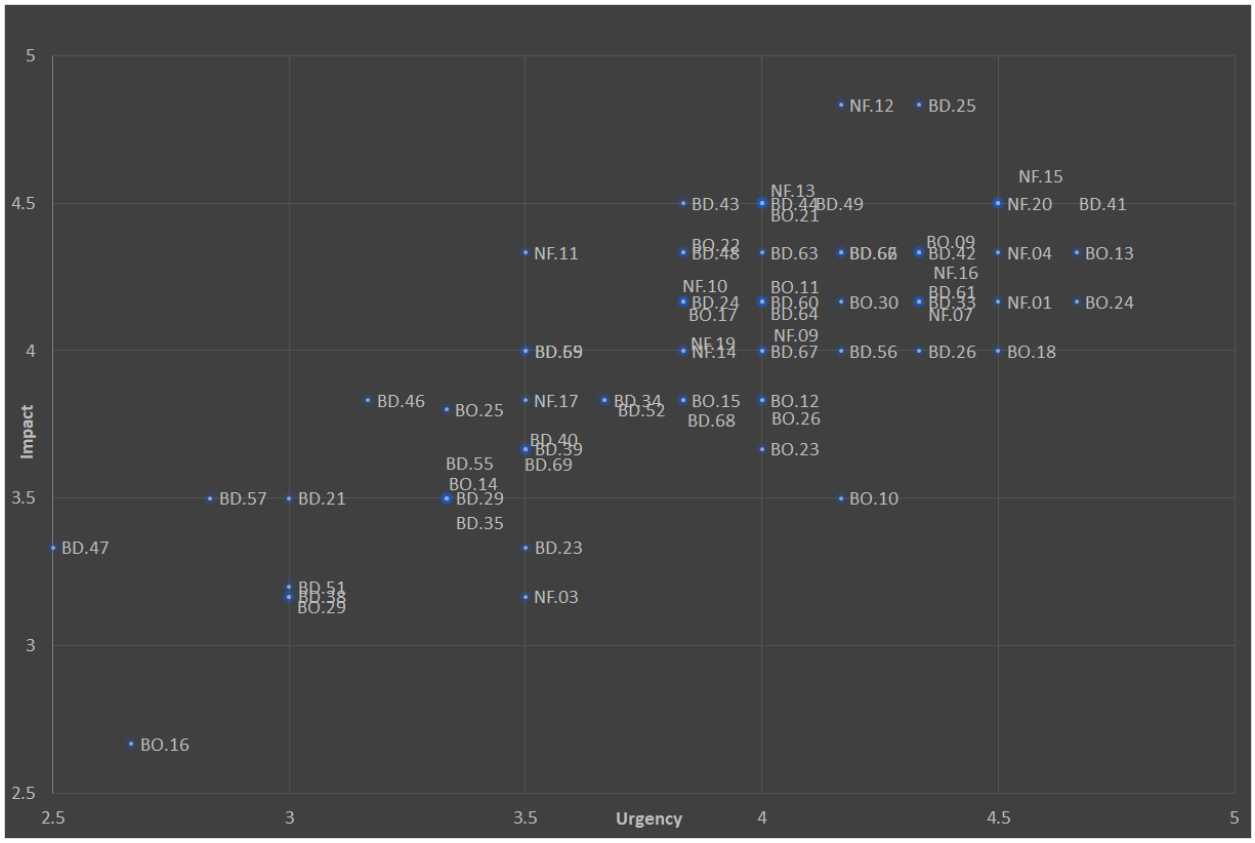

Figure 13 PHOENIX Feature Assessment

The results of this analysis pave the way for the final design of the PHOENIX MVP. In the following table we present the high value requirements, providing some more details about the

assessment process and the way to be incorporated (in terms of a user story) in the PHOENIX MVP.

ReqID	Requirement Description	Requirement Assessment
BD.24	PHOENIX should prioritize the installation of costless smart hardware solutions	The selection of hardware interventions that best fit to the user needs is a key requirement for the project. A guidance should be available for the end users focusing mainly on selection of low cost and low consumption hardware interventions.
BD.25	PHOENIX should prioritize the installation of energy preserving or efficient smart hardware solutions	
BD.26	PHOENIX should support seamless integration of 3rd party data entities to the data management framework	It is very important for further reusability of the PHOENIX solution to enable 3rd party data sources integration in standardized way
BD.33	PHOENIX shall support the extraction of now-casts and forecasts for customer behaviour analysis	The extraction of building occupants' behavioural analytics on the basis of raw data is very important towards the extraction of personalized analytics that best fit to individual user needs
BD.34	User preferences/ behavioural profiles should be extracted and continually updated in a dynamic manner	
BD.41	PHOENIX shall support the extraction of energy consumption forecasts at building level	The extraction of accurate demand (per energy source)/generation forecasts (as baseline analytics) is a key step for any further business analysis. This information will be very useful for the proper management/scheduling of the storage entities available in the building environment.
BD.42	PHOENIX should be able to monitor the energy use of each energy carrier	
BD.43	PHOENIX shall support the extraction of energy generation forecasts at generation asset level	
BD.44	PHOENIX shall support the extraction of energy storage schedules (day - ahead) at asset level	
BD.48	PHOENIX should support reporting and alerting about failure/lack of	A notifications-based mechanism that will support alerting in case of failure of the different systems at the building level is a key priority for the building occupants

	communication events of building systems	
BD.49	PHOENIX should support the calculation of the different KPIs related to building performance	The calculation of building performance KPIs is fundamental need for the users. The main priority is the calculation of these KPIs on the basis of actual measurements as retrieved from the systems in building environment
BD.52	PHOENIX should support the dynamic calculation of SRI score on the basis of actual data	
BD.56	PHOENIX should support the retailers to define different billing alternatives and smart plans for their customers	As a first step for the definition of new contractual schemas, the definition of different billing alternatives is a key milestone
BD.60	PHOENIX should support the implementation of flexibility related demand adjustments based on grid needs	The incorporation of buildings in demand response campaigns is a high priority for the project. This enrolment should take into account the grid related requirements/peak demand management and will focus on direct load control strategies. Flexibility nowcasts and forecasts should eb available for the business actors to coordinate their portfolio, along with a-posteriori performance reports.
BD.61	PHOENIX should support the implementation of direct load control programs	
BD.62	PHOENIX should support the implementation of demand response interventions to reduce peak demand	
BD.63	PHOENIX should support the extraction of flexibility nowcasts and forecasts	
BD.64	PHOENIX should support the provision of flexibility related performance reports to Aggregators	
BD.66	PHOENIX should provide self-consumption optimization with battery system in place	The interest from the users about self-consumption optimization (both with or without a battery system in place) is high. Self-consumption optimization forecasts / schedules should be available as information for the business actors.
BD.67	PHOENIX should provide self-consumption optimization without battery system in place	

BD.68	PHOENIX should provide self-consumption optimization forecasts to the ESCOs.	
BO.09	PHOENIX should provide information to building occupants about total energy consumption	From the available information, the top priority for the building occupants is to gain access on consumption, environmental, savings and energy waste information.
BO.11	PHOENIX should provide information to building occupants about historical consumption	
BO.12	PHOENIX should provide information to building occupants about comfort levels and environmental conditions	
BO.13	PHOENIX should provide information to building occupants about energy savings and waste	
BO.15	PHOENIX should provide to building occupants comparative information about past performance	
BO.18	PHOENIX should provide to building occupants information about total energy waste	
BO.17	PHOENIX should provide to building occupants information about local generation and the level of self-consumption	In case local generation is available, information about self-consumption level should be available to the building occupants
BO.21	PHOENIX should provide to building occupants the option for remote control of smart devices	A dynamic control layer should be available for the end users enabling, manual control, scheduling and full automation with the possibility of overriding control settings
BO.22	PHOENIX may provide to building occupants the option for scheduling the operation of devices	

BO.23	PHOENIX may provide to building occupants the option for semi automation - automation with user interaction	
BO.24	PHOENIX should provide to building occupants the option to override automated control actions	
BO.26	PHOENIX should provide to building occupants updates of energy and environmental information at daily/week/month level	Access on real time information is not that critical for the building occupants; the main interest is about information at daily/week /month level
BO.30	PHOENIX should provide to building occupants updates of building performance KPIs at week/month level	
NF.01	PHOENIX shall support integration of hardware systems in a user-friendly way	The plug and play integration of smart systems is a top priority for the building occupants who are not familiar with the installation of these smart systems
NF.04	PHOENIX should ensure that the data will be stored in a privacy preserving repository at building gateway level	Compliance with security and privacy regulation is a key priority for the users. Users should have access only on classified information via secure authentication mechanisms
NF.07	PHOENIX should ensure that all potential security risks has been analysed and appropriate mitigation techniques apply	
NF.09	PHOENIX should consider the coverage of GDPR requirements when required, considering the applicability of the regulation in all demo countries	
NF.10	PHOENIX application should support an authentication mechanism to ensure classified access on the different apps based on the user role	

NF.12	It is important to provide reliable applications for the building occupants	The most important for the building occupants is to have access on a simple, reliable and easy to use application. The UI should be as simple as possible and with plain UX design in order to facilitate end users on the usage of the tool.
NF.13	The development of user-friendly applications (UX) is a key requirement from building occupants	
NF.14	The look and feel of the applications are very important (UI) for the building occupants and thus the applications should be visually appealing	
NF.16	The system should by design aid users to understand the different features provided by the applications	
NF.19	The system should consider the national regulation for energy performance on the customization of the different business applications	The definition of the system functionalities should take into account the national regulation in terms of energy performance and market conditions. The final results should be applicable at the context of each market environment.
NF.20	The system should consider the national regulation about energy markets operation on the customization of the different business applications	

Table 20 PHOENIX Requirements Elicitation and Assessment

We presented above the high priority requirements to be considered in the project design (PHOENIX MVP definition), and the preliminary impact expected from these features.

Overall, the preliminary version of the PHOENIX MVP is defined in accordance with the business scenarios and use cases definition, fully considering the market and regulatory analysis also reported in this document. As stated above, the PHOENIX MVP definition is a primer to collect early feedback and appropriately steer the design and development activities without being restrictive for any additional development to be performed in the project.

8. SUMMARY AND CONCLUSIONS

PHOENIX has the aim of investigating and testing technologies and methodologies that will help on the upgrading of legacy equipment in buildings on the way to provide smart services for users and occupants. For this, PHOENIX aims to develop an ICT platform that will serve as a common arena to connect the different devices that one can find in a building changing the role of them from unorganised energy consumers to active agents orchestrating and optimising their energy consumption, production and storage, with the goal of increasing energy performance, maximising occupants' benefit, and facilitating grid operation.

In order to property design a portfolio of ICT solutions that clearly meet end users' needs, we proceed at the early phase of the project with the definition of PHOENIX project foundations. At first, a market and regulatory analysis is provided in order to screen the latest evolvements on the external environment. Market analysis focus on the definition of the key market trends and features to be considered also at the design of PHOENIX platform. On the other hand, regulatory analysis is a mandatory step to ensure that the overall solution is in line with the latest guidelines and recommendations at E.U. level.

At the next step, the internal analysis of PHOENIX solution is performed. By taking into account the feedback from the business stakeholders (partners of the consortium), the list of business scenarios and use cases of the project is defined. In addition, questionnaires were circulated to the building occupants (that are planned to test the final solution) in order to gather their feedback about their interest for the PHOENIX solution and potential services. Furthermore, by analysing the input received from the different actors, a non-exhaustive list of business and end user requirements is defined. A step beyond, an early elicitation of the different requirements is performed in order to prioritize the different needs and thus to pave the way for the design of the PHOENIX MPV.

The list of requirements along with the identification of the PHOENIX MPV screen the landscape for the final design of the PHOENIX solution in the following tasks of WP2. More specifically, the mapping of the use cases and requirements to the project technologies will be initially depicted in D2.3 as part of the architecture definition and will further be reflected at the development of the different project technologies in WP3, WP4, WP5 and WP6. In addition, and following the development of the different project technologies the traceability of requirements will be provided to ensure the coverage of the business needs of the project. Last but not least, as part of the demonstration activities, the business scenarios refinement will take place in order to align the

business priorities of the project with the needs as defined by the demonstration partners of the consortium.

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10. ANNEX I

The template for the building occupant's questionnaire is provided in Annex. The questionnaire template is available in https://ec.europa.eu/eusurvey/runner/851e025c-c9e6-d3a3-a80f-8ca8e50137df

PHOENIX Project - Building Occupants Questionnaire

Fields marked with * are mandatory.

Intro

I. General Information

* Your age
  - <30
  - 30-44
  - 45-64
  - 65+

* Your Country
  - Greece
  - Spain
  - Ireland
  - Sweden

* Your educational level
  - Early childhood and primary education/ Equivalent
  - Secondary education/ Equivalent
  - Tertiary education/ Equivalent or higher

* Your computer literacy level
  - Beginner
  - Basic knowledge
  - Moderate
  - Expert
  - None

* Your annual income (in euro)?
  - < 10,000
  - 10,000 - 20,000
  - 20,000 - 30,000
  - 30,000 - 40,000
  - > 40,000
  - I don't want to tell

* What gender do you identify most with?

- Female
- Male
- Gender neutral
- I don't want to tell

* Household/ office zone composition. Please state the number of people in the household / zone including yourself.
  - 1
  - 2-3
  - 4-6
  - >6

* Size of dwelling – floor space
  - Less than 50 m2
  - 50–100 m2
  - 100–150 m2
  - 150–200 m2,
  - More than 200 m2

II General building and consumption information

PHOENIX project will aim to enhance the level of smartness of buildings by promoting the installation of smart systems, smart controls, smart metering and smart appliances that can be integrated seamlessly in existing buildings to interface and/or to control the major energy consuming domestic appliances. The role of the questions provided here is to set a better understanding of user priorities in terms of smart equipment installations.

* What is your opinion about building energy consumption?
  - Not important to me because I don't pay the bills
  - I have little control over it
  - No reason to conserve energy
  - I am concerned about energy issues but I don't know how to manage it
  - I am concerned about energy issues and try to manage it

* Do you currently use smart devices/systems?
  - Yes
  - No
  - Not Sure

If yes, can you please specify what devices/systems have smart features?
- [ ] HVAC (Heating, Cooling)
- [ ] Lights
- [ ] Domestic Hot Water
- [ ] Smart Domestic Appliances
- [ ] Smart Meters

2

- [ ] Sensors
- [ ] Other

* Are you willing to install smart home equipment (smart metering devices, sensors) as a means to get a better understanding about your energy consumption and further enable your participation in energy efficiency programs?
  - ( ) Yes
  - ( ) No
  - ( ) Not Sure

* How aware are you about Building Smartness and Energy Services?
  - ( ) Yes
  - ( ) No
  - ( ) Limited

* Why do you think people may not participate on Smart Energy Management Programs?
  - [ ] Limited Knowledge
  - [ ] Limited economic benefit
  - [ ] Disturbance of Users
  - [ ] Lack of Incentives
  - [ ] Limited penetration of energy management programs

* Are you aware about the new EPC framework supported by E.E. and named Smart Readiness Indicator (SRI)
  - ( ) Yes
  - ( ) No

III. Energy and non-energy applications for building occupants

PHOENIX will setup and provide several applications, aiming to provide rich analytics on energy consumption along with the provision of non - energy services (e.g. improve comfort etc.). The role of the questions provided is to set the basis for the extraction of the main functional requirements related to the establishment of monitoring and recommendations services.

* What is the main priority for you towards the establishment of a smart building?
  - ( ) Comfort & Convenience
  - ( ) Energy Savings
  - ( ) Smart Energy Management

* Which are the main results about the energy performance you would be interested to know?
  - [ ] Total Energy Consumption
  - [ ] CO2 Emissions
  - [ ] Historical Consumption
  - [ ] Comfort Level
  - [ ] Energy Consumption Savings

3

- [ ] Energy Consumption Waste
- [ ] Environmental Conditions
- [ ] Other

* Would you like to get insights about your energy use compared to similar peers (neighbors, prosumer clusters etc.)?
  - ○ Yes
  - ○ No
  - ○ Not Sure

* Would you like to get insights about your energy use compared to your past behavior (last week, last month etc...)?
  - ○ Yes
  - ○ No
  - ○ Not Sure

* Would you like to get insights about your comfort levels in premises?
  - ○ Yes
  - ○ No
  - ○ Not Sure

* Would you like to get insights about the Indoor Air Quality levels in premises?
  - ○ Yes
  - ○ No
  - ○ Not Sure

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

* In case of Solar Panels installation, would you like to get insights about your local generation and self-consumption?
  - ○ Yes
  - ○ No
  - ○ Not Applicable

* What is the type of insights to get about your energy waste?
  - ○ Total energy waste
  - ○ Energy waste per device
  - ○ Energy waste timeseries

* One of the innovations of the possible services is to offer insights about the smart readiness level of the building. What is the level of detail required from your side?
  - ○ A signel indicator for the whole building

4

- Smartness per device type
- Smartness per user priority (comfort, savings, smart energy management)

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* Do you consider as an interesting feature the deployment of a smart home solution to remotely control your energy use?
  - Yes
  - No
  - Not Sure

How interested are you in some type of control / automation to:

Text	1 (Low)	2	3	4	5 (High)
* increase convenience and ease of control?					
* increase comfort levels in premises?					
* establish a healthy and wellbeing environment in premises?					
* increase energy savings?					
* gain profit from participating in new business services?					

* Which of the alternative approaches seems more interesting towards the intelligent control of some devices in premises?
  - [ ] Remote control
  - [ ] Scheduling
  - [ ] Semi Automation (Automation with user interaction)
  - [ ] Full Automation
  - [ ] Different control alternatives per device type

* Would you have a problem to accept an automatic control mechanism on the systems or devices within your working area that will actually "learn" from your control actions and try to control HVAC and lights without affecting your typical comfort preferences?
  - Yes
  - Yes but with the option to disable this function
  - No

* Would you prefer to customize the control boundaries for the automated control of the devices?
  - Yes
  - No
  - Not Sure

Along with the technical design of the different features mentioned above, it is important to address also usage requirements; how the users will interact with the different apps, how often…. The following questions will help us to design the applications based on your specific requests

5

* Do you believe that a User Interface could provide useful energy related information to the occupants?
  - ○ Strongly Agree
  - ○ Agree
  - ○ Neutral
  - ○ Disagree
  - ○ Strongly Disagree

* Where do you like to get this information?
  - ☐ Web Portal
  - ☐ Tablet
  - ☐ Smartphone App

* How often would you like to get updates about the different insights (smartness, energy reporting, comfort levels etc.…) associated with the smartness of the building?
  - ☐ Real time
  - ☐ Daily
  - ☐ Weekly
  - ☐ Monthly

* How often would you like to get updates of your energy and environmental data?
  - ☐ Real time
  - ☐ Hourly
  - ☐ Daily
  - ☐ Weekly
  - ☐ Monthly

* Would you prefer to customize the time period for data visualization?
  - ○ Yes
  - ○ No
  - ○ Not Sure