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DELIVERABLE: D2.5

Integrated Smart Energy Efficiency Service Package Concept and Detailed Service Model

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Building Up Next-Generation Smart Energy Services Offer and Market Up-take Valorising Energy Efficiency and Flexibility at Demand-Side.

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Executive Summary

This report builds on previous reports D2.1 and D2.2 and is complemented by document D2.4 which provides more detailed descriptions of the non-energy services associated with the Smart EES Model Prototype. The document is designed as a stand-alone document, the first chapters contain a description of EE services in qualitative way and the following chapters a description in quantitative way.

The document provides a comprehensive view of the Smart EES Service Model design that was conceived in the framework of the BungEES project. The aim of the document is to present the developed detailed design of the upgraded service model, including the service structure and components, technical requirements and analysis. The cost structure, key resources and revenue streams associated with the proposed services have been analysed and are also presented in this report.

The prototype model is a design that is based on existing models and is enriched with the necessary components to be in line with modern technologies and their capabilities. The design also reflects the strategic plans of the European Union and the individual countries for energy savings and energy policy. The document focuses on the various financing options, which include both internal financing and financing of the services provided. It also addresses aspects of flexibility, data use and management, and communication on energy flexibility needs.

In addition, the report looks at the energy market and the benefits that an aggregator can bring to households and the energy market as a whole. An important part of the analysis is also the technical barriers that may hinder the implementation of the proposed model. The different needs and preferences of owners are also taken into account, as well as the legislative constraints and specific national barriers that apply to Slovakia, the Czech Republic, Portugal, Spain and Germany.

This comprehensive approach allows for a better understanding of the challenges and opportunities that arise in the field of energy efficiency and flexibility and provides valuable information for the further development and implementation of innovative energy solutions.

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Abbreviations, Definitions and glossary

EE	Energy Efficiency
EES	Energy Efficiency Service
SEES	Smart Energy Efficiency Service
NEBs	Non-energy Benefits
DR	Demand Response
HVAC	Heating, Ventilation, and Air Conditioning
ESCO	Energy Service Company
EPC	Energy Performance Contracting
ROI	Return on Investment
RES	Renewable Energy Source

Decentralization of Energy Resources: The process of distributing energy generation and storage closer to the point of use, rather than relying on centralized power plants.

Energy Efficiency Service: A service designed to assist individuals and organizations in reducing their energy consumption while maintaining the same level of comfort and productivity.

Energy Flexibility: The ability of consumers to adjust their energy usage in response to changing supply conditions, prices, and demand, thereby enhancing the overall efficiency of the energy system.

Demand Response: A strategy that encourages consumers to modify their energy usage during peak demand periods in response to time-based rates or other incentives.

Non-Energy Benefit: Advantages gained from energy efficiency measures that extend beyond energy savings, such as improved comfort, increased productivity, and reduced maintenance costs.

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1. Introduction

Deliverable D2.5 Concept and detailed model of an integrated package of smart energy efficiency services builds on Task 2.2 Detailed design of an upgraded service model and Task 2.4 Assessment of NEB and other non-energy services to be integrated into a package of smart energy efficiency services.

This deliverable builds on the previous one: D2.2 Smart EES Service Model Prototype. The model has been further developed in greater detail, taking into account user groups' preferences and convenience in using the services, the value proposition, and the key services integrated into the service package. Additionally, the necessary infrastructure has been identified, along with the market actors, their interactions, and the potential applications of the model being developed.

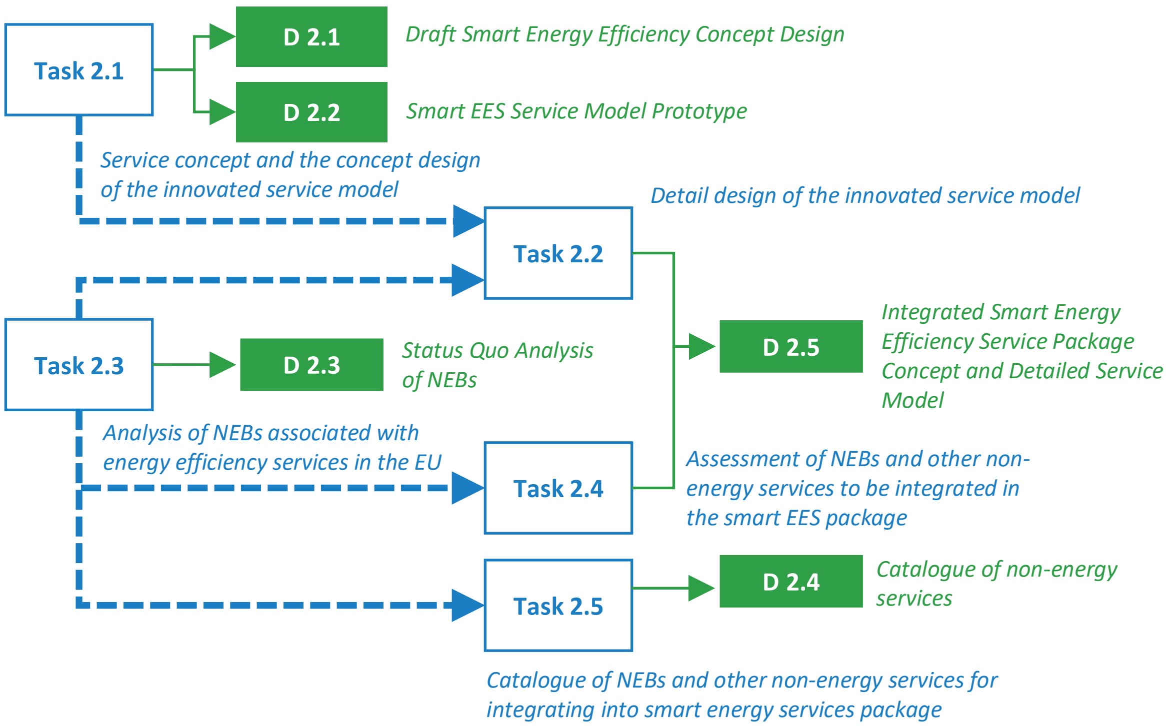

Figure 1: Diagram of the interconnection of deliverables and project tasks in WP2

Objectives of the project

The European energy market is currently facing significant challenges that require innovative approaches and comprehensive solutions. With the increasing emphasis on sustainability and reducing greenhouse gas emissions, energy efficiency is becoming a key element in EU policy. As part of the European Green Deal, Member States have committed themselves to achieving climate neutrality by 2050, which emphasises the transformation of energy systems and the integration of renewable energy sources.

Current energy markets are fragmented and often lack the necessary coordination between different sectors such as electricity, heating and transport. This fragmentation hinders the efficient use of available resources and makes it difficult to implement integrated energy

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services. In addition, regulation and legislation vary across Member States, making it difficult to harmonise approaches and increasing the administrative burden for market participants.

Another important factor is the growing demand for e-mobility and energy storage systems, which present new opportunities for improving energy efficiency. However, without adequate legal and financial frameworks to encourage innovation and investment in these technologies, their potential remains untapped.

In this dynamic and complex situation, it is essential to identify and overcome the barriers that hinder the development of integrated energy efficiency services. This includes not only technical and market aspects, but also legal and regulatory frameworks that need to be adapted to current needs and trends. The aim is to create synergies between different sectors and market players, leading to more efficient use of energy and improving the overall sustainability of energy systems in Europe.

This project addresses these challenges and seeks to develop innovative solutions that will allow the full potential of integrated energy services to be exploited, thus contributing to the objectives of sustainable development and climate neutrality.

1.1. Deliverable Scope

This document focuses on the analysis and design of the Smart EES model, aiming to identify and evaluate the benefits associated with the implementation of these services. The document emphasizes the identification and analysis of various benefits that energy efficiency services can bring primarily to the residential sector. These benefits include reduced energy consumption costs, increased energy efficiency, positive environmental impacts, and many other non-energy benefits that have been specified in D2.4 Catalogue of non-energy services.

Based on the identified benefits, a comprehensive set of service offerings will be developed, encompassing various aspects of energy efficiency, including technological solutions, energy audits, monitoring and management of energy consumption, compliance consulting, and other services. These service packages are tailored to the specific needs of different customer segments.

The next part of the document focuses on validating the proposed service packages through pilot projects and market assessment. The goal is to ensure that the designed services are effective, feasible, and meet current market demands. Based on analyses and validations, the document provides recommendations for the further development and implementation of smart EES services. These recommendations include strategies for effective communication with stakeholders, financing mechanisms, and approaches to mitigate technical and regulatory barriers.

In summary, the scope of the document encompasses a comprehensive methodology for designing and implementing energy efficiency services that takes into account both market demands and strategic goals related to energy savings and sustainability.

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1.2. Objectives of deliverable

The aim of this deliverable is to provide a comprehensive view of the proposed model, its structure, components, technical requirements and analysis that is necessary for the effective implementation and operation of energy efficiency services. The first part of the document provides a qualitative and quantitative description of energy efficiency services, highlighting key elements such as value proposition, customer segments, channels and revenue streams. This approach provides a better understanding of how the Smart EES model works and its potential impact on the energy sector.

The document goes on to discuss the various funding options, which include both internal and external sources of funding for the services provided. Aspects of flexibility, data use and management, and communication on energy flexibility needs are also considered. The market analysis examines the benefits that an aggregator can bring to households and the overall energy market.

An important part of this report is the identification of technical barriers that may hinder the implementation of the proposed model and the consideration of different needs and preferences of owners. Legislative constraints and specific national barriers affecting Slovakia, the Czech Republic, Portugal, Spain and Germany will also be analysed in detail.

This document aims to provide valuable information and recommendations for the further development and implementation of innovative energy solutions that meet current market needs and contribute to achieving energy efficiency and sustainability goals.

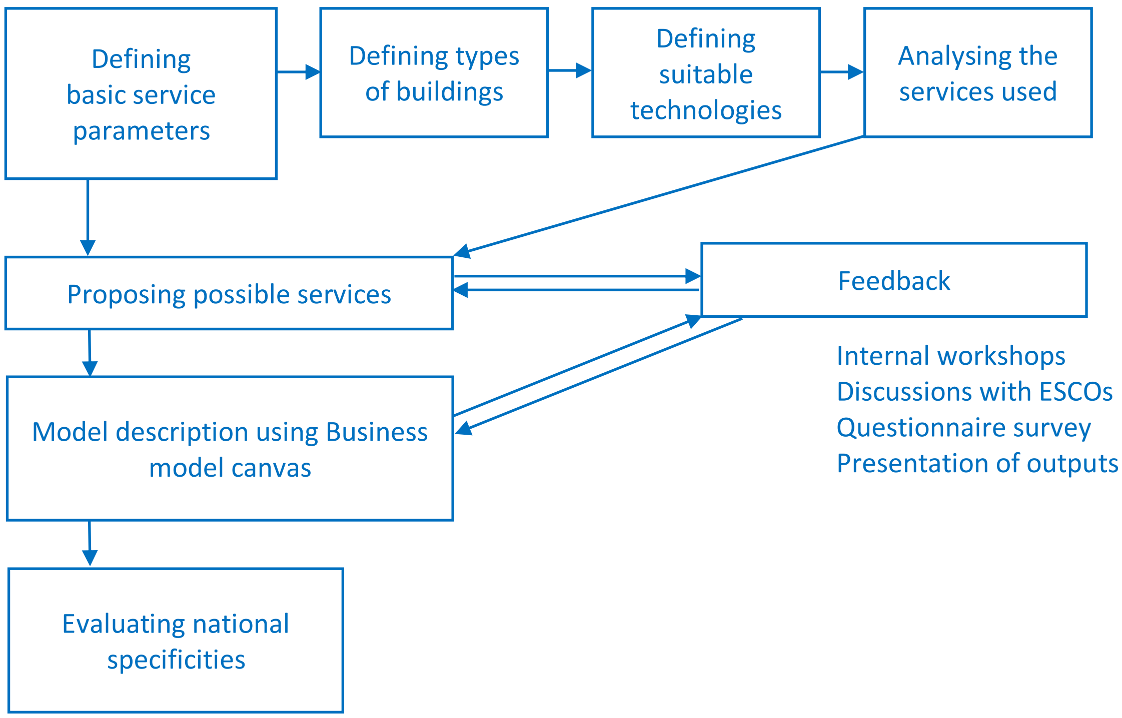

Figure 2: Workflow for creating a service prototype

As part of the work on Tasks 2.1 Service concept and the concept design of the innovated service model and 2.3 Analysis of NEBs associated with energy efficiency services in the EU,

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analyses of the market, available technologies and the design of energy efficiency services were carried out. Within the framework of these drawings, the basic form of the model was established, which was further refined and elaborated in greater detail. This was followed by the 2.2 Detail design of the innovated service model, in which a detailed design of the service model being developed was developed and adapted based on the national specificities for each selected country. The design of the prototype model is in line with the assessment of non-energy benefits and potential non-energy services that can be included in the model, this activity was carried out under Task 2.4 Assessment of NEBs and other non-energy services to be integrated in the smart EES package.

Following their identification and analysis, selected services were then described in detail. The primary focus was on describing them in accordance with the Business model canvas. The focus was on outlining the required technologies, the associated benefits for the end user/customer, and the potential revenues for the service provider. All identified services are part of deliverable D2.4 Catalogue of non-energy services, only selected services that have been identified as appropriate services in relation to the national specifics and focus of the model are included in this document.

EES service objectives and strategies

The objectives and strategies outlined in the proposed service focus on enhancing energy efficiency and promoting sustainable practices among users. The primary goal is to provide tailored energy and non-energy solutions that meet the diverse needs of various user groups, thereby maximizing energy savings and reducing environmental impact. Strategies include the implementation of advanced technologies for real-time monitoring and data analysis, fostering user engagement through educational initiatives, and developing partnerships with key stakeholders in the energy sector.

Additionally, the service emphasizes the importance of energy flexibility, enabling users to adapt their consumption patterns to changing energy supply conditions, energy prices, and other market signals. By prioritizing user convenience and satisfaction, the EES service aims to create a comprehensive framework that supports the transition to a more efficient, flexible, and sustainable energy system.

Main target group and beneficiaries

This report can be helpful to a wide range of stakeholders. Specially, it provides detailed information on the different packages of energy efficiency services that aggregators can offer to their customers. This will allow them to expand their portfolio and better respond to market needs. The analysis of benefits and best practices can help aggregators develop innovative strategies to improve their market position and attract more customers. The report includes recommendations for effective communication of energy flexibility needs, which can help aggregators better inform and educate their customers.

The document provides also useful background to DSOs and outlines the benefits of energy services, primarily in the areas of energy flexibility and decentralization of the energy market. These are well suited for effective management and integration of decentralized energy resources, which can lead to optimized operations and reduced costs.

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The report is also suitable for government organizations and policy makers. The paper provides valuable information to government agencies on the benefits and best practices in energy efficiency that can be used to formulate and implement effective policies and programs. The analysis of various funding options and recommendations for service development can help governments attract investment in energy conservation and renewable energy projects. The implementation of recommended measures and services can contribute to achieving sustainability goals, reducing greenhouse gas emissions and improving the quality of life of residents.

1.3. Methods used to create a detailed service design

Various methodological approaches have been used in the work on the relevant project tasks and in the development of this document to ensure a comprehensive and thorough assessment of the Smart EES (Energy Efficiency Services) model. These methods mainly include desk research, analysis of survey information, pilot project experience, cost estimates, Business Model Canvas framing and revenue stream estimates.

Extensive desk research was conducted which included analysis of available literature and studies on energy efficiency, energy flexibility and related EE services. A survey of available publicly available information from EE service providers was conducted. This approach allowed gathering relevant information on current trends, best practices and challenges in the field of energy services. Desk research also included an analysis of legislative and regulatory frameworks in different countries, which contributed to the understanding of specific market conditions and requirements.

The work builds on the Tasks carried out under WP2 of the BungEES project, where surveys were conducted among key actors in the field of energy efficiency and EE service provision. These surveys provided valuable information on the needs and preferences of service providers and customers, as well as on the perceived benefits and barriers associated with the implementation of energy efficiency services. The analysis of this data has enabled a better understanding of the market and the tailoring of proposed services to specific requirements.

The project also includes pilots. Partial experiences primarily from the development of the pilots provided practical insights on service implementation, technical challenges and successful strategies. The information gained was key to validating the proposed services and identifying areas that require further development or modification.

Estimates of the costs associated with the implementation of individual services and service packages have been made. These estimates included both upfront investment and operational costs and were based on available data from national projects addressing the cost optimum for implementing energy efficiency measures and the experience of the consortium members. The cost estimates allowed to assess the economic viability of the proposed services and their potential benefits for providers and potential customers.

This combined approach of methods allows for a comprehensive analysis and design of a Smart EES service model that is based on evidence and best practice and that is able to respond effectively to market needs and contribute to energy efficiency targets.

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Using Business model canvas & Service Model Canvas

The Business Model Canvas principle was used to develop the EE service model as a strategic management tool that serves as a visual framework for describing, analysing and designing business models. This tool, developed by Alexander Osterwalder and Yves Pigneur, provides entrepreneurs, start-ups and established companies with a systematic approach to understanding the fundamental aspects of their business and how they create, deliver and capture value. BMC consists of a one-page diagram that is divided into nine key building blocks that represent critical aspects of the business model. These blocks include customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships and cost structure. Within this document, BMC has been used to identify and analyse the key elements of the Smart EES business model. This enabled the mapping of how the different components relate to each other and how they contribute to the overall strategy. The visual nature of the BMC facilitates communication and collaboration between team members, stakeholders and investors, which is particularly important when developing and implementing new services. In addition, BMC encourages creativity and innovation by allowing entrepreneurs to explore new ideas and experiment with different business models. This framework has proven to be a valuable tool for strategic decision-making and business model innovation, contributing to the overall evaluation and design of Smart EES services.

Pilot programme methods - implementation and evaluation

The BungEES project's Spanish pilot program, led by Plenitude in collaboration with CONAIF, focused on testing HVAC technologies in regions with significant potential customer bases, specifically Cataluña and Cantabria. These regions were selected due to the high prevalence of air-conditioning units, which were more common than heat pumps due to Spain's hot climate. The pilot involved a series of steps, beginning with site surveys and customer recruitment by Plenitude and partners 3Xako Energi SL and Ingualva, identifying a total of fifteen residential participants.

Technical assessments of selected equipment, such as heat pumps and air conditioning units, were carried out by Voltalis, confirming compatibility with their energy management solutions. Homeowners were informed and signed agreements to participate in the pilot, after which installation schedules were coordinated between Voltalis, Plenitude, and the participants. Installation was a joint effort, with local certified electricians supporting Voltalis due to certification requirements in Spain. Plenitude handled communications, scheduling, and post-installation services, acting as an intermediary between Voltalis and homeowners. Voltalis was responsible for data collection and providing access to their platform, ensuring that the installations were successful.

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2. Detail design of the innovated service model

2.1. Using the Business model canvas for detailed service identification

The optimal business model for the newly developed energy efficiency service was carefully discussed and determined in consortium meetings and project workshops. Existing models were analysed and the services that the new innovative model should offer were sought. After much discussion, analysis and consultation, it was decided to create a business model canvas that maps out the key aspects of our business model. This chapter presents a detailed look at the different components of the business model canvas and explores how the framework can be used effectively to achieve our project objectives.

The first designs and the initial form of the model are described in more detail in the previous project deliverables, in particular Deliverable D2.1 Draft Smart Energy Efficiency Concept Design & D2.2 Smart EES Service Model Prototype. This deliverable builds on these project outputs, further deepening their results and providing a more detailed description of the model and its components adapted to the order of the selected countries.

USERS	**SERVICE PROPOSITION**	**CHANNELS**	**KEY ACTIVITIES**	**CHALLENGES**
ACTORS	**USAGE**	**COMPETITORS**	**KEY RESOURCES**	**COSTS**
ROI		**KPIS**		

Figure 3 – Service model canvas[1]

The service model design involves knowing each of the points that the service offered has. This is intended to clarify the service and give value to the product offered. In relation to this service, it is known that a series of services such as heat pumps, recharging points or self-consumption are combined.

They could have different bundles as can be:

- Premium → Heat Pump (Installation and control) + Solar (Installation and control) + Recharging points (Installation and control) + Maintenance + Energy
- Control → Heat pump (control) + Solar (control) + Recharging points (control) + Maintenance + Energy

[1] https://www.uxforthemasses.com/service-model-canvas/

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- Basic Electric mobility → Recharging point (Installation and control) + maintenance + Energy
- Basic Solar → Solar (Installation and control) + maintenance + energy
- Basic Heat pump → Heat pump (installation and control) + maintenance + energy

With these differentiated products in which the installation of equipment is not mandatory, services can be modulated. For example, you can start by offering the Basic Heat Pump service in which your heat pump would be controlled if you had one and if not, the installation of the same is offered. This allows the user to start learning about his consumer preferences and interests in other energy devices, and to offer an increase in product as might be the control service to mange only these devices.

In this respect, different service products can be offered and included at various scales as can be an integrated service as can be all services heat pumps, recharging points and self-consumption. On the other hand, having the synchronization and agglutination of different services or packages such as a lower package in which only the heat pump is controlled for example, being able to know the energy saving, economic savings, scheduling, or how flexibility management can be.

In the recent years, the demand-side of the energy sector has undergone dramatic evolution. This change is driven by the proliferation of distributed energy resources (DERs) and the digitalization of the sector, enabling consumers to actively participate in the energy supply value chain. Traditional utility business models are becoming obsolete, replaced by emerging consumer-centric models that are fragmenting the energy market. In this new market, consumer participation is as crucial as the roles of entities responsible for generation, transmission, and distribution. Below, examples of such business models are detailed. Specifically, within the context of the BungEES project, the servitization and energy service bundling business models are particularly relevant.

Servitisation (Pay-for-service or outcome)

The BungEES project aims to develop smart energy service packages for demand-side energy services. Moreover, these service packages combine energy and non-energy services to extend the service provider’s portfolio. These service packages can guarantee energy and cost savings along with dwellers' well-being. In this regard, the business models to monetize connected service business models are also debated in the project.

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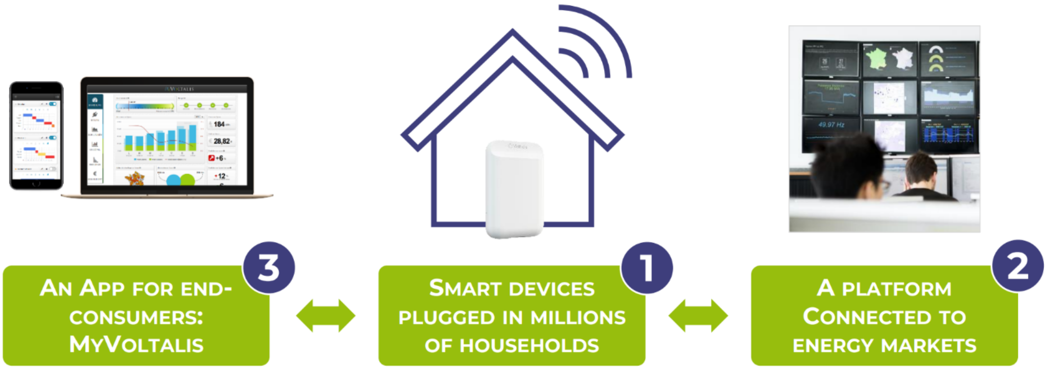

Figure 4 – Voltalis servitised business model

Servitised business models, offered with no or minimal capital cost (CapEx), are considered viable for developed energy service packages. Moreover, the implementation partner in the project, Voltalis, is already offering a servitisation business model for demand-side residential energy flexibility (see figure X). In this model, the company provides an intermediary device to communicate flexibility requirements and availability between consumers, the aggregation platform, and transmission system operators (TSOs).

To this end, several resources providing demand flexibility could be seamlessly integrated as 'connected flexibility-as-a-service' and delivered to consumers at no cost.

Undoubtedly, servitisation offers a better opportunity for both consumers and service providers. However, at the same time, it brings various market implementation challenges such as the availability of data, regulatory barriers, and financial returns. These challenges and barriers are discussed in Deliverable D 3.2.1 in a detailed manner.

Platformization of energy service:

Platformization refers to the trend of creating centralized digital platforms that integrate various energy-related services and stakeholders. These platforms facilitate the exchange, management, and optimization of energy resources by connecting consumers, producers, and service providers. This model promotes efficiency and sustainability by enabling real-time data sharing and more responsive energy distribution solutions. As a result, platformization enhances consumer engagement, better connectivity, transparency and drives the transition towards more decentralized and renewable energy systems. In the European context, several platform driven business models are already active in the fields of energy flexibility, trading, EV charging, and energy management. A few such examples are given below in the table. Often, these platforms are owned by utilities and service providers.

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Table 1 – Platform based business model in European energy sector (Source: Lech, Łukasz. (2022)[2])

Platform name	Electric Utility	Platform purpose
Powershift	EdF S.A.	Energy flexibility, optimisation and trading platform that helps turn business' energy into a valuable asset.
Agregio	EdF S.A.	Virtual power plant (VPP) that optimises renewable energy generation, demand response and storage assets' flexibilities.
Dreev	EdF S.A.	V2G technology provider, whose mission is to lower the cost of electric vehicle ownership while supporting the integration of renewable energy sources, including solar and wind.
E2M (Energy 2market)	EdF S.A.	Virtual power plant (VPP) that aggregates flexibility and energy supply from both decentralised generation and consumption systems.
Ener2crowd	Enel SpA	Lending crowdfunding platform (also known as Social Lending) that allows a multitude of retail or institutional investors to invest money in energy efficiency, renewable energy and environmental sustainability projects.
Enel X	Enel SpA	It offers the support needed for people to live in a smarter, more sustainable way through innovative and scalable solutions that respond to their ever-changing needs.
PresAGHO	Enel SpA	E-maintenance platform where predictive models using Artificial Intelligence algorithms are defined and implemented. It gives O&M a powerful tool for efficiently planning and executing inspections and maintenance, thereby significantly increasing safety and savings in terms of time and money.
E.ON Optimum	E.ON SE	Cloud-based energy platform that gives customers energy intelligence, which can help to reduce their consumption and costs with ease, enabling them to make faster and better decisions for their business and to meet their sustainability goals.
HEMS	E.ON SE	It combines data from all electrical devices within the home – including heating and cooling systems, PV installations, battery storage or chargers for electric vehicles – on a single platform rather than a combination of incompatible individual apps.
Data Management Platform	Engie SA	Data Management Platform unites energy, water, and waste data across a global portfolio of sites into one view to deliver powerful insights that help organisations manage their spending and consumption of resources.
EGMA	Engie SA	ENGIE's in-house trading platform.
e-star	Engie SA	Specifically designed to cater for a pan-European portfolio and based on ENGIE's experience as one of the major actors in the gas market.
Snoop-E	Engie SA	Snoop-E allows smart negotiation. Snoop-E is a digital contract negotiation platform that manages the contract's lifecycle, replacing email exchanges.
EnergyScan	Engie SA	It provides economic research to manage clients' assets and investments.
TiP	Engie SA	TiP is designed as an integrated digital solution 'as a service' gathering the comprehensive expertise of short-term power teams.

[2] Lech, Łukasz. (2022). Emerging platform business models among the European electric utilities. Kwartalnik Nauk o Przedsiębiorstwie. 66. 84-104. 10.33119/KNoP.2022.66.4.6.

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Platform name	Electric Utility	Platform purpose
The Energy Origin (TEO)	Engie SA	The electricity matching & blockchain certification platform. It provides an autonomous device plugged into any type of meter on production and consumption sites to collect data in real-time instantly. With the device, the data is then signed and can be registered on any blockchain for decentralised applications.
WattsOn	Engie SA	The Platform allows the Client to access its data via its Authorised Representatives.
Operate	Uniper SE	Neural network-based tool that directly operates asset processes such as the combustion in waste-to-energy or biomass-to-energy.
SaaS Platform	Fortum Oyj	SaaS Platform for EV Charging Network Management.
Fortum Online	Fortum Oyj	The portal that allows for real-time energy consumption tracking and comparing it with previous estimates.
Virtual Power Plant	EnBW AG Plant	It bundles decentrally generated energy into a virtual power plant and sells it.
PGE eSklep	PGE S.A.	The platform for buying the products of PGE's partners.
Driviz	ČEZ AS	EV charging management system for the entire ČEZ electromobility network.
SSE Enhance	SSE plc	Smart grid, aggregation, and trading platform enabling large energy users to earn money from balancing supply and demand.
Retail Service Platform	Ørsted A/S	Retail Service Platform offers energy supply companies a wealth of trading and risk management solutions.
GreenH2Chain	Acciona SA	It allows customers to verify and visualise the entire green hydrogen value chain in real-time and from anywhere in the world.
Platforma Integracyjna	Tauron Ekoenergia Sp. z o.o.	It allows the aggregation of the generation sources such as RES and energy storage and selected categories of controllable loads, e.g., HVAC, to regulate the electricity generation and consumption.
POI	PKN Orlen Energa S.A.	It allows customers to purchase electricity and gas from the wholesale market.

Energy service bundling (Connected energy services)

Service bundling is also an emerging business model for energy service providers. In fact, sectors like Telecom, Internet, and Entertainment have already been practicing service bundling for many years. In such business models, service providers create additional value by combining two or more services together

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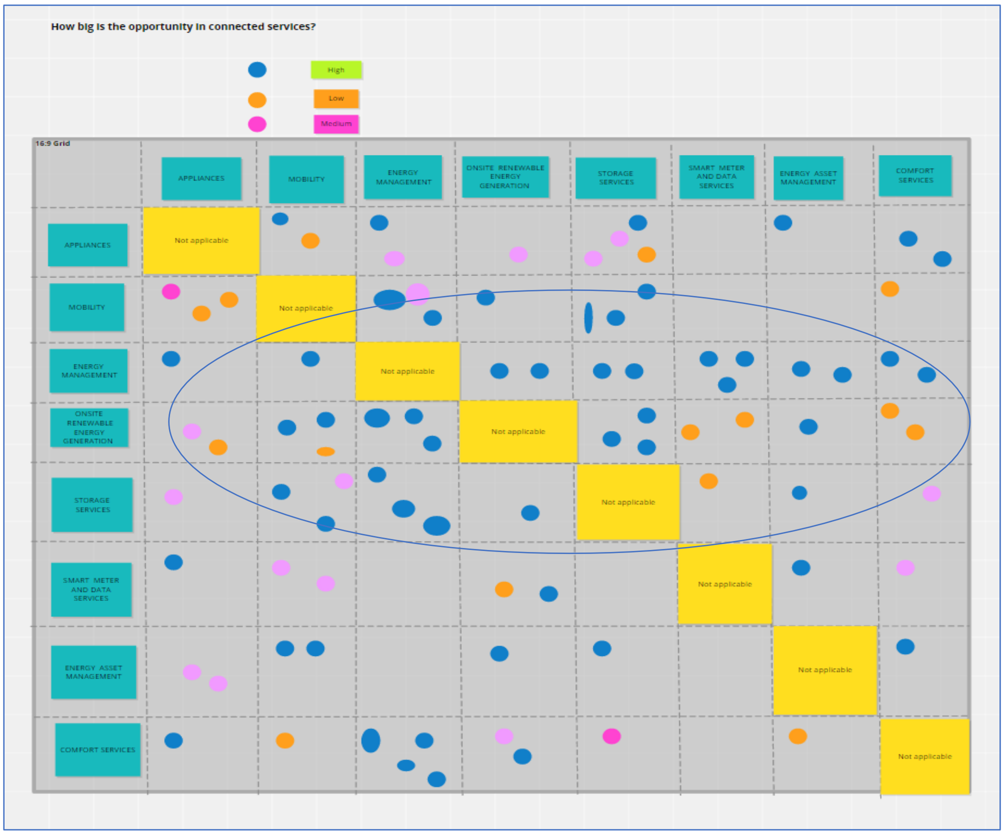

Figure 5: Business opportunity in bundled or connected energy services.

In the energy sector, service providers could offer bundles that combine two energy services or a mix of energy and non-energy services. However, the additional proposition brings multiple benefits to end-consumers, together with the possibility to avail tailored energy services.

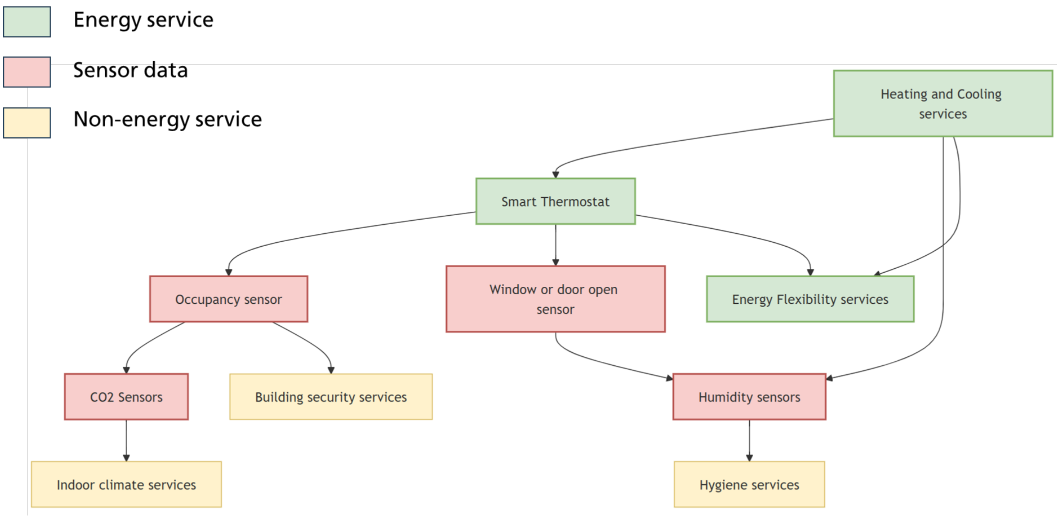

Figure 6: Energy and non-energy service configuration

In the context of the BungEEs project, a workshop was conducted among project partners to identify business opportunities arising from connected or bundled energy services. Figure 6 illustrates the potential of combining various energy services. The results clearly show that onsite renewable generation and energy management possess strong business value compared to others. Additionally, non-energy services could be bundled with energy services, enhancing the value proposition of the energy services and potentially increasing revenue as well as attracting new consumers. Below are a few examples of such service bundles (also in Figure 6).

1. Energy flexibility service from heating and cooling systems, integrated with indoor humidity monitoring using a humidity sensor.
2. Heating and cooling services paired with indoor air quality management, utilizing sensors to detect open windows or doors.
3. Smart thermostat linked with occupancy sensors, capable of communicating with building security services.

Energy service marketplace

An energy service marketplace is a digital platform that connects energy service providers with consumers or businesses seeking energy-related solutions. These marketplaces offer a range of services, such as energy consulting, renewable energy installation, energy efficiency upgrades, utility management and Smart grids. Such platforms often include tools for comparing providers, managing energy consumption, and accessing innovative technologies like smart grids or battery storage. Companies like Kiwi Power[3], Flexitricity[4], and NODES[5] are offering flexibility services marketplaces

2.2. Infrastructure and requirements on the state, energy suppliers, utility managers, etc.

Energy Efficiency Services represent a cornerstone for achieving sustainable energy systems, reducing environmental impacts, and enhancing energy security. To fully realize their potential, it is essential to establish a robust infrastructure and meet the requirements of key stakeholders, including energy suppliers, utility managers, and state authorities. This chapter outlines the technological infrastructure, role of energy suppliers, utility management, and the state's involvement in developing and supporting EES.

Modernization of Distribution Networks

For EES to function effectively, distribution networks must support bidirectional energy flows. This involves upgrading existing grid infrastructure to accommodate distributed energy resources (DERs) and ensure seamless energy distribution and exchange.[6], [7]

Distributed Energy Resource Management Systems (DERMS)

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3 https://www.antennagroup.com/portfolio/kiwi-power

4 https://www.flexitricity.com/market-access

5 https://activeefficiency.org/project/kent-state-university-central-plant-optimization-ratcheting-up-energy-cost-savings-2/

6 https://www.iea.org/reports/energy-to-2050-scenarios-for-a-sustainable-future

7 https://www.iea.org/news/the-energy-world-is-set-to-change-significantly-by-2030-based-on-today-s-policy-settings-alone

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The integration of DERMS is crucial for managing decentralized energy generation, such as solar panels and wind turbines. These systems optimize the operation of DERs and enhance grid stability.[8] The implementation of DERMS can be technically challenging and requires coordination between different actors in the energy sector, which can slow down the integration process.

Smart Metering

Just as it is important to have a distribution network and flow management in place on the power grid, there is a need to focus on the development of Smart Metering and Demand Response Systems. There is a need to collect end-user data, ideally in real time, to allow room for response and management of the consumption system. This will also allow for behavioural patterns to be established and more predictive of future consumption and preparation. In return, smart metering systems will enable users to better understand their consumption and identify savings opportunities. This can lead to more efficient use of energy and reduced costs as well as increased user education on energy savings and consumption. Some users may be sceptical of new technologies and concerned about their privacy, which may hinder the widespread adoption of systems.

Real-time collection of energy consumption data requires strong security to prevent leakage of sensitive information and to ensure user privacy. With increasing demands on technology, there may be a risk that system failures or malfunctions will lead to disruptions in energy supply and therefore losses to the user or service provider.

Clarification from the Czech environment

Energy flexibility is a key element to ensure the stability and efficiency of modern energy systems, especially with the growing share of renewable energy sources. In the Czech Republic, this area is regulated by legislative frameworks and requires cooperation between the state, energy suppliers and utility managers.

The Energy Act and related regulations set out the rules for the provision of energy services and promote the integration of flexible resources into the energy grid. For example, the 2024 amendment to the LEX RES III energy law introduces new rules for the electricity market, including changes for electricity storage and the provision of flexibility services.

Infrastructure: the deployment of smart metering and the modernisation of distribution networks are essential for the effective use of energy flexibility. These technologies enable accurate real-time monitoring of energy consumption and generation, which is key to managing flexibility.[9]

Requirements for energy suppliers and utility managers: Energy suppliers and utility managers must implement demand and supply management systems that allow for rapid response to changes in the energy grid. This includes investments in energy storage

8 https://www.nrel.gov/grid/distributed-energy-resource-management-systems.html

9 https://www.ote-cr.cz/cs/o-spolecnosti/soubory-vyrocni-zprava-ote/rocni_zprava_2018.pdf

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technologies such as battery storage and distributed energy management systems. It is also important to work with end-users to implement consumption management programmes.

Role of the State: The State should create a supportive legislative and regulatory environment that facilitates the integration of flexible resources and encourages innovation in the energy sector. This includes supporting research and development in energy flexibility and providing financial incentives for the implementation of smart technologies.

The implementation of energy flexibility requires a coordinated effort by all stakeholders and is key to achieving energy efficiency and sustainability goals.

2.3. Technical requirements and suitable equipment

2.3.1. Experience of services in France

During installation, Voltalis will provide all the equipment required for the implementation of the solution. The solution requires the heat pump to be fed from single breaker alone with no other appliances connected to the same breaker.

On the other hand, the heat pump both indoor and outdoor units should be accessible to perform the implementation by the technicians. For connectivity, it is required to have a good mobile network coverage on the installation site.

2.3.2. Ideas of Plenitude for infrastructure

The management of this type of product requires technicians specialized in the different products being processed. They must have the necessary training in installing heat pumps, recharging points, self-consumption etc.

On the other hand, it will also be necessary to have a management system and specialized technicians in control of this type of installation. Now, the technicians who can control the sites are those of Voltalis in heat pumps.

It is necessary to have a management system of the different products, currently this system is of Voltalis that in France are able to manage the heat pumps and electric radiators among other devices. They are currently working on the design of other systems such as solar installations or electric vehicle chargers.

The technical assistance service is also required to answer any questions or problems that arise for customers.

2.3.3. Experience from national pilots

The following chapter describes the findings of the pilot projects in the Czech Republic, Portugal and Spain. In particular, it describes the shortcomings and specificities identified, which need to be taken into account in the design of the services offered and their subsequent implementation.

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Experience from national pilots - Czechia & Slovakia

The pilot project in the Czech Republic includes the installation of equipment connected to the heat pumps, which takes control and manages their start-up. The most suitable devices for this installation are older "non-smart" devices. During the pilot project it was found that there are mostly modern and smart heat pumps in the Czech Republic, as the market has only recently started to develop. Previously, the option of home heating with gas heat sources was rather promoted.

Although modern units and technologies are designed to be as compact as possible, sufficient space, primarily in cabinets, is needed to install the modern equipment required for energy flexibility. In the Czech Republic, especially in older buildings, space is limited, and switch cabinets are often used to their maximum extent. As it has been shown during the preparation of the pilot project in the Czech Republic, it is necessary to take this fact into account and to consider that there may be additional costs for modification/reconstruction of technical equipment or the need for building modifications.

The Czech Republic is still lagging some EU countries in the implementation of directives concerning energy communities and flexibility. RED II (Renewable Energy Directive II) and EED (Energy Efficiency Directive) are partially implemented, but the rules for energy communities are not yet fully set.

Identified problems with space for placement - space in the switchboard

Although modern units and technologies are designed to be as compact as possible, sufficient space must be provided for the installation of modern equipment needed for energy flexibility, primarily in the switchgear. In the Czech Republic, especially in older buildings, space is limited, and switch cabinets are often used to their maximum extent. As it has been shown during the preparation of the pilot project in the Czech Republic, it is necessary to take this fact into account and to consider that there may be additional costs for modification/reconstruction of technical equipment or the need for building modifications.

Experience from national pilots - Portugal

The BungEES pilots allowed to have a hider perspective on the technologies most used for heating/cooling house in Portugal, as well as on its limitations. In rural areas biomass and bottled gas is still very common for heating, that is related either with biomass availability or energy poverty of these populations. For cooling, in these areas people tend to use fans, which is still the cheapest technology to provide some comfort in the summer. However, even in rural areas air-to-air heat pumps are starting to have a larger share especially in new construction.

In urban area, the most used technologies for heating are small electric heaters and for heating/cooling air-to-air heat pumps. The first option is usually made by families with lower incomes, middle class families (or above) usually install air-to-air heat pumps because it can used either for winter or summer.

In Portugal large retail stores (e.g. Leroy merlin, Worten, Radio Popular, etc.) and electricity suppliers (e.g. EDP Comercial) often make campaigns where the end-user can pay the air-to-

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air heat pumps in monthly payments with very low or non-existent interest rates. This way families can acquire high-efficient heat pumps with low financial effort.

When the residential BungEES pilot was deployed in Portugal the Voltalis equipment had the limitation of only working with air-to-water heat pumps, which are not common in Portugal. The Portuguese BungEES found a building in Coimbra where this type of heat pump is used for climatization. However, since the heat pump is not very efficient, and the building has a good thermal inertia the inhabitants tend to do a very low usage of this equipment.

The interoperability of systems, as well as the integration of legacy appliances has revealed to be a challenge in the BungEES pilots. However, in the ISR building (the second pilot in Portugal) the control of air-to-air heat pumps (some of them with more than 10 years) this situation has been overcome with the used of Sensibo smart thermostat that allow to remotely control legacy heat pumps transforming them into smart appliances, as well as new heat pumps. This pilot also includes the use of air-to-air heat pumps in combination with photovoltaic production, battery storage and electric vehicles charging. This orchestration will allow to fully take advantage of the solar production, as well as the battery storage system (charged during low tariff periods or solar surplus production) to create flexibility and reduce the energy demand from the power grid.

In Portugal the list of companies registered in the National Directorate of Energy as aggregators[10] is significant. However, it is not clear how many of them are currently actively working in the market as aggregators. Some energy suppliers (EDP Comercial, Repsol Portugal, MEO Energia) are in this list but they are also energy suppliers. Some companies are working in both sides (as aggregators and energy supplier) which creates some confusion, especially for end-users. In Portugal the role of aggregators still needs additional clarification, both at end-user level to show them the benefits of having an aggregator, as well as at regulatory level to avoid companies to play at both side of the field.

Experience from national pilots - Spain

The pilot in Spain can be divided into the following phases which have been carried out during the project. In this stage we can collect all the information about the first six months of the pilot project.

Collaboration between companies

The collaboration between companies, a process has been developed between Voltalis and Plenitude for collaborating within this pilot. Voltalis' team was responsible for the management and installation of equipment in Spain, while Plenitude's team was responsible for the search for customers.

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10 Aggregators in Portugal, https://www.dgeg.gov.pt/pt/areas-setoriais/energia/energia-eletrica/atividades-e-profissoes/no-setor-eletrico-nacional/agregadores-de-eletricidade-em-regime-de-mercado/

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Within this collaboration between Plenitude and Voltalis, the CONAIF team has been introduced to realize the installation of equipment and verify that it complies with Spanish regulations.

Tripartite contract

It was considered necessary to include the services and obligations of each participant in the pilot project by means of a tripartite contract defining the responsibilities of each company. This defines Voltalis as the technology supplier (control and automation equipment) in addition to being the manager of the application that will be provided by the customer. Plenitude is responsible for the generation of leads in cooperation with CONAIF. As for the work of CONAIF, it is in the installation of equipment by means of verification of Voltalis because they have the knowledge and experience of managing the equipment.

Customer acquisition

The collaboration between Plenitude and CONAIF has been initiated in the search for customers, for this purpose from Plenitude and CONAIF have defined the areas in which to act according to installers and future customers, This is why the best areas of action have been determined to be Cantabria because the headquarters of Plenitude is here and Catalonia due to the difference in climate and equipment with Cantabria and the contact that was had with the installer of the area.

Once the search has been launched, a total of 24 customers have been presented between Cantabria and Catalonia, of which it has been possible to carry out installations at the homes of 15 customers. Ten of them are in the Catalonia area, while five have been in the Cantabria area.

Problems with the other customers who have not been able to install the solution have been diverse. For example, the non-compatibility of their heat pumps with Voltalis devices, the impossibility of installing them in the customers' home due to the state of the machinery, due to the impossibility of accessing it, etc.

Installation planning

The planning of the installations has been carried out jointly by Plenitude, CONAIF and Voltalis. With this, it was decided to dedicate one week to carry out the installations around Catalonia at the end of May 2024. On the other hand, in Cantabria, it was established to carry out the installations in three days during the middle of June 2024.

Once the dates were defined and the clients and installers were informed, the installations were carried out.

Installation's process

The customer's home was visited to carry out the installation processes, which were estimated to take an average of 3 hours. Prior to the installation, a visit to the client's house was made to provide an explanation of the work to be done as well as the equipment that would be installed. Eamples are three equipment detailed below:

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Figure 7 – Equipment examples

Gateway

► Connected to internet, receives orders from Voltalis aggregation platform and transmit these orders to every smartswitch. It also transmits data from smartswitchs and meters to aggregation platforms.

Smartswitch

► It is connected to electric equipment and communicates with the gateway. It sends the order to the electric appliance (heat pump, air conditioning)

Smart electric meter

► It measures the electricity consumption of global housing or specific appliances.

The installations are divided into two types a solution for heat pumps, and for air conditioners. The following is an example of a solution for installation in air conditioning equipment, used in Catalonia.

The installation procedure for air conditioning:

1. Preparation
    a. Explanation of the Voltalis solution to the user
    b. Checking the device eligibility
    c. Taking pictures of the devices and electrical panel before starting
2. Installation and configuration of the communication device in the application
3. Install and configure the measuring device on the electrical panel
4. Install IR control devices
    a. Configuration of the IR device
    b. Determination of the good location
    c. Testing the different orders sent by the device

The installation procedure for heat pumps is shown below:

1. Preparation
    a. Explanation of solution to the user
    b. Checking device eligibility
    c. Taking pictures of the devices and electrical panel before starting
2. Setting up the heat pump
3. Installation of the communication module and its declaration in the application
4. Installation of the measured module in the home electrical panel and its declaration in the application
5. Installation of the dry contact module in the indoor unit and its declaration in the application
6. Installation the temperature probe

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Following these steps, the installation was completed, pending the last communication check to verify that all the equipment was working correctly.

Obtaining keys

As soon as the installations are completed, they are declared on the Voltalis platform, and the keys are provided to the users so that they can manage their devices and carry out the corresponding programming and adjustments.

Analysis of the pilot

Once the pilot has been put into operation, the data obtained during these periods will be analyzed. At present, no conclusions are available other than the preliminary estimates of 15 % energy savings achieved.

Regular communications with customers are ongoing through the pilot phase. So far, only one issue was encountered by particular customer claiming having problems to sufficiently heat home in December 2024. Therefore, the device was disconnected to continue the regular operation of the equipment.

In conclusion, the experience of the first six months of being a pilot is positive as it is being seen that achieving energy flexibility by controlled disconnection of the equipment for short periods of time, around 10-15 minutes, has a positive influence and that, as a rule, it has not affected the comfort of the customers. In addition, a new concept of a device that is suitable for managing this type of services is being tested to verify flexibility in the residential sector with heat pumps.

2.4. Market size, Market actors and Interactions

The following chapter describes the specificities of the energy efficiency services market. The analysis focused primarily on describing the size of the market, i.e., potential customers, technical parameters of the facilities, condition of the buildings, etc., primarily information that relates to the services offered and can influence their quality or intensity of benefits.

Market size, Market actors and Interactions - Czechia

Development of the heat pump market[11], [12]

The development of heat pumps in Czechia has been extremely fast in recent years. Their annual sales have increased from around 6 000 per year in 2010 to over 55 500 per year in 2023, according to statistics from the Ministry of Infrastructure and Trade and showed in the table below.

[11] https://vytapeni.tzb-info.cz/tepelna-cerpadla/25042-tepelna-cerpadla-prodeje-v-roce-2022-scenare-do-2040-a-ne-dostatek-elektriny

[12] https://www.mpo.gov.cz/cz/energetika/statistika/obnovitelne-zdroje-energie/tepelna-cerpadla-_-prodeje-2010_2023--275595/

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Table 2 – Estimated annual supply of heat pumps to the Czech market

Year	Water-Air	Air-Water venting	Earth-Water	Water-Water	Total
2010	4 199	0	1 707	53	5 959
2011	4 908	0	1 951	50	6 909
2012	5 323	21	1 808	44	7 196
2013	5 752	23	1 679	49	7 503
2014	6 367	45	1 512	46	7 870
2015	7 304	31	1 463	107	8 905
2016	10 827	40	1 435	83	12 385
2017	13 718	65	1 438	120	15 341
2018	16 977	70	1 568	80	18 695
2019	21 603	67	1 333	84	23 087
2020	22 680	69	1 371	69	24 189
2021	29 737	162	1 566	57	31 522
2022	57 966	120	2 269	85	60 439
2023	52 898	26	2 603	93	55 620

Note: Air-to-air heat pumps have not been accounted for.
Source: Ministry of Industry and Trade
Total number of newly completed dwellings in family houses (FH) and apartment buildings (AB) heated by heat pumps and their share in the total number of completed dwellings, 2012 – 2022

About 90% of those sales were for households. The recent growth in heat pump sales in households was caused by increase of natural gas expenditures following Russia's invasion of Ukraine. The second stimulus is the law regulating building energy performance, which tightens criteria for the construction of new family and apartment buildings. Those built after 2022 must comply with nZEB (nearly zero-energy buildings) regulations. The figure below shows the growth in the number of newly constructed houses and apartment buildings equipped with heat pumps. In 2022, heat pumps accounted for 20.3% of newly built apartment buildings.

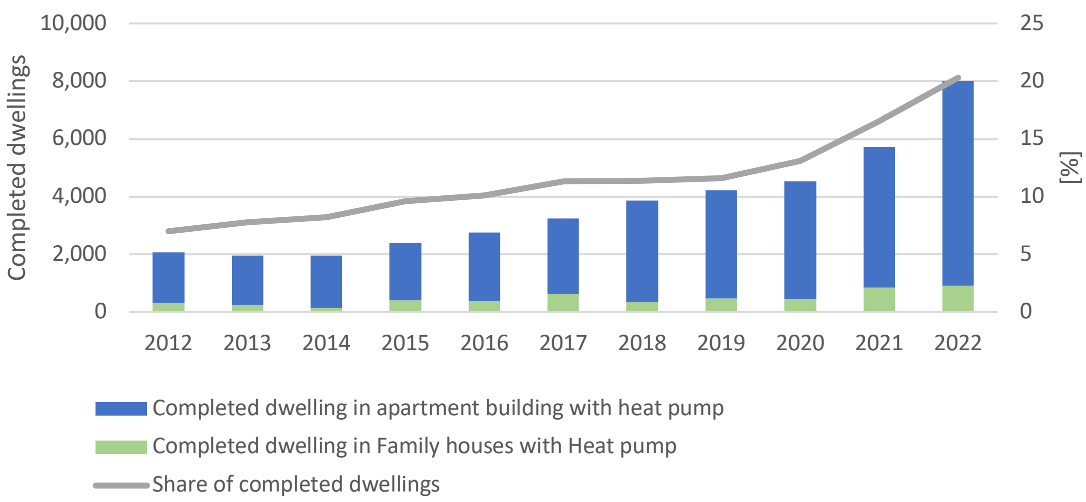

Figure 8 – Total number of newly completed dwellings in family houses (FH) and apartment buildings (AB) heated by heat pumps and their share in the total number of completed dwellings, 2012 – 2022 (source: Ministry of Industry and Trade).

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Size of the housing stock in the Czech Republic

Table below show the size of the housing stock in the Czech Republic. The highest share has flats in the apartment buildings. Over 15% of the houses (16% of flats) in the Czech Republic is not occupied.

Table 3 - Size of the housing stock in the Czech Republic - Number of houses[13]

	Total houses	Occupied	Unoccupied
CZ	2 317 276	1 952 668	364 608

Table 4 - Size of the housing stock in the Czech Republic - Number of flats[14]

	Total flats	Occupied	Unoccupied
CZ	5 340 033	4 480 139	859 894

The construction of the building stock took place in waves over time. The largest increase occurred between 1920 and 1945, in both family dwellings and apartment buildings. The development of apartment buildings increased significantly also in the years immediately following that (1946-1970). This was created by the increased construction of prefabricated buildings in the socialistic period following World War II, when there were insufficient dwelling units in the Czech Republic. These types of apartment buildings took the lead over new brick structures. The second largest rise in the development of family houses occurred significantly later, from 2001 to 2010. After year 2016 was constructed only 3 360 family houses and 855 apartment buildings, for which is the lowest point in history.

Table 5 - Age of the housing stock in the Czech Republic

Year of construction or reconstruction	Total	Family houses	Apartment buildings	Other
1919 and earlier	9 308	3 040	5 910	358
1920-1945	24 625	16 335	7 995	295
1946-1970	12 667	6 491	5 950	226
1971-1980	9 888	6 105	3 621	162
1981-1990	8 356	4 448	3 711	197
1991-2000	9 113	6 669	2 167	277
2001-2010	13 414	10 094	2 932	388
2011-2015	4 040	3 037	881	122

13 https://scitani.gov.cz/pocet-domu

14 https://scitani.gov.cz/pocet-bytu

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2016 and later	4 292	3 360	855	77
Not detected	2 514	1 599	377	538

Source: Czech Statistical Office

Energy service providers

In the Czech Republic, according to Act 406/2000 Coll. on Energy Management, a list of energy service providers is compiled and updated. The list is managed by the Ministry of Industry and Trade and is publicly available. Service providers are divided into two categories, namely Service Providers with Guaranteed Results and Other Service Providers. In 2023, according to the published list, there were 21 service providers with guaranteed results and 35 providers of other services.

Market size, Market actors and Interactions - Slovakia

Through the national projects "Green for Households" and "Green Solidarity", the installation of renewable energy devices in households across all regions of Slovakia has been supported from 2023 to 2029. This support contributes to the adoption of technologies such as photovoltaic panels, solar collectors, biomass boilers, and heat pumps in both family homes and apartment buildings. Additionally, for family houses, the program also offers support for the installation of wind turbines. The "Green for Households" program covers 50% of eligible expenses for the purchase and installation of these technologies. Furthermore, the project provides an additional 15% financial benefit for households in single-family homes installing emission-free devices, or for those that discontinue the use of solid fuels.

"Green Solidarity" programme is designed for low-income households and aims to address energy poverty among vulnerable communities. Eligible households can apply for support for the installation of photovoltaic panels, solar collectors, and biomass boilers. Those who meet the program's criteria will receive an 80% increase in the funding rate. The support can cover up to 90% of eligible expenses for the purchase and installation of the equipment.

The "Green for Households" and "Green Solidarity" projects build upon the success of the first three national "Green for Households initiatives," which were financed through the Operational Programme Quality of the Environment from 2015 to 2023. Thanks to European and state support, nearly 60,000 renewable energy devices have been installed in Slovak households to date. These include 20,716 heat pump installations, 16,998 photovoltaic systems, 14,516 solar collectors, and 7,045 biomass boilers. Households used support totalling €124.5 million to purchase the equipment. The total installed capacity of the supported systems has exceeded 460 MW. Over 1,700 eligible contractors participated in the projects. Between 2009 and 2011, the initial state subsidies were awarded for installation of 5,410 solar systems in family houses and just 39 in apartment buildings. Additionally, 1,427 households received subsidies for biomass boilers.

These figures do not include renewable energy technologies installed by individuals and businesses that did not receive state support for their acquisition. As a result, the numbers presented here represent only a portion of the devices installed in Slovakia during these years. Many early adopters were motivated more by a desire to use renewable energy sources than by financial savings, as investment costs typically exceeded the regular costs of energy consumption at state-regulated prices, and the return on investment over the lifetime of the technology was often very low. Currently, the financial benefits of renewable energy systems are more in protecting households against sharp increases in energy prices due to market volatility and further deregulation of the energy prices for households, which could lead to significant financial impacts on households.

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In 2022, 12,100 air-to-water heat pumps were sold in Slovakia. However, in 2023, sales fell by 16%, reaching 10,171 units. Overall, the sales trend has been growing for a long time. The lowest interest in this technology is primarily seen among middle- and low-income groups, who are accustomed to using gas infrastructure and find gas heating more cost-effective.

Market size, Market actors and Interactions - Germany

Total number of Residential building units in Germany

The number of residential buildings in Germany is constantly increasing over time. The total growth is shown in the red line the figure below. Individual apartment buildings account for the highest share (blue line). Beginning in 2010, the number of residential buildings with three or more apartments surpassed that of two apartments, and the number of dormitories also expanded.

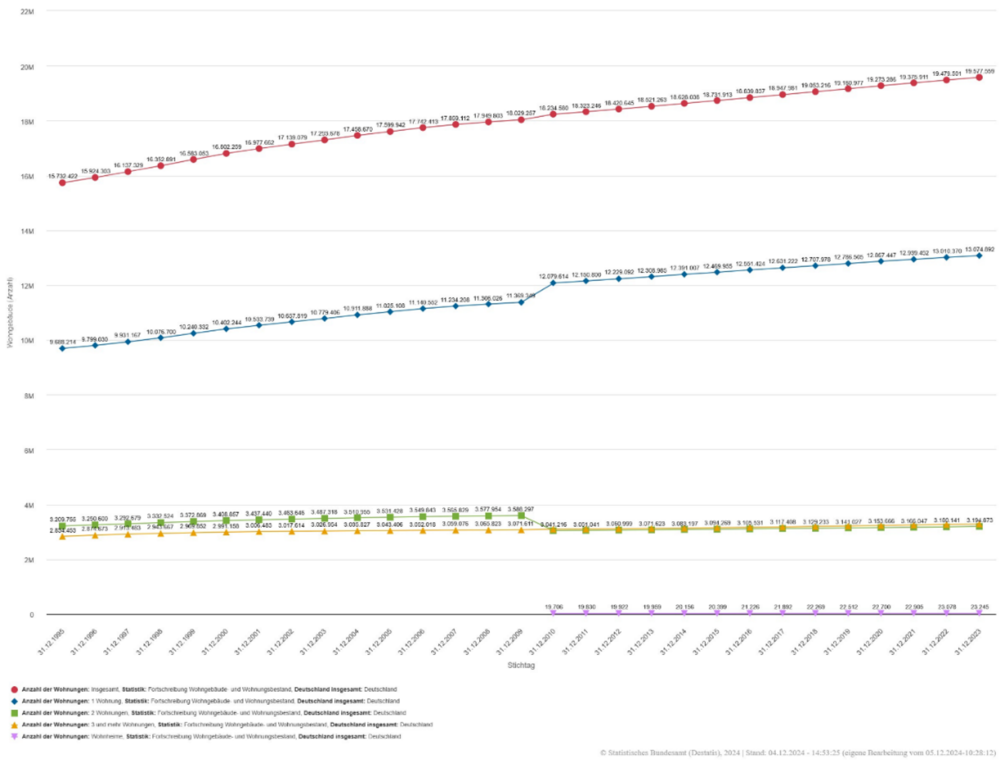

Figure 9 – Trend in the number of dwellings in Germany (Source: Statistisches Bundesamt (Destatis), 2024)

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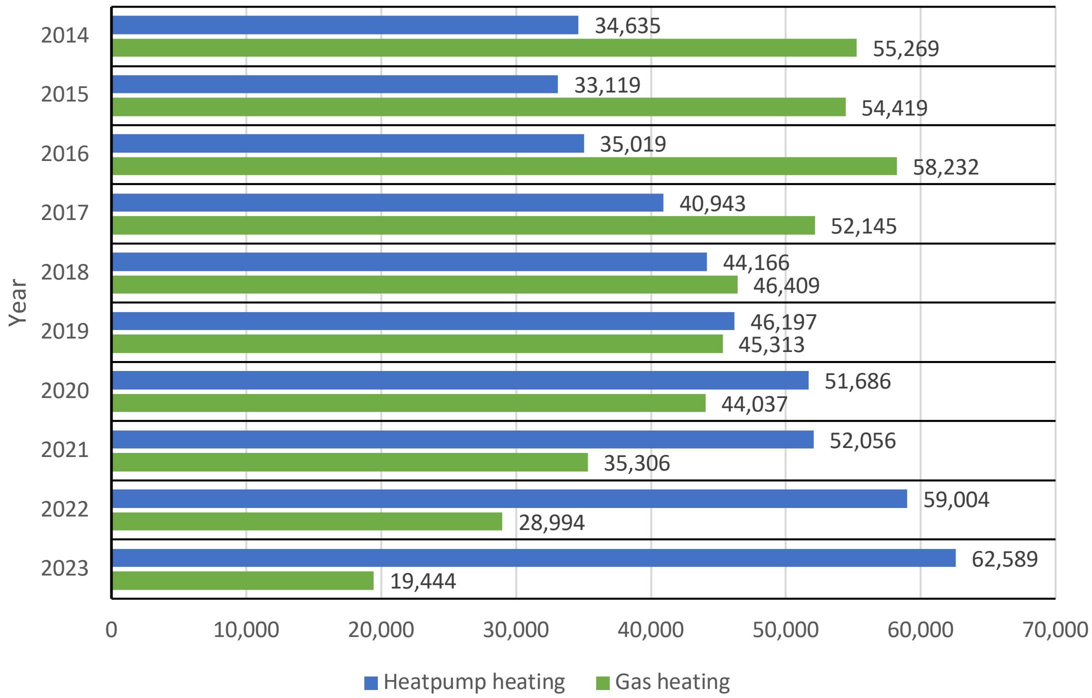
Comparison of Heatpump vs. Gas heating in Germany



Source: Statistisches Bundesamt (https://www.destatis.de/DE/Home/_inhalt.html)

Heatpump (air-to-air and Ground-Coupled) sales in Germany

Heat pump sales in Germany are gradually increasing. As shown in the figure below, in 2023, it reached 316 800 air-to-water heat pumps and 39 200 ground-coupled heat pumps.

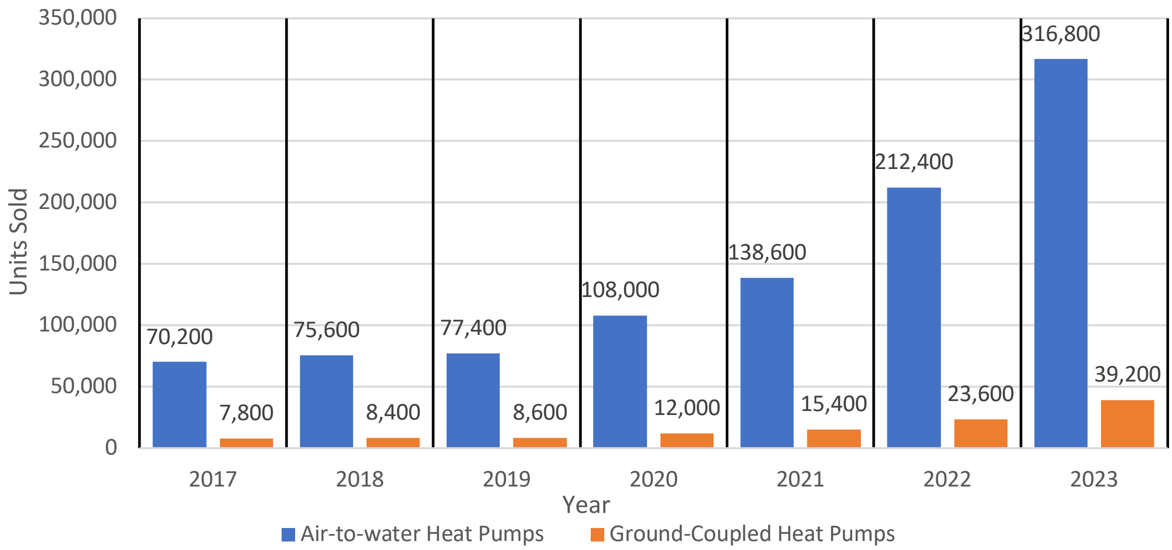


Figure 10 – The annual sales of heat pumps in Germany (2017-2023)
(source: Statistisches Bundesamt https://www.destatis.de/DE/Home/_inhalt.html)

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Heat pumps are mainly used in single-family and two-family houses. In 68.9% of all single-family and two-family houses completed in 2023, a heat pump was used as the primary source of heat. Much less was used in apartment buildings (41.1%).

Yearly production of Heat pump in Germany

The figure below shows number of heat pumps produced in Germany. In the fourth quarter of 2023, around 54,400 heat pumps were manufactured in Germany. This was 41.4% fewer than the previous quarter, when 92,900 heat pumps were produced, and approximately half (minus 49.5%) less than the same quarter last year, when 107,700 heat pumps were produced.

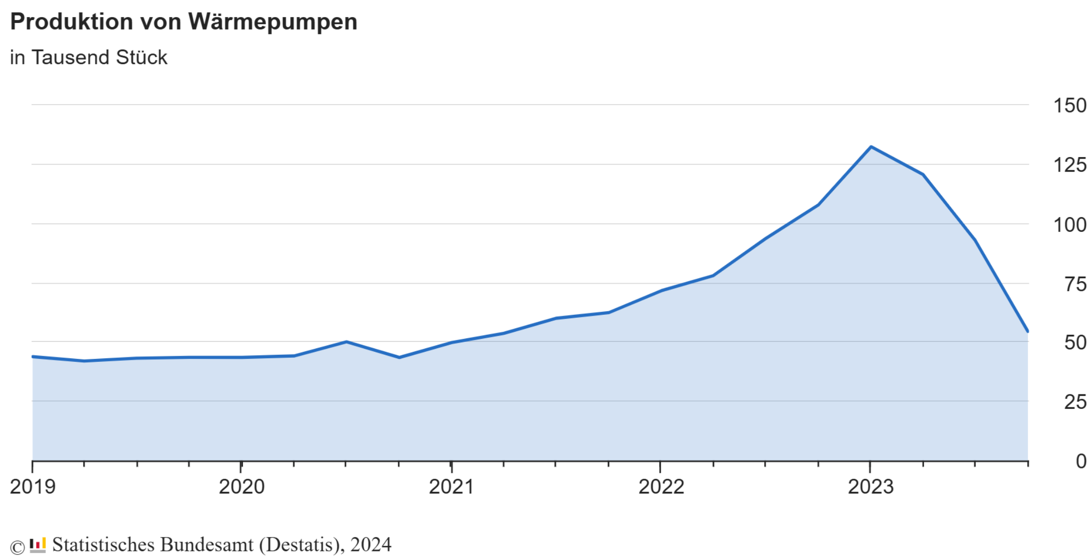


Figure 11 – Number of manufactured heat pumps in Germany, in thosusands (Source: Statistisches Bundesamt[15])

Smart home market

The figure below show number of users under so claled the smart home market. It includes the sale of networked devices for home automation to private end users (B2C). The consideration includes devices for controlling, controlling and regulating various functions in private households that are directly or indirectly connected to the Internet via a so-called gateway/hub (central control unit).

15 https://www.destatis.de/DE/Home/_inhalt.html

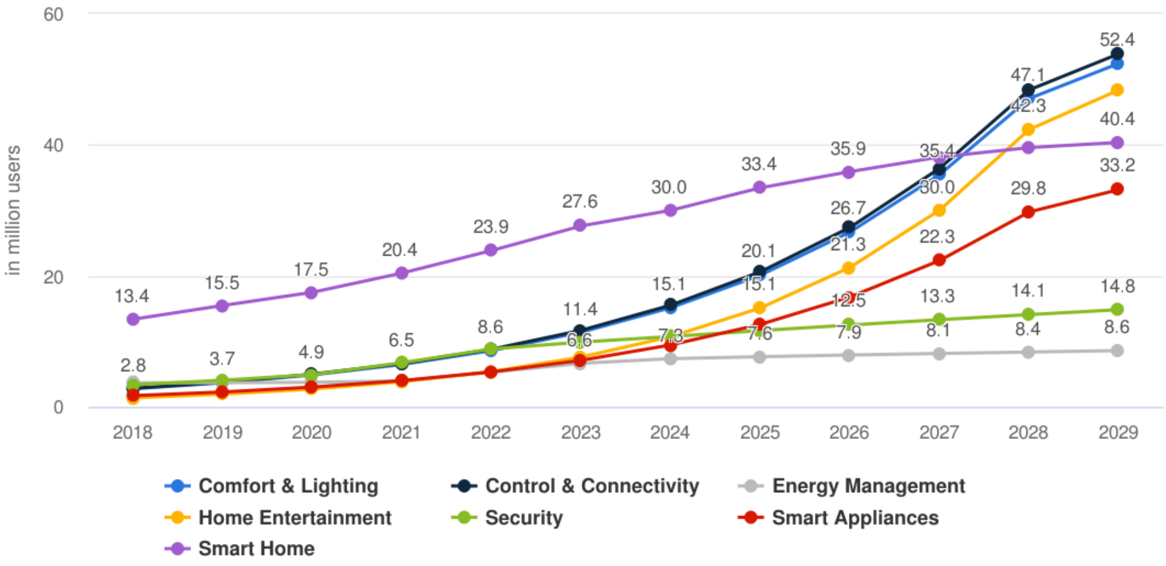
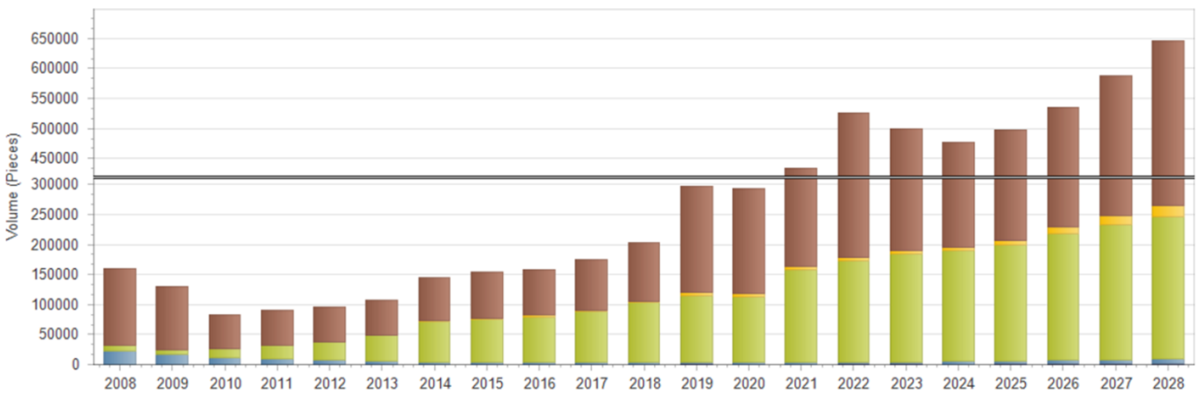


Figure 12 – Number of users (in millions) using smart home devices
(Source: Statista https://de.statista.com/outlook/cmo/smart-home/deutschland)

Market size, Market actors and Interactions - France

All hydraulic heat pumps by type of installation (air-water heat pump – water-water heat pump – brine-water heat pump – Thermodynamic water heaters)



Year 2023

	Air-to-water heat pumps: 310,500 units	(-14% vs. 2022)
	Hybrid heat pumps: 5,500 units	(-8% vs. 2022)
	Geothermal heat pumps: 3,600 units	(+18% vs. 2022)
	Thermodynamic water heaters: 179,000 units	(+6.5% vs. 2022)
	Extracted air heat pumps: 1,000 units	(+5% vs. 2022)

Source: Governmental sites, BRG Consult

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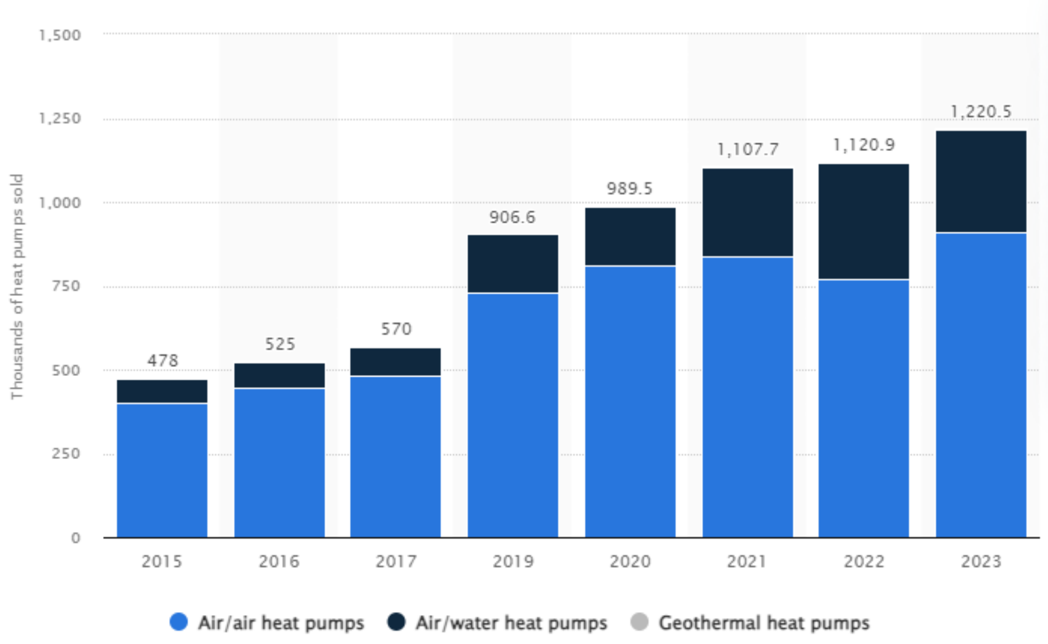

Figure 13 - Number of heat pumps sold in France from 2015 to 2023, by type (in 1,000 units), (Source: Statista)

Market size, Market actors and Interactions – Spain

The number of heat pumps in Spain is increasing every year. The table below shows the total number of heat pump units. Aerothermal heat pumps outnumber geothermal ones by several orders of magnitude. In sum, the amount has nearly tripled over the last decade.

Table 6 – Total number of heat pump units in Spain

Year	Aerothermal heat pump	Geothermal heat pump
2014	1 642 745	1 642
2015	1 942 510	1 836
2016	2 250 055	2 057
2017	2 594 232	2 296
2018	2 933 673	2 523
2019	3 243 088	2 698
2020	3 517 775	2 924
2021	3 819 686	3 218
2022	4 095 056	3 420

(Source:estadisticas-bombasdecalor[16])

Furthermore, the annual sales of heat pumps are gradually increasing. The table below shows that the number of heat pumps increased from approximately 50 000 per year in 2012 to

16 https://estadisticas-bombasdecalor.idae.es/

more than 180 000 per year in 2022. Until 2018, mostly air-to-air heat pumps were sold. In 2018, the number of air-to-water heat pumps sold increased, and by 2022, they had taken over more than one third of the heat pump market.

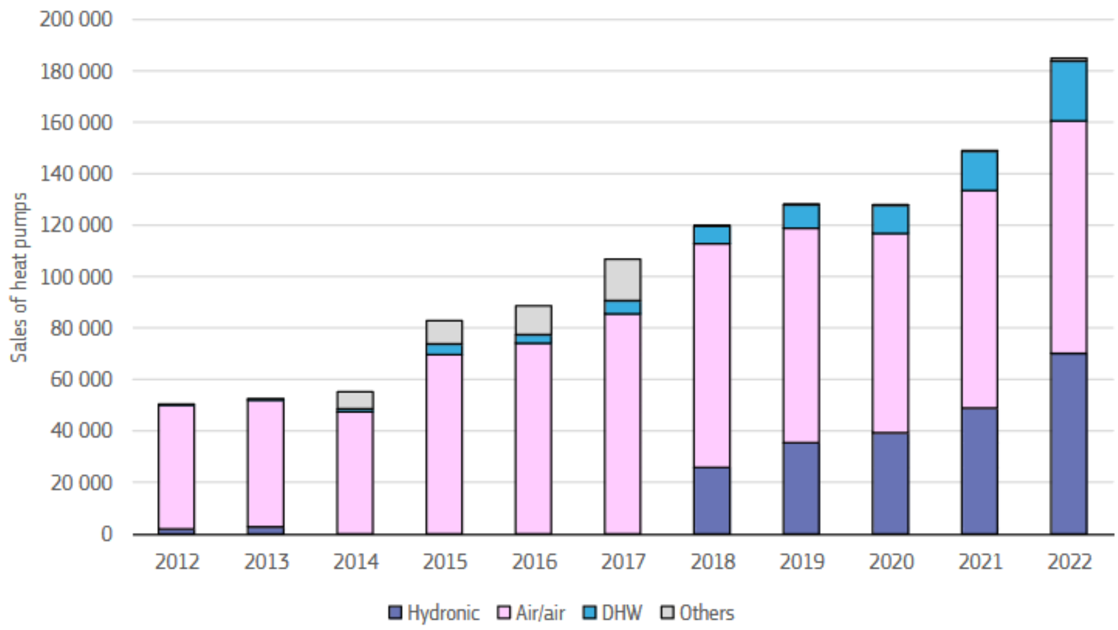

Figure 14 - Annual sales of heat pumps in Spain
(Source: SPAIN: STATUS OF THE HEAT PUMP MARKET (JRC 137131))[17].

Table 7 - Heat pump sales in Spain[18]

	2019	2020	2021	2022	2023	2023 vs 2022
Industrial HP – ground source	187	9	11	1 100	-	-
Reversible HP – air/air	83 532	77 614	84 690	90 500	119 101	31.6%
Reversible HP – air/water	35 249	38 989	48 802	70 000	66 762	-4.6%
Reversible HP – brine/water	158	248	107	200	130	-35.0%
Sanitary hot water HP – water heaters	9 023	10 995	15 202	23 150	23 686	2.3%
Total	128 149	127 855	148 812	184 950	209 679	13.4%

Source: Sales development – Spain (EHPA)

Portugal

Even though in Portugal there is no concrete data on the national heat pump market, the “Heat Pump Barometer 2024” produced by the European Heat pump Association (EHPA)[19] states that in 2023 Portugal increased the sales of heat pumps by around 24% compared to the previous year. This growth is in line with countries such as Germany, Belgium, the Netherlands and Spain (with a more modest increase). In contrast countries as France, Italy,

17 https://publications.jrc.ec.europa.eu/repository/handle/JRC137131

18 European Heat pump market and statistics report 2024 - https://www.euractiv.com/wp-content/uploads/sites/8/2024/07/Statistics_2024MarketReport_Marketandstatisticreport2024_EuropeanHeatPumpAssociation_forEHPAmembersonly.pdf

19 https://www.eurobserv-er.org/heat-pumps-barometer-2024

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Sweden, Finland, Poland and Denmark have experience a significant reduction in heat pump sales in 2023. The next table presents the heat pumps sales evolution in Portugal over the last years.

Table 8 - Heat pump sales in Portugal[20]

	2019	2020	2021	2022	2023	2023 vs 2022
Industrial HP – air source	631	509	505	612	562	-8.2%
Reversible HP – VRF	4 016	4 125	4 898	6 357	5 274	-17%
Reversible HP – air/air	16 947	16 842	19 777	22 594	25 804	14.2%
Reversible HP – air/water	492	448	374	318	480	50.9%
Reversible HP – brine/water	28	64	57	82	78	-4.9%
Sanitary hot water HP – water heaters	3 382	4 638	7 005	10 346	17 843	72.5%
Total	25 497	26 626	32 617	40 310	50 041	24.1%

In Portugal this increase in the 2023 sales of heat pumps can potentially be explained by the support programme provided by the Environmental Fund for More Sustainable Buildings in 2023, despite the existence of an adverse economic climate with high interest rates and inflation. At this moment there is no data on the 2024 sales, but since there were no support initiatives at national or European level (the action plan for heat pumps was postponed) during that period it not expected to have any increase in heat pump sales.

The next figure presents the EU markets with the largest variations (increase and decrease) in heat pump sales.

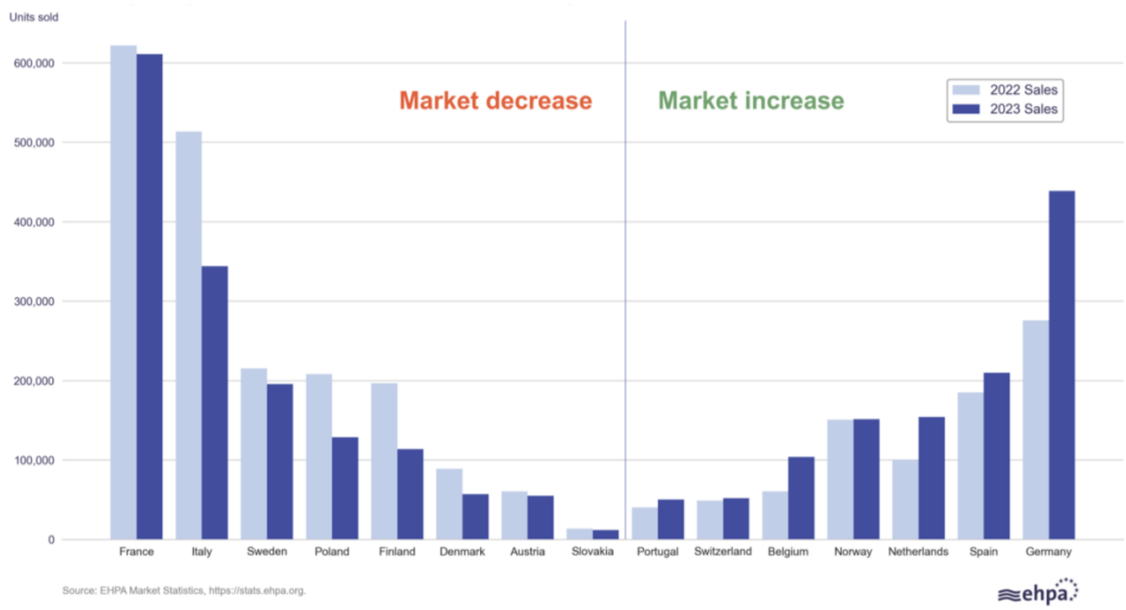

Figure 15 – Heat pump sales decreased in most European markets in 2023 (Source: EHPA)[21]

20 European Heat pump market and statistics report 2024 - https://www.euractiv.com/wp-content/uploads/sites/8/2024/07/Statistics_2024MarketReport_Marketandstatisticreport2024_EuropeanHeatPumpAssociation_forEHPAmembersonly.pdf

21 https://www.ehpa.org/wp-content/uploads/2024/04/Pump-it-down-why-heat-pump-sales-dropped-in-2023_EHPA_April-2024.pdf

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In this report the EHPA also points out that even in many countries that experienced global growth, quarterly sales declined at the end of 2023. Market analysts expect this downward trend to continue until 2024.

As mentioned above, there is little information available on the Portuguese market regarding heat pump stock (number of heat pumps in operation) since retailers and installers do not need to report the installation or replacement of heat pumps to any national authority. However, the 2024 heat pump barometer presents data on heat pump sales per type, as well as the number of heat pumps in operation (stock) as presented in the next figures.

Table 9 – Market of aerothermal heat pumps for heating and cooling in 2022 and 2023 in the European Union (number units sold) (Source: EurObserv'ER,2024, Heat pumps barometer)*[22]

	2022				2023*			
	Aero-thermal HP	of which air-air HP	of which air-water HP	of which exhaust air HP	Aero-thermal HP	of which air-air HP	of which air-water HP	of which exhaust air HP
Italy	2 200 957	1 911 912	289 045	0	1 947 309	1 835 290	112 019	0
France	1 163 679	808 206	355 473	0	1 216 954	910 420	306 534	0
Spain	414 396	357 796	56 600	0	527 905	465 713	62 192	0
Netherlands	398 011	304 031	93 980	0	451 385	305 086	133 799	12 500
Germany	242 059	0	205 702	36 357	412 788	0	330 358	82 430
Portugal	332 300	331 982	318	0	355 775	355 295	480	0
Sweden	187 213	150 000	19 162	18 051	160 623	113 500	21 289	25 834
Poland	208 574	20 374	188 160	40	110 840	0	110 800	40
Finland	184 587	161 920	19 035	3 632	105 258	90 866	11 715	2 677
Hungary	99 127	87 659	11 468	0	74 347	65 745	8 602	0
Malta	60 796	60 796	0	0	60 796	60 796	0	0
Denmark	83 720	48 472	34 975	273	53 395	32 456	20 803	136
Czechia	57 644	0	57 524	120	52 924	0	52 898	26
Belgium	23 754	0	23 754	0	40 527	0	40 527	0
Austria	44 645	1 201	43 444	0	39 613	2 047	37 566	0
Ireland	25 288	6 397	17 554	1 337	31 645	156	26 943	4 546
Slovenia	28 750	18 650	10 100	0	28 750	18 650	10 100	0
Lithuania	14 866	8 907	5 959	0	28 280	18 450	9 830	0
Greece	30 519	30 519	0	0	21 966	21 966	0	0
Estonia	19 575	13 902	5 636	37	17 500	12 000	5 500	0
Slovakia	12 774	1 219	11 555	0	11 383	1 602	9 771	10
Luxembourg	303	0	303	0	303	0	303	0
Total EU	5 833 537	4 323 943	1 449 747	59 847	5 750 266	4 310 038	1 312 029	128 199

Note: Market data for air-air heat pump for Italy, France, Spain, Portugal and Malta are not directly comparable to others, because they include high part of reversible heat pumps whose principal function is cooling. Only heat pumps that meet the efficiency criteria (seasonal performance factor) defined by Directive 2018/2001 (EU) are taken into account. Market data for Romania, Bulgaria, Latvia, Croatia, Cyprus and Malta was not available during our study.

[22] https://www.eurobserv-er.org/heat-pumps-barometer-2024/

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** Estimation. (Source: EurObserv'ER 2024)*

Table 10 – Market of geothermal (ground source) heat pumps for heating and cooling in 2022 and 2023 in the European union (number of units sold) (Source: EurObserv'ER,2024, Heat pumps barometer)*

	2022	2023		2022	2023
Sweden	28 160	35 470	**Estonia**	2 191	2 500
Netherlands	22 693	26 563	**Slovenia**	1 248	1 355
Germany	25 320	24 979	**Italy**	625	781
Finland	11 772	11 728	**Lithuania**	710	670
Poland	7 200	8 100	**Spain**	246	531
Belgium	5 922	7 331	**Greece**	356	356
Austria	5 748	5 911	**Slovakia**	319	260
Denmark	5 113	3 646	**Ireland**	190	243
France	2 972	3 517	**Luxembourg**	199	199
Czechia	2 419	2 696	**Portugal**	82	78
Total EU	123 485	136914			

** Hydrothermal heat pumps included. Note: Market data for Romania, Bulgaria, Latvia, Cyprus, Croatia and Malta was not available during our study. **Estimation. Source: EurObserv'ER 2024.*

Table 11 – Total number of heat pumps in operation for heating and cooling in 2022 and 2023 in EU (Source: EurObserv'ER,2024, Heat pumps barometer)*

	2022			2023*		
	Aerothermal heat pumps	Geothermal heat pumps**	Total heat pumps	Aerothermal heat pumps	Geothermal heat pumps**	Total heat pumps
Italy	20 831 000	17 723	20 848 723	20 900 000	18 300	20 918 300
France	9 548 000	169 800	9 717 800	10 500 000	166 000	10 666 000
Spain	5 410 730	4 062	5 414 792	5 938 635	4 593	5 943 228
Portugal	2 326 400	1 187	2 327 587	2 586 418	1 265	2 587 683
Sweden	1 767 110	560 997	2 328 107	1 897 595	564 903	2 462 498
Netherlands	1 760 665	125 374	1 886 039	2 196 295	147 837	2 344 132
Germany	1 216 249	449 742	1 665 991	1 611 551	471 103	2 082 654
Finland	1 234 715	157 896	1 392 611	1 339 973	169 624	1 509 597
Denmark	585 783	82 316	668 099	655 279	87 092	742 371
Belgium	631 035	28 524	659 559	671 562	35 855	707 417
Poland	466 032	78 989	545 021	576 872	87 089	663 961
Greece	607 017	4 234	611 251	628 983	4 590	633 573
Malta	535 000	0	535 000	595 796	0	595 796
Austria	232 575	118 070	350 644	271 077	120 419	391 496
Bulgaria	349 667	4 695	354 362	349 667	4 695	354 362
Czechia	266 808	31 812	298 620	319 732	34 508	354 240
Slovenia	284 120	16 014	300 134	312 870	17 370	330 240
Estonia	214 750	23 757	238 507	232 250	26 257	258 507
Slovakia	231 412	4 773	236 185	242 795	5 033	247 828
Hungary	124 251	4 419	128 670	198 598	4 419	203 017

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Ireland	101 409	5 418	106 827	133 054	5 661	138 715
Lithuania	45 600	24 800	70 400	73 880	25 470	99 350
Luxembourg	3 095	1 596	4 691	3 398	1 795	5 193
Total EU	48 773 423	1 916 198	50 689 620	52 236 280	2 003 878	54 240 158

** Estimation. ** Hydrothermal HP included. Note: Data from Italian, French, Spanish Portuguese and Maltese aerothermal heat pump market are not directly comparable to others, because they include high part of reversible heat pumps whose principal function is cooling. Only heat pumps that meet the efficiency criteria (seasonal performance factor) defined by Directive 2018/2001 (EU) are taken into account. (Source: EurObserv'ER 2024)*

The next figure summarizes the European heat pump stock in a graphical image. This Figure allows to see the predominance of air-to-air heat pumps, as well as that in the southern countries (e.g. Portugal, Spain, etc.) these heat pumps are mostly used for cooling according to EurObserv'ER 2024.

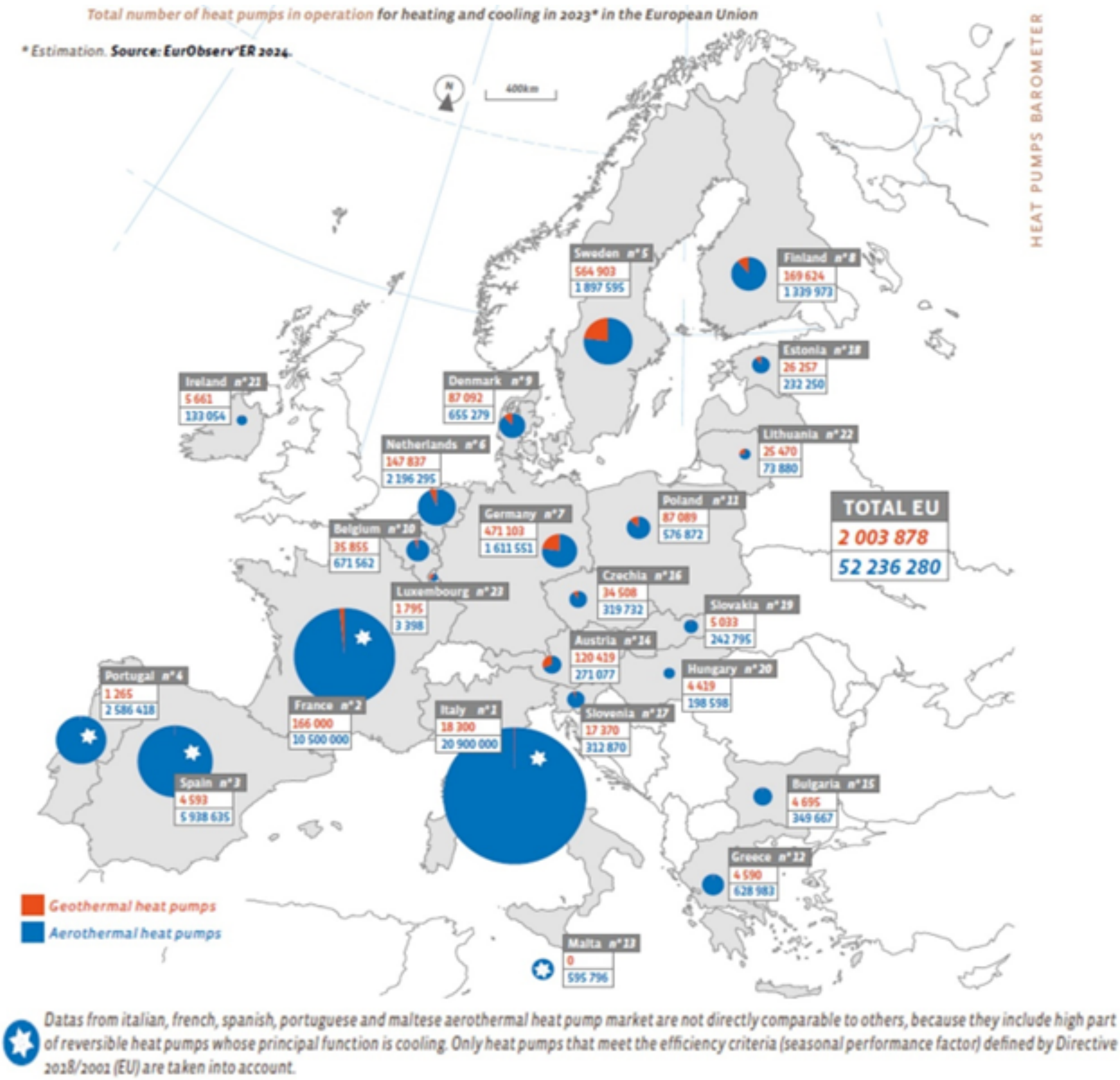

Figure 16 – Graphical dispersion of heat pump stock in Europe (Source: EurObserv'ER,2024, Heat pumps barometer)

2.4.1. Market Actors

The energy efficiency market is a rapidly evolving ecosystem, encompassing a diverse array of actors whose collaborative efforts drive innovation, sustainability, and economic growth. These actors or key stakeholders include governments, regulatory bodies, energy service companies (ESCOs), utilities, financial institutions, technology providers, consumers, and businesses. Each actor plays a distinct role, from setting policies and providing financing to implementing energy-efficient solutions and promoting sustainable behaviour. Together, they form a dynamic network that fosters widespread adoption of energy-saving practices across all economic sectors.

A vital component of this market is the interaction among these stakeholders. Governments, for instance, work closely with ESCOs and utilities to establish incentives, regulations, and public-private partnerships that make energy efficiency initiatives viable and promote the use of high-efficiency technologies. Financial institutions collaborate with ESCOs and corporations to fund energy projects, while technology providers and manufacturers align with utilities to deliver accessible and user-friendly smart energy solutions to end-users. Through these interactions, actors leverage shared resources, insights, and expertise, creating synergistic relationships that amplify the impact of energy efficiency efforts. This section provides an in-depth analysis of these actors and their interconnections, explaining the complexities and collaborative dynamics that drive the energy efficiency market forward.

The key actors in the energy efficiency market are:

Governments and Regulatory Bodies

Governments at local, regional, and national levels are one of the most influential actors and play a critical role in shaping the energy efficiency market. Their involvement includes:

- **Policy and Standards Development** - Governments set Minimum Energy Performance Standards (MEPS) for buildings, equipment, appliances, lighting and vehicles, which drive the demand for energy-efficient products. For example, the European Union’s Energy Performance of Buildings Directive (EPBD) mandates specific efficiency standards for all new and renovated buildings;

- **Incentives and Subsidies** - Through tax rebates, grants, and subsidies, governments promote and encourage the adoption of energy-efficient technologies. For instance, several EU countries support solar energy installations, making renewable energy more accessible and complementing energy efficiency efforts;

- **Public Procurement and Infrastructure Projects -** By mandating energy efficiency requirements in public sector projects, governments create large-scale demand, leading to a larger and more efficient market. Municipalities often retrofit public buildings or installing LED street lighting, which drives demand for efficient technologies;

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- **Educational Campaigns and Outreach** - Public awareness campaigns raise knowledge about energy-saving practices, influencing consumer and business behaviour. Campaigns may involve advertisements, online resources, or local workshops to inform the public about the benefits and incentives related to energy efficiency.

Governments also coordinate international cooperation efforts, such as EU-Policies and the Paris Agreement, which emphasize energy efficiency as a crucial element for reducing global carbon emissions in a cost-effective way.

Energy Service Companies (ESCOs)

ESCOs are specialized firms that focus exclusively on delivering energy efficiency services to their clients, typically through guaranteed performance-based contracts. Their services include:

- **Energy Audits and Assessments -** ESCOs start by evaluating current energy consumption patterns and identifying efficiency opportunities. They often use diagnostic tools and software to find inefficiencies in motor systems, HVAC, lighting, appliances, etc.;
- **Project Design and Implementation -** ESCOs propose specific measures tailor made for a specific client according to its needs, such as motors systems, heat pumps, HVAC upgrades, lighting retrofits, or energy management systems;
- **Performance Contracting** - ESCOs use performance-based contracts, where payments are directly tied to the actual energy savings achieved. This model reduces financial risk for clients and provides a clear path on the timeframe to recover the investment;
- **Financing Options** - To minimize the financial burden on clients, ESCOs often work with financial institutions to arrange financing solutions, such as energy efficiency loans or leasing. They may secure third-party financing or create partnerships that allow clients to pay overtime.

ESCOs provide services to various sectors, including commercial buildings, hospitals, schools, and industrial facilities, where energy consumption is often large, making efficiency upgrades particularly impactful.

Utilities

Utilities are central actor in the energy efficiency market due to their role in delivering power and managing grid stability. They engage in energy efficiency efforts to:

- **Manage Peak Load** - Energy efficiency helps utilities to reduce the peak demand, as well as matching renewable generation with demand thus avoiding costly infrastructure investments. Demand response programs, for example, incentivize consumers to reduce or shift their energy use during peak times, lowering grid stress. The demand response programs combined with storage systems are much more cost-effective than investing in power grid expansion;

- **Offer Rebates and Incentives**: Utilities provide rebates for high-efficiency products, such as appliances, heat pumps, refrigerators, HVAC systems, LED lighting, etc. to encourage its adoption. This helps utilities to reduce future investments and overall energy consumption;
- **Implement Demand-Side Management (DSM) Programs**: DSM programs actively engage consumers in energy efficiency practices, often through smart technologies, such as programmable smart thermostats and appliances, as well as energy tracking apps;
- **Time-of-Use Pricing**: Some utilities implement dynamic pricing models, where energy prices vary by the time of day or season. By encouraging consumers to use less energy during high-cost periods, utilities drive efficient energy use and reduce stress on the grid.

Utilities also collaborate with ESCOs to improve efficiency at a systems level, particularly in large commercial or industrial complexes, where upgrades can have a significant impact on peak demand and overall energy usage.

Financial Institutions and Investors

The role of financial institutions is critical, as they provide the necessary capital for energy efficiency projects. Without capital availability the implementation of energy efficiency projects faces a large barrier. To avoid this, the involvement of financial institutions and investors in key areas is crucial. These key areas include:

- **Project Financing** – In some country's commercial banks and private equity firms offer loans, leases, or financing packages specifically designed for energy efficiency improvements. For example, green loans or dedicated energy efficiency lines of credit are increasingly common;
- **Green Bonds and ESG - Environmental, Social, and Governance Investments** - Green bonds raise capital for projects with environmental benefits, such as energy efficiency upgrades in buildings or power infrastructure. ESG (Environmental, Social, and Governance) investments also emphasize energy efficiency, as investors increasingly seek sustainable projects;
- **Third-Party Ownership Models -** In third-party financing models, the investor owns the energy-saving equipment (e.g., solar panels. lighting systems or HVAC systems), and the client pays for the service. This enables clients to enjoy energy savings without dealing with the upfront costs;
- **Risk Mitigation for ESCO Contracts** - Investors help ESCOs to mitigate risk by structuring performance-based contracts, where the return of investment depends on the energy savings achieved. This model makes energy efficiency

projects more bankable by securing a predictable return on investment for financiers.

By making capital accessible, financial institutions enable both small and large-scale energy efficiency projects, driving broader market participation.

Manufacturers and Technology Providers

Manufacturers and technology providers design, produce, and distribute energy-efficient products and solutions. These products or solutions include:

- **Energy-Efficient Appliances and Equipment -** Products like high-efficiency motor systems, heat pumps, HVAC, LED lighting, and smart appliances are essential for reducing energy consumption in homes and businesses;
- **IoT and Smart Technology Solutions**: IoT-enabled devices allow real-time monitoring and control of energy consumption. Examples include smart thermostats, energy meters, and automated lighting systems, which help consumers to control, track and reduce their energy use;
- **Software Solutions and Analytic Platforms -** Energy management platforms provide businesses with data insights and analytics to optimize their energy use. Platforms like these are becoming essential for larger facilities, which require precise monitoring to maximize savings. These software solutions and analytics platforms are also taking advantage on the recent developments on AI and Machine Learning (ML) algorithms to improve energy savings;
- **R&D for Next-Generation Technologies**: Manufacturers are investing heavily in research and development for more advanced energy-efficient products, such as next-generation insulation materials, energy storage solutions, and AI and ML-driven energy management systems.

These companies also support energy efficiency programs through partnerships with utilities and ESCOs, often coordinating on incentive programs and education campaigns to promote the adoption of high-efficient technologies.

Consumers and Businesses

Consumers, businesses, and organizations are the end-users who ultimately implement energy efficiency measures. These entities play the following roles:

- **Residential Consumers**: Homeowners seek energy efficiency to reduce utility bills, improve comfort, and reduce environmental impacts. Incentives like rebates and tax credits play a significant role in motivating households to implement energy-efficient upgrades;
- **Commercial Businesses -** For companies, energy efficiency is both an economic and a strategic choice. Many businesses set sustainability goals to improve their brand image, attract eco-conscious consumers, and lower operational costs;

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- **Industrial and Institutional Organizations -** Manufacturing plants, hospitals, and educational institutions are intensive energy users, so energy efficiency can lead to significant cost reductions. These organizations often engage ESCOs or partner with utilities to implement large-scale efficiency measures;
- **Behavioural Adoption** – Residential consumers and businesses influence market demand through their purchasing choices, affecting the commercial portfolios of manufacturers and utilities. High demand for energy-efficient products spurs innovation, reduces costs, and encourages greater adoption.

As awareness of climate change grows, consumers and businesses increasingly prioritize energy efficiency, reinforcing the demand for sustainable energy practices.

2.4.2. Interactions and Dynamics Between Market Actors

In the previous section all the actors involved in the energy efficiency market were identified. However, it is also important to identify the interactions that occur between these actors to successfully implement an energy service model or project.

The intricate interactions and dynamics among key actors in the energy efficiency market need to be analysed in detail. This analysis is focused on the collaborations between the above identified actors to present how these partnerships foster innovation, drive energy savings, and create a cohesive ecosystem for sustainable energy practices. These interactions are analysed below in a bilateral perspective, but all actors play their role in the market dynamics. Some examples of interaction are:

Government and ESCOs

Governments often collaborate with ESCOs to meet national and regional energy efficiency goals. The key aspects of this interaction include:

- **Policy Incentives for ESCO-driven Projects** - Governments provide subsidies, tax incentives, and low-interest loans for projects led by ESCOs, helping to overcome financial barriers.
- **Public-Private Partnerships (PPPs)** - Governments and ESCOs often enter PPPs, especially for retrofitting public sector buildings like schools, hospitals, and government offices. These partnerships demonstrate the benefits of energy efficiency and sets a model for the private sector.
- **Regulatory Support for Performance-Based Contracts** - Some governments support the ESCO performance-contracting model by providing guarantees or favourable legal frameworks, making it easier for ESCOs to work with public and private clients.

This collaboration helps governments achieve energy efficiency targets while creating market opportunities for ESCOs.

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Utilities and Consumers

Utilities and consumers interact through various programs and pricing models that encourage energy-saving behaviour, such as:

- **Rebate Programs** - Utilities offer rebates to residential and commercial customers who purchase energy-efficient appliances or retrofit their buildings, reducing the upfront cost and encouraging the adoption of high-efficiency equipment;
- **Demand Response Programs -** Utilities incentivize consumers to reduce energy usage during peak times. For example, during high-demand periods, utilities may offer financial rewards to consumers who reduce their energy use;
- **Time-of-Use Pricing -** By charging different rates based on the time of day, utilities encourage consumers to shift usage to off-peak times, which aligns energy consumption with grid capacity creating flexibility and delaying expansion;
- **Smart Metering** - Utilities install smart meters that give consumers more control/management over their energy use, allowing them to make informed decisions to reduce energy consumption and costs.

This dynamic interaction helps utilities to manage demand more effectively while empowering consumers to save energy and reduce costs.

Investors and ESCOs

Investors play a significant role in supporting ESCO-driven energy efficiency projects by providing funding, such as:

- **Project Financing for ESCOs -** Investors provide crucial capital for ESCOs to implement large-scale projects, sharing the financial returns generated through energy savings;
- **Green Bonds and Loans -** Green bonds and loans help ESCOs to access capital at lower rates, reducing project costs and making energy efficiency upgrades more affordable for clients;
- **Risk Sharing in Performance-Based Contracts** - Investors often share the financial risk of performance-based contracts with ESCOs, ensuring that the returns are contingent on the achievement of energy savings. This alignment incentivizes ESCOs to maximize project effectiveness;

This relationship enables ESCOs to achieve economies of scale in their operations and make energy efficiency projects feasible and cost-effective for a wider range of clients.

Manufacturers and Technology Providers with Consumers and Businesses

Manufacturers and technology providers engage consumers and businesses by offering innovative products and educational resources. Some examples are:

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- **Collaborative Marketing with Utilities and ESCOs**: Manufacturers partner with utilities and ESCOs on marketing campaigns to raise awareness about high-efficiency products/equipment;
- **Product Rebates and Incentives -** By working with utilities, manufacturers offer rebates and discounts to reduce the cost of energy-efficient appliances and equipment;
- **Customized Solutions for Business -** Manufacturers work with commercial and industrial clients to provide solutions tailored to their specific energy needs, such as automated lighting for offices or HVAC systems for factories.

This interaction ensures that consumers and businesses have access to the latest energy-saving technologies, which also promotes market growth.

Cross-Sectoral Collaborations

In the energy efficiency market, cross-sectoral partnerships enable large-scale projects and enhance the market's impact. Some examples of these collaborations are:

- **Green Building Initiatives** - In green building initiatives, governments, manufacturers, construction companies, and ESCOs collaborate to design and build energy-efficient buildings that meet specific environmental standards, such as LEED or BREEAM certifications.
- **Smart City Projects -** Smart city projects integrate energy efficiency across transportation, public lighting, and infrastructure. Governments, utilities, and technology providers work together to implement high-efficiency interconnected systems;
- **Research and Development (R&D) Partnerships**: Governments often fund R&D initiatives with universities, research institutes, manufacturers, and technology providers to develop the next-generation of high energy-efficient technologies.

Cross-sectoral collaborations align goals, combine expertise, and pool resources, allowing for ambitious energy efficiency projects that would be challenging for individual actors to undertake alone.

2.5. User Groups/Customer Groups

There is a wide spectrum of potential users for the EES. In this study, we primarily focus on using EES in buildings (residential, commercial, or public). As a result, the service's primary end consumers will undoubtedly be building owners or associations of unit owners. However, the range of possible users is broader. When the EES provides flexibility to the aggregator, then energy communities, TSOs, DSOs, and others can take an advantage of the service.

Building owners
The owner's objective to improve comfort, energy efficiency, or cost savings is a direct consequence of the need for the EES service to be integrated. Here described EES primarily

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addresses households, i.e. the residential sector (single-family houses and apartment buildings). The approach to EES may differ depending on whether the end user is the owner of the house or an association of unit owners. Furthermore, additional contract terms are required when the tenant occupies the unit and is the end user of the energy services offered.

Public sector

Public sector should set an example in terms of energy efficiency. Thus, its own buildings' energy consumption and production should adopt the flexibility and EES. However, public sector involvement may require some conditions, such as procurement for the installation of new technologies and devices. This should be considered by the EES provider. Here, Energy Performance Contracting (EPC) is a very effective tool for implementing energy saving measures. The EPC guarantees correct system setup and can thus be the best option, particularly for technologically advanced buildings.

Energy communities

EES can help energy communities better manage their energy consumption and production. This can be accomplished through a shared EE service or several EES end customers (with the possibility of sharing some equipment, such as batteries or EV chargers), providing flexibility to users within the energy community. EES also offers flexibility opportunities for grid balancing, which reduces grid congestion and improves the efficiency of the existing electricity infrastructure. EES offers members access to predictive analytics and digital management systems, which helps to optimize energy usage patterns throughout the community.

TSOs, DSOs

Another crucial group are Transmission System Operators (TSOs) and Distribution System Operators (DSOs). These operators monitor the stability of the electrical grid, and using the information gathered about the flexibility that EES provides, they may better control the network. This cooperation through EES provides solutions for effective and strong communication and cooperation between the many essential levels of control, resulting in grid balancing capabilities at the municipal, city, and regional levels

2.6. Communication channels

Communication with customers can take many forms. This type of communication will be described in section 5.2. communication channels and strategies.

Information Flows

The flow of information with customers can be in both directions. It can be based on direct communication with customers to encourage consumption or to inform them about new products. Another type of communication between supplier and customer can be surveys. This is an interesting point as it is not so intrusive as it does not offer anything, but simply wants to know the opinion of the end customer on certain issues raised in the questionnaire.

On the other hand, the customer can also contact the supplier to clarify doubts, give feedback about the product, or look for better conditions.

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The type of communication with the client can be different depending on the time of the year or the actions to be carried out. It can be an article on the supplier's website to show the different activities they are carrying out or new initiatives. On the other hand, campaigns can also be carried out to increase sales at special times, sending e-mails to inform about new products or to congratulate special holidays and take advantage of this to encourage sales.

2.6.1. Communication Channels and Strategies

Communication channels and communication strategies can be differentiated as the following communication channels with customers:

- **Web communication** → One of the ways to communicate with customers is through the website, creating a link between BungEES and the future customers. On the website, you can create a mailbox to collect data to offer and another mailbox to collect input or feedback from customers about the proposed solution. In addition, the website shows the products and the different levels of FlexiSmart Home so that the customer can adopt the solution that best suits their needs.
- **Telephone communication** → Communication with customers can be carried out by means of a customer service hotline so that users can call to report problems with their product. Also, in case they want to purchase a superior product they can contact the customer service phone number.
- **Email communication** →You can contact the current customer base of which you have their data to offer certain products and generate customer needs to implement your energy services.
- **Presential communication** → If you have physical sales channels, you can use this type of channel to offer products to end customers and increase sales of the service and improve the relationship between the product and the customer due to a close relationship.

In relation to the communication strategy, the target customer must be defined to be able to adapt to this communication to the customers. In our case, the product is intended for a residential customer, which as has been analysed in the different surveys is a customer who is focused on the environment and intelligent energy management, as well as being familiar with energy concepts.

Should we create a message to associate it with our product?

- Make your home efficient with FlexiSmart Home.

Once the possible channels of communication with our future customers have been defined, we should define which of them can have more weight. In our specific case, we would encourage communication via e-mail to customers of the Plenitude or Voltalis portfolio, as they have proprietary customers who can launch communications about this product to their customers through the means they deem appropriate, the most relevant being through:

- E-mail;
- Telephone communication.

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This would be a good communication strategy to offer the product once it has been tested through these companies once its scope has been defined. In this way we would have a presence in several EU countries such as Spain and France.

2.6.2. Communication with Customers

Communication with customers should follow a standardised procedure and protocol to address them politely and in appropriate language. The forms of communication are those mentioned above to be able to offer new products or services to current or future customers. The communication processes for each of the channels with end customers are detailed below:

- **Communication by the web**: This communication via the web is known as a non-invasive relationship channel as it is the customer who approaches the vendor by having a like-minded position or an attraction to the product offered. The procedure would be that the customer to leave their details on the service provider's website. Once the service provider has obtained the customer's lead, he can contact the customer via telephone.
- **Communication by telephone channel**: This is a type of direct action, based on a customer database. These data are already known whether they are former customers, customers of other services, or have been obtained from a database. The key in this type of communication is to obtain the database to offer the service. The database can be self-sourced. These customers of their own origin can be differentiated as current customers who have a product and want to be offered another product or old customers who want to contract again with a current product. On the other hand, some kind of alliance can also be made to obtain customer data from other companies to sell them services/products.
- **Communication by email**: This is a type of direct action on an already known customer database. This process is like telephone sales with the difference that it is done by means of written communication via email, allowing you to reach a large number of customers at a lower cost than a telephone call. This is an interesting type of communication to inform about a new product, promotions or offers. It is also used in campaigns to make customers switch to a superior product because it has certain economic advantages for customers.
- **Communication by traditional channels**: There is another way of communication and sales, which is through face-to-face channels. These sales channels are companies that visit end customers to offer them the product that best suits their needs. This method is a direct action as they are called door to door due to the fact the customers are visited, and the services are offered to them physically.
- **Points of sale**: The point of sale is considered a non-direct sales action since it is the customer who goes to your business to inquire about your services. This type of sale is like web sales, since the customer, by his own decision, visits this place to get information about a product or to make a change in his current product configuration.
- **Customer area**: Whitin the service companies, there are service providers' own applications. Therefore, these applications can also be used as points of sale of energy solutions for end customers, as they have access to customer data, they know their

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habits and consumption and can offer a product that meets their needs and can cross-sell or up-sell a superior service.

2.6.3. Experience in Communication with Customers

The communication by Plenitude to obtain customers and the communication with customers during this pilot is organised in several steps. At first, Plenitude conducted a survey of 10,000 customers from Plenitude's residential portfolio throughout Spain, with the aim of finding out whether these customers were interested in a project to control energy systems like heat pumps, air conditioning devices, solar systems and electric mobility. In this survey, which was carried out at the end of 2023 and the beginning of 2024, it was found that customers were interested in this proposal for a service that would bring together the management of all services.

On this basis, it was decided to carry out a pilot project to study heat pumps and air conditioning equipment in Spain with the Voltalis solution. Contact with customers has been made with the support of installers in Spain who work with CONAIF (National Confederation of Associations of Installers and Fluids), this contact is established between Plenitude and CONAIF with customers having direct contact with them and, if necessary, would be referred to those responsible for Voltalis in the management of the pilot.

After installation, energy consumption for heat pumps can be monitored, and operation schedules can be present for each appliance. Clients can track their energy usage and savings via a mobile app on their phones.

Reliable information on their energy consumption and savings

The energy supplier provides reliable information to customers, which can be obtained by means of the electricity bill, It shows the monthly consumption by detailing the period in which the invoice is issued and also shows the power that the customer has requested during the month in question.

Through the MyVoltalis platform, you can get information from the devices every 10 minutes getting real information of the consumption of the equipment (heat pump; air conditioning; etc). This information can be used to obtain the on-off period of the computers controlled by the MyVoltalis solution.

2.7. Attributes of smart EES operation

2.7.1. Value Proposition

Smart energy efficiency services are revolutionizing how energy is consumed, managed, and conserved across residential, commercial, and industrial sectors. These services combine cutting-edge technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), machine Learning (ML) and big data analytics to optimize energy usage.

These systems enable precise control and monitoring of energy consumption in real-time, empowering users to reduce waste, lower costs, and minimize their carbon footprint. For

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example, a smart home system may use IoT-enabled devices like smart thermostats and energy-efficient lighting to adjust energy use based on occupancy patterns and preferences. Similarly, industrial facilities employ energy management systems (EMS) that analyse operational data to identify inefficiencies and recommend corrective measures. By integrating smart meters, connected appliances, and automated control systems, these services allow users to monitor and reduce energy consumption in real-time. In an era defined by increasing energy demands, environmental concerns, and technological advancements, these services have emerged as a critical tool for achieving sustainability and cost-effectiveness.

The value proposition of smart energy efficiency services lies in their dual benefit of economic savings and environmental sustainability. On the one hand, they empower consumers to achieve significant reductions in energy costs through precision and automation. On the other, they help mitigate climate change by lowering carbon footprints and encouraging the adoption of renewable energy sources. A smart thermostat, for example, can reduce heating and cooling costs by up to 20% by automatically adjusting the temperature based on occupancy patterns. Similarly, industrial facilities can use predictive maintenance tools to avoid energy-intensive equipment failures, saving both time and resources.

These services also support grid-level optimizations, such as demand response programs. For instance, during periods of high electricity demand, smart systems can automatically reduce non-essential energy use in buildings, thereby stabilizing the grid and preventing blackouts. This not only enhances grid resilience but also ensures equitable energy distribution.

The core value proposition of smart energy efficiency services lies in their ability to align economic, environmental, and operational benefits. These provide:

- ***Economic Savings****: By reducing energy waste and improving operational efficiency, these services lower energy costs for consumers and businesses alike.*
- ***Environmental Impact****: Smart systems contribute to the global effort to mitigate climate change by reducing greenhouse gas emissions and promoting renewable energy integration.*
- ***Enhanced User Experience****: Automated systems and intuitive interfaces simplify energy management, offering users greater convenience and control.*

Smart energy efficiency services are an essential component of the global energy transition, enabling societies to move toward more sustainable and resilient energy systems.

Value for customers

The core value delivered to customers through smart energy efficiency services revolves around cost savings, convenience, and empowerment. These services enable significant reductions in energy expenditures by optimizing usage and minimizing waste. For example, a commercial building equipped with a building energy management system (BEMS) can analyse historical energy consumption data, predict future usage patterns, and automatically adjust systems such as lighting and HVAC to operate only when needed. This can result in energy savings of up to 20-30%.

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The benefits of smart energy efficiency services for customers are multifaceted, encompassing financial, operational, and lifestyle improvements. These services are aimed at various customer segments, including residential users, companies and industrial installations. Some examples of benefits are:

Cost Savings and Return on Investment - A primary driver for adopting smart energy systems is the potential for significant cost savings. By optimizing energy consumption, these services reduce utility bills and improve energy efficiency.

Residential Use Cases - In residential settings, smart devices like programmable thermostats, energy-efficient appliances, and smart lighting systems play a key role. For example:

- **Smart Thermostats:** Devices like Sensibo, Nest or Ecobee learn user preferences and adapt to optimize heating and cooling, reducing energy costs by up to 10-20%.
- **Smart Plugs:** These devices track and control the power usage of connected appliances, allowing homeowners to reduce the standby energy consumption.

Commercial and Industrial Applications - For businesses, energy efficiency services reduce operational costs while enhancing productivity. Examples include:

- **Building Energy Management Systems (BEMS):** These systems monitor and control energy usage in commercial buildings, reducing HVAC and lighting costs by 20-30%.
- **Predictive Maintenance:** Industries use smart sensors and AI to identify equipment inefficiencies, reducing downtime and energy-intensive repairs.

Enhanced Convenience and Control - Smart energy services improve user experience by automating routine energy management tasks. Mobile apps and dashboards provide real-time insights into energy consumption, empowering users to make informed decisions. For example:

- **Smart Home Automation:** A homeowner can remotely control appliances, lighting, and HVAC systems via smartphone apps, ensuring efficiency even when they are not at home.
- **Customizable Alerts:** Businesses receive notifications for abnormal energy usage, enabling timely interventions.

Support for Sustainability Goals - Increasingly, customers are motivated by environmental concerns. Smart energy systems help individuals and businesses align with sustainability goals by:

- Reducing carbon footprints through efficient energy use.
- Supporting renewable energy adoption, such as solar and wind power integration.

Energy Independence and Resilience - Smart energy solutions facilitate energy independence and resilience (in case of outages and natural disasters) by enabling users to generate, store, and consume their own energy. For instance:

- **Residential Solar Systems:** Homeowners with solar panels can maximize self-consumption by using energy storage systems and load-shifting techniques.
- **Microgrids:** Businesses and communities can use localized smart grids to reduce reliance on centralized power sources.

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Additionally, smart energy systems enhance customer engagement by providing detailed insights into consumption. Dashboards and reports allow users to visualize their energy usage, identify inefficiencies, and set personalized energy-saving goals. For instance, a homeowner might use a smart meter report to identify that their old refrigerator consumes significantly more energy than newer models, prompting a cost-saving upgrade.

Environmental value

Energy efficiency services bring a range of environmental benefits for both the state and the end user. For the state, these services represent a key tool in the fight against climate change and the reduction of greenhouse gas emissions. By improving energy efficiency, overall energy consumption is reduced, leading to a decreased need for energy production from fossil fuels, and consequently lower CO2 emissions and other pollutants. More efficient energy use means less pressure on natural resources such as coal, oil, and natural gas, contributing to their more sustainable utilization. By reducing the need for fossil fuel combustion, the amount of pollutants is decreased, which contributes to better air quality and public health, along with associated public services, such as reduced healthcare costs and increased labour market productivity.

- **Reduction of greenhouse gas emissions;**
- **Improvement of air quality;**
- **Conservation of natural resources;**
- **Support for renewable energy sources;**
- **Reduction of healthcare costs;**
- **Increase in energy security;**
- **Support for sustainable development;**
- **Enhancement of comfort and quality of life.**

Energy security refers to the ability of a state to ensure stable and reliable access to energy, which is essential for economic development and the daily lives of its citizens. By improving energy efficiency, reducing dependence on energy imports or energy carriers, and increasing renewable energy production, overall energy demand is lowered, allowing the state to better cope with fluctuations in the energy market, such as price volatility or energy supply shortages. When dependence on fossil fuel imports is reduced, the state becomes less vulnerable to geopolitical crises.

Improving energy efficiency in households and businesses brings a range of benefits that manifest not only in savings on energy bills but also in an overall improvement in quality of life. Users can invest the saved funds into other eco-friendly initiatives or enhancements to their living environment. Additionally, energy-efficient technologies often increase living comfort, contributing to greater satisfaction and convenience.

- **Improvement of air quality;**
- **Support for eco-friendly initiatives;**
- **Increase in property value;**
- **Reduction of dependence on fossil fuels;**
- **Greater awareness and responsibility.**

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Risks and uncertainties

Despite their advantages, the operation of smart energy efficiency services faces several challenges and uncertainties that require careful consideration and management.

Data Security and Privacy - The reliance on IoT devices and cloud-based platforms makes smart energy systems vulnerable to cyber threats. Potential risks include:

- **Hacking**: Unauthorized access to energy management systems can disrupt operations or steal sensitive data.
- **Data Privacy**: Detailed energy consumption data could be exploited for commercial or malicious purposes.

Mitigation strategies to address this issue can include encrypting data transmission and storage to prevent unauthorized access and implementation of multi-factor authentication and robust security protocols.

High Upfront Costs - The initial investment required for smart energy systems can be a barrier, particularly for small businesses and low-income households. For example:

- A comprehensive smart home setup, including smart thermostats, lighting, and appliances, can cost several thousand dollars.
- Businesses may face additional expenses for integrating energy management systems with existing infrastructure.

The solution to mitigate the high upfront costs may include incentive programs such as tax credits and rebates for energy-efficient upgrades and other financing schemes such as leasing or pay-as-you-save models to reduce the financial burden.

- **Technical Challenges -** Smart energy systems are complex and require reliable technology to function effectively. Common challenges include:
- **Compatibility Issues**: Ensuring interoperability between devices from different manufacturers.

System Failures: Hardware malfunctions or software glitches can undermine efficiency.

The most common approaches to address these types of technical issues include development of standardized protocols to ensure compatibility across devices and providing a robust customer support, as well as remote diagnostics to resolve technical issues quickly.

Regulatory and Policy Uncertainties - The growth of smart energy efficiency services depends on supportive regulatory frameworks. These frameworks need to address the following challenges: inconsistent energy efficiency standards across regions and changes in government priorities that affect subsidies or incentives programmes. To avoid or mitigate the effects of these challenges it crucial to establish clear and consistent regulations for energy efficiency and create long-term policy incentives to encourage adoption of smart technologies.

Behavioural Barriers - Customer adoption can be hindered by a lack of awareness or resistance to change. For example, residential users may be reluctant to adopt new technologies due to perceived complexity and companies/businesses may prioritize short-term costs over long-term savings. To overcome l these behavioural barriers it is essential to

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create educational campaigns to highlight the multiple benefits of smart energy systems and offer user-friendly interfaces and training programs to simplify adoption of these services by the end-users.

Smart energy efficiency services offer unparalleled opportunities to transform energy management, delivering tangible economic, environmental, and social benefits. By optimizing energy use, reducing costs, and minimizing environmental impact, these systems empower customers to play an active role in the energy transition. However, their success hinges on addressing critical challenges such as data security, affordability, and regulatory support.

As technology continues to advance and awareness of sustainability grows, the adoption of smart energy efficiency services is expected to accelerate. Governments, businesses, and individuals must collaborate to address risks and maximize the potential of these systems. Together, these efforts can create a cleaner, more sustainable, and resilient energy future.

2.7.2. Cost Structure

The chapter focuses on the analysis of the costs associated with the provision of energy efficiency services in the energy flexibility sector, with a particular focus on key cost items and their impact on the overall project economics.

Technical equipment	Purchase of basic IT equipment, servers, and communication devices.
Software development/purchase	Development of custom flexibility or analytical software tools.
Administrative space and equipment	Lease or purchase of office space and basic office equipment.
Certification and Legal Assurance	Obtaining licenses, certifications and legal support for the service.

Fixed costs

Fixed costs for energy efficiency services are primarily associated with the company's operating expenses, employee salaries, and specific costs related to the provision of individual services. These include, for example, installations that encompass the acquisition and maintenance costs of essential equipment and tools needed to implement energy-saving measures. The same applies to administrative activities, which require funding for office space, specialized project management software, and customer support. Regardless of the volume of services provided, these costs remain constant and are essential for the smooth operation of the organization.

Another significant component of fixed costs is the evaluation of the effectiveness of energy measures, which involves investments in analytical tools and expert assessments. The costs

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of these activities are fixed because they are indispensable for ensuring the quality and efficiency of services, regardless of the number of evaluations conducted. Fixed expenses also include maintenance, which involves storing spare parts and ensuring the availability of technicians to provide regular servicing and repairs of systems. These costs are planned and do not depend on the specific number of service interventions.

In addition to direct expenses for the services provided, fixed costs also encompass rent and operational costs for facilities, including offices, warehouses, and other necessary premises. These expenses include not only the rent itself but also costs for utilities, water, internet, and other services required to maintain a functional operational background. These costs remain stable regardless of the scope of the company's activities.

An important component of fixed costs is also employee salaries, which include the wages of administrative staff, technicians, managers, and other key team members. The amount of these expenses is not directly dependent on the volume of contracts but reflects the need to maintain a qualified workforce that ensures continuity and stability in the services provided. Thus, fixed costs represent the fundamental framework for financing the company in the field of energy efficiency and constitute a key component of the organization's overall budget.

Hourly Rate for Industry[23]

There is currently no direct data available for the European market that shows the variation in labour costs across levels by education, job focus and job performance qualification. US values have been used as a basis (even allowing for the possibility of differences in the economy). The following table shows the differences in wage costs for the various occupations needed within EES services.

Table 12 – Hourly rate

Job Title	Range	Average
HVAC Service Technician	\$17 - \$36	\$25
HVAC Technician	\$16 - \$33	\$22
HVAC Service Manager	\$23 - \$40	\$31
Heating, Air Conditioning, or Refrigeration Mechanic / Installer	\$15 - \$31	\$21
Solar Energy System Installer		\$21
Civil Engineer	\$25 - \$54	\$33
Civil Engineering Technician	\$17 - \$30	\$24
Construction Inspector	\$20 - \$40	\$29

Wages and labour costs

The model being developed should be applicable across European countries, so it is necessary to take into account the differences in costs between individual states. The following graph shows the hourly wage costs for selected European countries; based on the average value, it is possible to determine the likely differences in costs between the countries.

23 https://www.payscale.com/research/US/Industry=Heating%2C_Ventilation%2C_and_Air-Conditioning_(HVAC)_Contractor/Hourly_Rate

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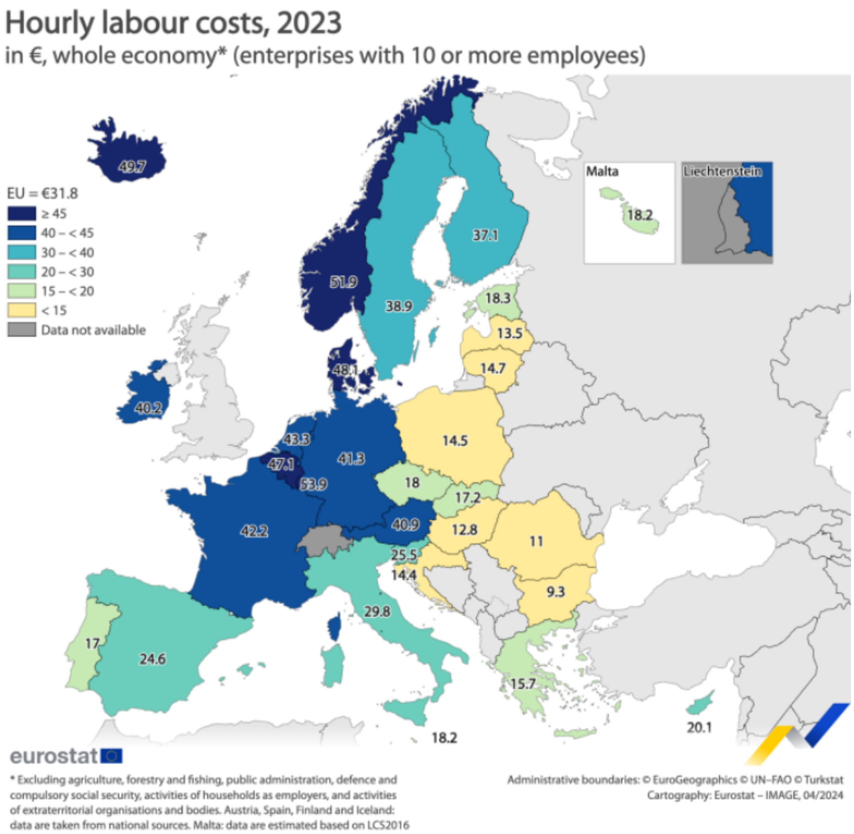

Figure 17 – Hourly labour costs, in €, whole economy, 2023 (source: Eurostat, Wages and labour costs)[24]

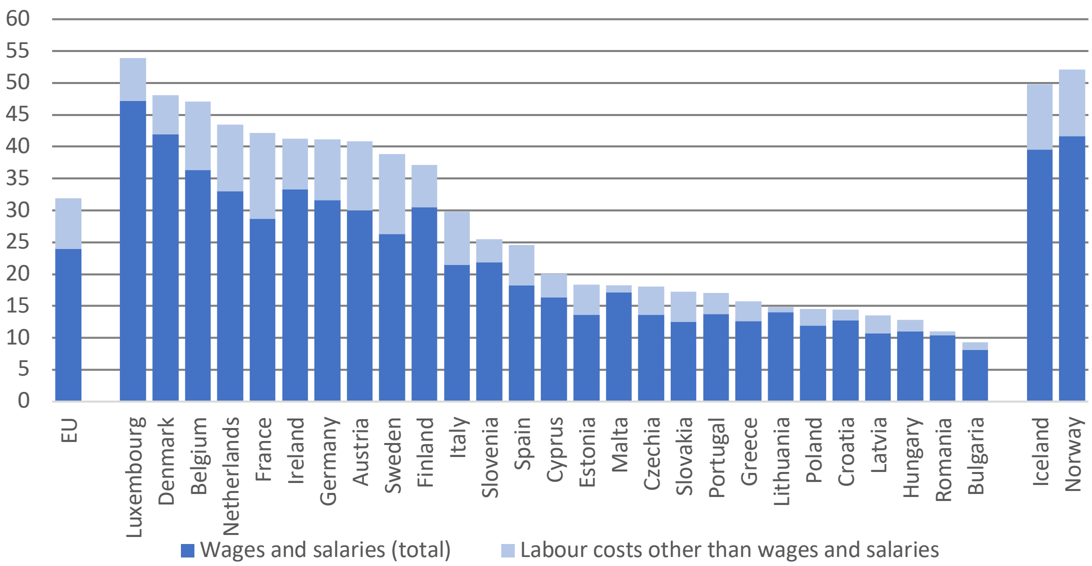

Figure 18 – Labour cost levels by NACE (source: Eurostat, Labour cost, 2024)[25]

24 https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Wages_and_labour_costs

25 https://ec.europa.eu/eurostat/databrowser/view/lc_lci_lev/default/table?lang=en

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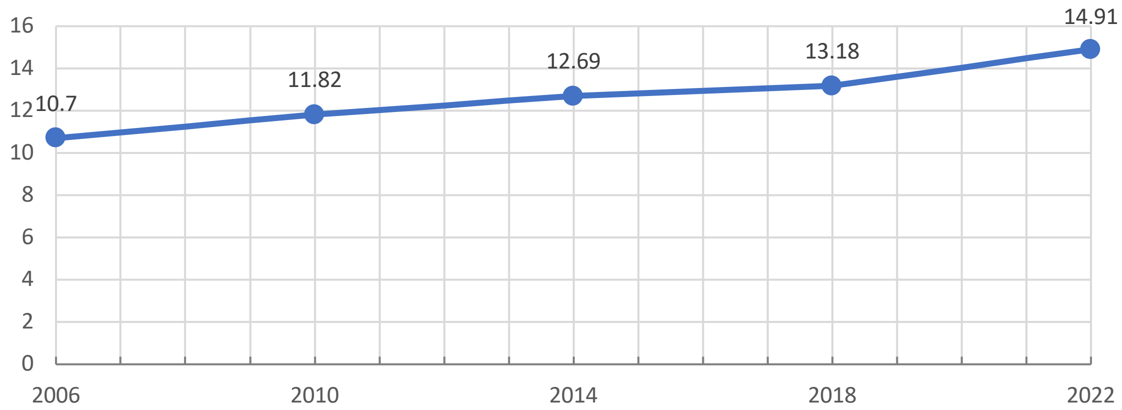

Figure 19 - Median gross hourly earnings, all employees (source: Eurostat, 2024)[26]

Variable costs

Variable costs for energy efficiency services fluctuate depending on the volume of projects and customer demand. These costs include expenses for on-site assessments, such as transportation costs for specialists to the customer, diagnostic measuring instruments, or temporary rental of monitoring equipment. They also encompass energy audits, including the work of auditors, analysis of energy consumption, and preparation of reports with recommendations for savings.

A significant item is also the costs associated with the installation of **equipment**, such as smart meters, air quality sensors, or HVAC control systems. These costs include not only the components themselves but also the labour of technicians, calibration, and testing of the system's functionality.

For energy services related to offering energy flexibility, it is essential to consider costs associated not only with the **installation of equipment** but also with the subsequent **communication of devices** with a central "brain" that will collect and **process data**, as well as costs for **servers** and **telecommunications technology**.

In addition, variable costs include fees for external specialists, such as experts in consumption optimization or certification of energy measures. There are also costs for maintenance and support, such as regular servicing of installed equipment, troubleshooting, and customer support.

Risks of changes in prices of technical components

One of the most significant risks faced by providers of energy-efficient services (EES) is the instability of prices for technical components and materials. The technologies used to enhance energy efficiency, such as heat pumps, photovoltaic panels, battery storage, and smart control systems, are subject to market fluctuations that can have a profound impact on the economics of the services offered.

26 https://ec.europa.eu/eurostat/databrowser/view/earn_ses_pub2s/default/table?lang=en

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Dependence on materials such as rare metals (lithium, cobalt, neodymium) or more common commodities (copper, aluminium) leads to price instability for components. For example, the growing demand for lithium batteries in the electric mobility sector often results in increased prices for battery storage in the energy sector. Geopolitical tensions, pandemics, natural disasters, or logistical issues can lead to limited availability of technologies, driving up their prices. For instance, the global semiconductor shortage has caused significant price increases for smart metering devices. [27]

Fluctuations in component prices present significant economic and strategic risks for energy-efficient service providers. EES providers often enter into contracts with fixed prices for the supply and implementation of technologies. However, if there is a rise in the prices of key components during the project execution, they may encounter financial difficulties. In extreme cases, the difference between original estimates and current costs can lead to unsustainable project losses. Rising technology prices typically translate into higher end prices for the services offered. In price-sensitive markets, where customers carefully select the most affordable solutions, a higher price can be a significant competitive disadvantage. As a result, EES providers may find themselves in a situation where they must either reduce their margins to maintain the attractiveness of their services or risk losing clientele. If technology prices increase during project implementation, the payback periods for investments may be extended. This means that customers will have to wait longer for their investments in energy-efficient solutions to start paying off. The reduced attractiveness of the investment may lead to a lower willingness among businesses and households to invest in upgrading their energy systems.

Risks associated with technological developments and energy efficiency

One of the key risks in the field of energy efficiency is the rapid technological advancement. Technologies that are considered innovative and efficient today may become outdated within a few years and less effective compared to new solutions. For example, heating or lighting systems that met the latest standards at the time of investment may soon be replaced by even more efficient alternatives. Investing in older types of lighting, such as compact fluorescent lamps, may prove disadvantageous compared to modern LED light sources, which have longer lifespans, lower consumption, and higher efficiency. Similarly, in the heating sector, traditional gas boilers can quickly be surpassed by modern heat pumps or hybrid systems that can utilize renewable energy sources more effectively.

This rapid technological development means that organizations investing in certain solutions today may face a situation where their technologies become inefficient and financially unviable. Without strategic planning, this can lead to higher operational costs, the necessity for premature upgrades, and an overall devaluation of the original investment. This trend also brings subsequent costs not only for purchasing new technologies but also for ensuring employee training, providing service for both existing and new technologies, and so on.

[27] https://www.goldmansachs.com/insights/articles/electric-vehicle-battery-prices-are-expected-to-fall-almost-50-percent-by-2025

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The risk of technological obsolescence is not only associated with the development of new technologies but also with the constantly changing legislation and regulatory requirements. In many countries, standards for energy efficiency, CO_2 emissions, and other environmental factors are regularly tightened. Organizations that fail to respond flexibly to these changes may find themselves in a situation where their systems no longer comply with new standards, which can have serious consequences, primarily in terms of interest in the services they offer.

2.7.3. Key Resources (physical and Technology)

Technological equipment

Technical equipment, like other key resources, is directly dependent on the final list of offered service packages. The following enumeration highlights the technologies and tools that are essential for the analysis, implementation, and monitoring of energy-efficient solutions and non-energy services.

Data Analysis Software
Tools that allow for the collection and analysis of energy consumption data in buildings help identify areas where savings can be achieved. Programs that model energy systems enable the testing of various scenarios and the optimization of energy solution designs. Software that integrates data from various measuring devices provides users with an overview of energy consumption, allowing for trend analysis and the identification of savings opportunities.

Monitoring Systems
Devices that monitor and record energy consumption in real-time. These may include smart meters, sensors, and other technologies that provide accurate data on consumption.

Optimization Technologies and Service Content
Systems that automatically regulate lighting, heating, ventilation, and air conditioning (HVAC) based on current conditions and user needs contribute to energy efficiency. The types and quantities of technologies and devices are directly linked to the ordered services. A description of the necessary technologies for individual services is part of D2.4.

Human Resources

The following text outlines the main areas of the job responsibilities of human resources needed to fulfil the offered services.

Energy Efficiency Experts: These specialists possess deep knowledge of the principles of energy efficiency, technologies, and trends in the field. They are capable of conducting energy audits, analysing energy consumption, and proposing strategies for savings. Their role also includes educating clients about opportunities for improving energy efficiency. Consultants in energy efficiency provide expert advice to companies and organizations. They help clients identify opportunities for energy savings, design strategies, and implement solutions. Their role also involves analysing legislative and regulatory requirements that may impact energy efficiency.

Civil Engineers: Engineers, especially those specializing in energy, construction, or environmental engineering, play a key role in the design and implementation of technical solutions. They are responsible for the development and optimization of systems such as

HVAC, lighting, and renewable energy sources. Their technical skills are essential for ensuring the efficient and safe operation of these systems.

Data Analysts: Data analysts specialize in collecting and analysing data on energy consumption. They use advanced analytical tools and techniques to identify patterns and trends that can assist in decision-making regarding energy strategies. Their work is crucial for the effective monitoring and optimization of energy systems.

Technicians: Technicians focus on the practical aspects of implementing energy-efficient solutions. They may work on the installation, maintenance, and repair of devices and systems that contribute to energy efficiency. Their skills include working with measuring instruments, sensors, and other technologies that monitor and optimize energy consumption.

2.7.4. Revenue Streams

Direct Payment for Services and Margins on Technology Supply and Sales

One of the fundamental financing models for Energy Efficiency Services (EES) is based on direct payment for the services provided in the field of energy efficiency. The customer pays for specific actions, such as energy audits, consumption analyses, consulting, or the implementation of energy-saving measures. The advantage is the immediate coverage of the provider's costs and transparency for the customer. This model is often applied to smaller projects or where more complex financing associated with performance commitments is not suitable or necessary. The service provider adds a margin to the installed technologies, such as LED lighting, heat pumps, or consumption management systems. This financing method allows the provider to offer the customer favorable financing or a lower initial investment in exchange for a slightly higher price for the technology. The advantage is that the provider can ensure quality equipment with long-term returns.

Ongoing Operational and Service Fees

This financial model is based on regular payments from the customer to the EES provider. It is suitable for services related to maintenance, technology rental, and the upkeep and optimization of installed equipment. The customer secures long-term efficiency and reliability of energy systems. The service provider guarantees that the equipment will operate at an optimal level, thereby minimizing energy losses and unplanned outages. The financial model can be structured as a basis for technology supply, where installation occurs, followed by operation under the management of the EES provider, with the customer continuously paying for the service provided in the form of technology provision and its maintenance.

The provider offers software as a licensed service (SaaS), where the customer pays a monthly or annual subscription for access to the platform. This software helps optimize energy consumption, manage flexibility, and analyze energy usage data. The subscription model allows customers access to the latest technologies without the need for high initial investments.

Guaranteed Savings Model

In this model, the EES provider implements energy-saving measures and guarantees a certain level of energy savings. If the savings are not achieved, the provider covers the difference from its own resources. Project financing is often secured by a bank or investor, and the customer repays the investment from the achieved savings. This model minimizes financial risk for the customer and ensures a return on investment.

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Shared Savings Model
This EPC model involves the provider bearing the costs of measures to increase energy efficiency, while the customer repays the investment in the form of a share of the achieved savings. This model is advantageous for customers who do not have available financial resources for investments, as repayments are directly dependent on actual savings. The EPC provider thus shares both the risk and the potential returns of the project.

Energy Monitoring as a Service
In this model, the customer pays a monthly fee for consumption monitoring, data analysis, and savings recommendations. The service provider collects data from energy systems, evaluates it, and suggests optimizations. This model is beneficial for customers who do not want to invest in their own monitoring systems and prefer a flexible service with predictable costs.

Flexibility Trading
This model allows customers and aggregators to sell flexibility in energy consumption or production on electricity markets. For example, businesses can postpone or reduce consumption during periods of high demand and receive financial compensation from grid operators or energy traders.

Payments for Participation in Capacity Mechanisms
Companies or flexibility aggregators can receive payments for providing reserve capacity to transmission system operators. These payments are made for maintaining a certain portion of their consumption or production flexible and ready to adjust based on network demands.

Peak Consumption Optimization
Businesses that can manage their consumption in real-time can reduce capacity fees while generating additional revenue by optimizing energy use during peak times. This model is often implemented using smart control systems that automate energy consumption based on price signals and network requirements.

Subsidies and Incentives from the State

Governments often support energy efficiency projects through grants, tax breaks or soft loans. These incentives help to reduce the initial investment costs of energy efficiency measures and increase the payback of projects. Subsidies can cover part of the investment costs for upgrading technologies, introducing energy management or building renewable energy sources. They are not the primary revenue stream for the EES provider, but they help to reduce the end price and provide a more attractive final price for the customer for energy saving measures. The subsidy system and the amount of subsidies vary from country to country and over time, it is necessary to monitor the current situation. Detailed information is given for each country.

2.7.5. National specifics for Revenue Streams

In the field of Energy Efficiency Services (EES), national specificities play a key role in generating and optimising revenues for EES providers. Each country has its own regulatory frameworks, market conditions and policy priorities that influence how EES can be financed and what opportunities for revenue generation exist.

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One of the main sources of revenue for EES is support for renewable energy, which motivates investment in sustainable technologies and contributes to achieving climate goals. These supports can take the form of subsidies, tax breaks or guaranteed feed-in tariffs, creating a stable and predictable income for investors and service providers.

Another important aspect is the tariffs and flexibility regulations that allow the introduction of dynamic tariffs and market participation options for flexible energy sources. These mechanisms promote efficient management of energy consumption and production, generating additional revenues for market participants able to respond to changes in demand and supply.

National specifics for Revenue Streams – Czechia

In the Czech Republic, there are several specificities related to renewable energy revenues, tariff and regulatory flexibility, subsidies and incentives, and sustainability concerns.

Promoting renewable energy

The Czech Republic supports renewable energy through various programmes and funds. The New Green Savings Programme, administered by the State Environmental Fund of the Czech Republic, provides financial support for energy-saving measures in family and apartment buildings, including the installation of solar and photovoltaic systems, the replacement of non-ecological heat sources and other measures aimed at reducing the energy consumption of buildings.[28]

Another important source of funding is the Modernisation Fund, which supports the transition to a climate-neutral economy through investments in low-carbon technologies, modernising energy systems and improving energy efficiency. The Czech Republic has approximately CZK 300 billion available from this fund to support projects in areas such as modernising the heating sector, developing new renewable energy sources and improving energy efficiency in industry.[29]

In addition to the already mentioned programmes such as the New Green Savings and the Modernisation Fund, there are other subsidy and incentive mechanisms. For example, the National Renewal Plan, which is part of the European Instrument for Recovery and Resilience, includes investments in the transition to green energy with an allocation of approximately EUR 275 million. The supported investments include in particular the construction of new photovoltaic sources and the modernisation of heat distribution systems in district heating systems.[30]

Dynamic tariffs

The government also approved an amendment to the Energy Act, known as Lex OZE III, which introduces a legal framework for the accumulation and aggregation of electricity flexibility. This legislation aims to enable more efficient use of renewable energy sources and increase the stability of the energy grid. The introduction of dynamic tariffs and flexibility mechanisms

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28 https://www.sfzp.cz/en/administered-programmes/new-green-savings-programme/

29 https://www.sfzp.cz/en/about-the-modernisation-fund/

30 https://cms.law/en/int/expert-guides/cms-expert-guide-to-renewable-energy/czech-republic

gives consumers the opportunity to actively influence their energy costs. By adapting consumption to current prices, they can make significant savings. For example, charging an electric car or running energy-intensive appliances at a time of low prices can reduce overall electricity costs.[31] The amendment also strengthens consumer protection by introducing an obligation for energy traders to set a hedging index, which increases transparency and makes it easier to choose a supplier. Furthermore, the rules for licensing electricity and gas traders are tightened to protect consumers from unfair practices. This amendment complements previous legislative changes and contributes to the development of active customers and energy communities.[32]

National specifics for Revenue Streams - Slovakia

Public financial aid programmes

Green for Households and Green Solidarity: Through the national projects “Green for Households” and “Green Solidarity”, the installation of renewable energy devices in households across all regions of Slovakia has been supported from 2023 to 2029. This support contributes to the adoption of technologies such as photovoltaic panels, solar collectors, biomass boilers, and heat pumps in both family homes and apartment buildings. Additionally, for family houses, the program also offers support for the installation of wind turbines. The “Green for Households” program covers 50% of eligible expenses for the purchase and installation of these technologies. Furthermore, the project provides an additional 15% financial benefit for households in single-family homes installing emission-free devices, or for those that discontinue the use of solid fuels.

“Green Solidarity” programme is designed for low-income households and aims to address energy poverty among vulnerable communities. Eligible households can apply for support for the installation of photovoltaic panels, solar collectors, and biomass boilers. Those who meet the program's criteria will receive an 80% increase in the funding rate. The support can cover up to 90% of eligible expenses for the purchase and installation of the equipment.

The “Green for Households” and “Green Solidarity” projects build upon the success of the first three national “Green for Households initiatives,” which were financed through the Operational Programme Quality of the Environment from 2015 to 2023. Thanks to European and state support, nearly 60,000 renewable energy devices have been installed in Slovak households to date. These include 20,716 heat pump installations, 16,998 photovoltaic systems, 14,516 solar collectors, and 7,045 biomass boilers. Households used support totalling €124.5 million to purchase the equipment. The total installed capacity of the supported systems has exceeded 460 MW. Over 1,700 eligible contractors participated in the projects. Between 2009 and 2011, the initial state subsidies were awarded for installation of 5,410 solar systems in family houses and just 39 in apartment buildings. Additionally, 1,427 households received subsidies for biomass boilers.

31 https://mpo.gov.cz/cz/rozcestnik/pro-media/tiskove-zpravy/dalsi-krok-k-modernizaci-ceske-energetiky--vlada-schvalila-novelu-energetickeho-zakona--280338/

32 https://www.energiezamene.cz

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These figures do not include renewable energy technologies installed by individuals and businesses that did not receive state support for their acquisition. As a result, the numbers presented here represent only a portion of the devices installed in Slovakia during these years. Many early adopters were motivated more by a desire to use renewable energy sources than by financial savings, as investment costs typically exceeded the regular costs of energy consumption at state-regulated prices, and the return on investment over the lifetime of the technology was often very low. Currently, the financial benefits of renewable energy systems are more in protecting households against sharp increases in energy prices due to market volatility and further deregulation of the energy prices for households, which could lead to significant financial impacts on households.

Role of financial aid

For many apartment buildings, investing in renewable sources is very expensive and unaffordable. A cluster of energy communities approached the relevant ministry to include energy communities as potential recipients of subsidies from the Green for Households and Green Solidarity programs. Additionally, they requested that the state create a special grant system specifically for energy communities, which would ensure that people at risk of energy poverty cover 100% of their eligible expenses or otherwise favour those energy communities that provide social benefits.

Legislation

From 1 April 2025, the new Building Act No. 25/2025 Coll. comes into effect that will remove ambiguous legislative requirements for permits related to the installation of photovoltaic technologies. This should advance the development of renewable energy (RES) use in Slovakia. The new legislation should bring clear and consistent application of rules across Slovakia. The rules will be clearer, more precise, and more understandable for those interested in using energy from renewable sources, thus speeding up the process of integrating these technologies into practical use.

Cost of Distribution Fees

Currently, no feed-in tariffs are charged, unless the prosumer is sharing the excess electricity with other consumer withing the grid managed by the same DSO. Distribution fees are paid for each kW re-distributed via the operator of the distribution grid. Distribution fees are not exempt from sharing, whether at the level of a transformer station, street, district, etc. This practice hinders the achievement of the basic goal of increasing energy efficiency, i.e., ensuring that the electricity produced is used at the place of its production. From 1 January 2025, an exemption is introduced for sharing excess electricity in apartment buildings, but the provision is so ambiguously stated in the regulator's (URSO) decree that it is not possible to enforce this relief.

Insufficient and slow support from the state (subsidies) for individual energy producers

The support that can be obtained from the state is subject to time consuming red tape. The period from the conclusion of the support contract to the actual payment of the subsidy takes at least four months, and currently, it often takes even longer. This causes distrust among interested parties and reduces their willingness to join the system.

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Low awareness in society of effective use of RES and smart technologies
Citizens do not have sufficient information about the performance and parameters of photovoltaics, smart metering systems, and heat pumps. The information is mainly provided by agencies and non-profit associations with limited budgets. While some choose the design of the system based on the size of their current consumption, others consider the total area of the roof, for example, in the case of photovoltaics (PV). There is also low awareness among the population about non-financial benefits and a lack of environmental responsibility.

Electromobility and the low use of electric vehicles
Electric cars are not affordable for ordinary Slovak citizens. For this reason, the return of investment (ROI) of installed photovoltaics (PV) cannot account for the reduction in fuel costs by electric vehicles (EVs) when calculating the ROI, which means it does not reach an attractive level for customers. Electric cars are also not supported by employers, nor do they provide benefits associated with electromobility. An employee using an electric car cannot utilize the surplus electricity from the grid or use instantaneous energy production due to off-peak solar hours when they are at home. There is the possibility to use the ZSE Drive card, but this service is subject to additional fees. The development of electromobility, such as in combination with community energy, is not supported in any way. On the contrary, it is directly sanctioned by the exclusion of such a model from support schemes (Green for Households, State Housing Development Fund). For example, in an apartment building, photovoltaics is supported by the state only if the electricity produced is shared in common areas (e.g., lighting), not in households. If the project involves sharing energy in apartments or for a charging station for electric cars, this scheme is excluded from support.

Low use of battery storage
Due to the unappealing ROI, battery storage is not sufficiently utilized by ordinary residents in Slovakia, which could contribute to solving the problem of energy surpluses and shortages. Currently, purchasing battery storage worsens the return of investment rather than improving it. The poor return on investment in Slovakia is also due to the subsidization of electricity prices by the state.

Cost-effectiveness of heat pumps
The introduction and sale of heat pumps in Slovakia have been affected by several factors, including the price of electricity. In addition, the high and constantly rising prices of heat pumps, compared to the relatively low prices of gas boilers, discourage potential customers from purchasing them. Gas boilers could be subsidised from SPP (Slovak Gas Industry company) and other entities, such as distribution companies and boiler manufacturers and these subsidies further increase their attractiveness.

Energy Communities
In Slovakia, members of an energy community are currently required to use the same energy supplier. This obligation came into effect in January 2025 through an amendment to URSO Decree No. 207/2023, which means that homeowners or apartment owners who wish to join the community must agree on the same supplier. This conflicts with the principle of free supplier choice.

The installation of smart meters (SMI) by the distribution company should be free of charge for all active customers and members of the energy community who are interested in

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producing, storing, sharing energy, or providing energy flexibility. Currently, the smart meter costs around 150€ for community members. The apartment buildings made of prefabricated panels, which have ideal prerequisites for setting up an energy community, face a disproportionate financial burden. For example, in an apartment building with 16 apartments, this would amount to 2400€.

All distribution and other fees (payment for system services, payment for system operation, payments for electricity losses, distribution tariffs, etc.) should be exempt for energy produced by the energy community if the public grid is not used for energy transmission, in the case of apartment buildings. If an apartment building shares energy within its own distribution system, it should be done without additional fees from the distribution company, as it does not participate in the management of the distribution systems, which are owned by the apartment building. The energy consumed on-site is not subject to additional fees, even in family houses. This will incentivize on-site energy consumption.

For members of the energy community who use the public network for energy transmission, distribution fees should be reduced in the case of short-distance transmission. Additionally, other fees, such as those for sharing within the same distribution branch or for one transformer, should be exempt from distribution fees, as they minimally burden the network.

There are shortcomings in the current regulatory framework. It is necessary to ensure the legislative obligation of the distribution company to create conditions for the establishment of an energy community in an apartment building, particularly from the perspective of the administrative "creation of a collection point" that is identical to the current consumption of the entire apartment building.

The law should include a definition of a community source that would have the advantages of a local source (preferential connection, free meter, etc.), but would not be linked to a single collection and supply point (CSP). Instead, it would be linked to a group of CSPs included in the sharing group or energy community. The purpose of a community source would be to cover the consumption of members of the sharing group or energy community.

Members of the energy community should also have the possibility to share energy with other energy communities. Such groups make sense, especially in the case of local municipalities, where, for example, it is not possible to create a single common community between the town/municipality and town dwellers who would like to share their excess energy with entities in municipal administration (for example, a street of family houses wants to share its excess energy with a kindergarten or a retirement home). At the level of self-government or the region, there should be the possibility of creating so-called "social sharing groups," where surpluses from different communities or communities that remain unshared could be directed. In this way, energy communities can contribute to reducing energy poverty.

Access to the Grid: In Slovakia, there are areas where, due to the poor condition of the distribution network, distribution companies refuse to connect renewable sources to the grid. It is necessary for the state, together with the network operator, to create the conditions required and ensure access to the grid for new renewable energy sources for all those who want to establish an energy community. Currently, it is necessary to apply to the distribution company for connection before installing new sources, and the entire process is very non-transparent. Those interested in renewable sources often have no idea whether it is possible

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to connect sources in their vicinity. People anywhere in Slovakia have the right to establish an energy community, which is not possible without access to the grid. Slovakia is currently facing infringement proceedings from the EU in this area. The European Commission has decided to send reasoned opinions to eight Member States: Bulgaria, Spain, France, Italy, Cyprus, the Netherlands, Sweden, and Slovakia, for failing to incorporate into national law the EU rules laid down in Directive (EU) 2023/2413. These rules aim to speed up the permit-granting procedures for renewable energy projects.

Information campaigns about the benefits of energy communities
Currently, most Slovaks are unaware of the benefits that energy communities offer. Therefore, it is necessary to launch an information campaign on energy communities, focusing primarily on municipalities and public institutions, but also on apartment buildings and individuals who already own renewable sources. It is also important for the state to integrate an agenda into existing state structures that would facilitate the development of renewable sources and increase energy efficiency for households (e.g., regional offices of the Renovate House program or consultation centres of the Green Households program), helping those interested in the process of establishing an energy community.

Slovak National energy and climate plan
From 2014 to 2021, the savings achieved through the renovation of private buildings (40%) and the reduction of energy demand in industry (35%) made the most significant contributions to meeting the target set under Article 7 of the Energy Efficiency Directive. The contributions from the transport sector and the public sector (including buildings and lighting) each accounted for 8%.

The buildings sector will continue to be a key area for energy savings potential in the future. New legislation, adopted in line with the transposition of Directive 2018/844, will introduce new requirements for building renovation. These include an emphasis on increasing the number of buildings undergoing deep renovations, additional requirements for technical building systems (such as the installation of self-regulating devices, inspection of heating and cooling systems, and more), and the implementation of building automation and control systems.

The aim of these measures is to improve the energy performance of buildings and reduce overall energy demand, which should be covered as much as possible by energy supplied from renewable sources. Meeting the minimum requirements for zero-emission buildings (ZEBs) after 2027/2030 (public/private buildings) for existing buildings will require deep renovation, which involves higher financial costs. This means that the strategy will result in lower energy savings during subsequent renovations (after the lifespan of building elements has ended) for buildings that have already been renovated compared to those undergoing their first renovation.

The Climate Change observed over the last ten years in Slovakia and across the EU will lead to increased requirements for cooling and ventilation in buildings.

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National specifics for Revenue Streams - Germany

Tariffs and Regulation for Flexibility

Germany is introducing dynamic tariffs and market participation options to increase flexibility in the energy market:

- Time-variable and dynamic tariffs aim to incentivize flexible consumers to shift their consumption through variable prices.
- Local dynamic tariffs are being considered, especially within energy communities, to balance local generation and consumption. [33]

The government plans to remove barriers on the supply and demand side and provide incentives such as flexible tariffs and a more flexible grid fee structure.[34]

In Germany the energy services revenue model is very diverse and depends on the service provided and end-consumer. The conventional ESCO model is still dominating however new as-a-service data data-driven digitalized energy services are also emerging over the time. Few examples of service revenue model is given below.

1. Dynamic Tariffs & Demand Response
   - Real-Time Pricing & Time-of-Use Tariffs: Providers can earn revenue by offering dynamic pricing schemes that encourage consumers to shift usage to off-peak periods.
   - Incentives for Flexibility: Revenue is generated from demand response programs where energy service companies are paid for reducing load or shifting consumption during peak times.
2. Ancillary Services & Grid Stabilization
   - Participation in Ancillary Markets: Energy service companies (ESCOs) can offer grid-balancing services such as frequency regulation, voltage support, and reserve power through Germany's ancillary service markets.
   - Capacity Remuneration: DSOs and TSOs offer financial incentives for assets that can contribute to grid stability during critical periods.
3. Renewable Energy Integration
   - Feed-in Tariffs and Market Premiums: Under the Renewable Energy Sources Act (EEG 2023), renewable generators receive fixed payments or premiums when supplying power, creating a steady revenue stream.
   - Contracts for Difference (CfD): Renewable projects may use CfD schemes to stabilize revenues by offsetting market price fluctuations.
4. Energy Efficiency & Management Services
   - Energy Audits and Consulting: ESCOs offer energy management services that include audits, optimization, and retrofitting solutions, which can be billed as project fees or through performance contracts.

[33] https://www.ffe.de/en/publications/energy-sharing-local-dynamic-tariffs/

[34] https://www.bundesregierung.de/resource/blob/998352/2298242/b27ba5f4d51b2f9bad3a67d4e7234da8/2024-07-08-wachstumsinitiative-en-data.pdf?download=1

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- Digital Energy Management: Platforms that provide real-time monitoring and analytics allow for subscription-based models or software-as-a-service (SaaS) revenues.

5. Electric Mobility & V2G Integration
   - EV Charging Solutions: Revenue from deploying and managing smart EV charging stations, including flexible load management and variable pricing.
   - Vehicle-to-Grid (V2G) Services: Monetizing bidirectional charging by enabling EVs to supply power back to the grid during peak demand, with payments from grid operators or DSOs.
6. Digital Platforms & IoT Integration

Data-Driven Services: Digital platforms that aggregate and analyse energy usage data can be monetized via subscriptions or pay-per-use models.

Integration Services: Implementing IoT solutions and smart grid technologies creates additional revenue through installation fees, maintenance contracts, and service agreements.

Example of Energy Service Packages in Germany

Flexibility Services Package: Combines demand response, dynamic pricing, and ancillary services, allowing providers to capitalize on grid-balancing and load management.[35]

Renewable Integration Package: Bundles feed-in tariffs, battery storage, and smart grid connectivity to support renewable energy producers.[36]

Energy Management Package: Integrates digital monitoring, energy audits, and efficiency upgrades, often offered to commercial and industrial clients.

Electric Mobility Package: Offers EV charging infrastructure (charging-as-a-service),[37] and related digital management systems to support sustainable transport.

Tariffs and regulation for flexibility

(Introducing dynamic tariffs and market participation options for flexibility):

Germany is actively shaping its electricity market to integrate flexibility from decentralized energy resources, including Vehicle-to-Grid (V2G), battery storage, and demand-side response. The regulatory framework encourages dynamic tariffs and market participation to support grid stability and renewable energy integration. Dynamic electricity tariffs enable consumers and businesses to adjust their energy consumption based on real-time electricity prices, leading to cost savings and greater flexibility. Key tariff models include Time-of-Use (TOU) tariffs, which feature different prices depending on peak and off-peak hours; Real-Time Pricing (RTP), where prices fluctuate according to wholesale market conditions; Critical Peak Pricing (CPP), which imposes higher rates during periods of extreme grid demand; and Peak Load Reduction Incentives, which offer benefits to consumers who reduce their load during high-demand hours. Since 2023, energy suppliers in Germany are required to offer dynamic tariffs if they serve more than 100,000 customers, necessitating the use of smart meters

35 https://tibber.com/de/stromtarif

36 https://sonnen.de/stromspeicher/

37 https://meenergy.earth/magazin/chargingasaservice

(Smart Meter Gateway - SMGW) to facilitate real-time pricing. However, many consumers still lack access to dynamic tariffs due to delays in metering infrastructure deployment.

In the wholesale electricity markets, participants can engage in spot market trading, which includes day-ahead and intraday trading based on forecasted demand and supply. Renewable energy producers can also take advantage of direct marketing, allowing them to sell power directly through Power Purchase Agreements (PPAs). Additionally, in ancillary services markets, flexibility providers contribute to grid stability through mechanisms like Frequency Containment Reserve (FCR), which involves fast-response power adjustments, as well as Automatic Frequency Restoration Reserve (aFRR) and Manual Reserve (mFRR) to provide flexible power contributions. On the local level, flexibility markets and grid services, such as congestion management (Redispatch 2.0), utilize decentralized energy assets, including EVs and batteries, to help balance grid congestion. Furthermore, some distribution system operators (DSOs) are testing flexibility procurement from local assets through DSO flexibility programs.

Regulation & Policies Supporting Flexibility

- Renewable Energy Act (EEG 2023) – Supports dynamic pricing and direct market integration.[38]
- Energy Industry Act (EnWG) – Defines flexibility providers' rights and responsibilities.[39]
- Electricity Market Act (Strommarktgesetz) – Introduced capacity reserve mechanisms for flexibility.[40]
- Metering Point Operation Act (MsbG) – Mandates smart meter rollout to enable dynamic tariffs.[41]

Support for renewable energy sources:

The Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG) is the primary legislation in Germany promoting renewable energy, first introduced in 2000 and regularly updated to adapt to changing energy needs. The EEG guarantees priority grid access for renewable energy sources, ensuring that these energies are integrated into the power supply without discrimination. It provides feed-in tariffs (FiTs) and market premiums to support renewable power producers, while also encouraging direct market participation through auctions and subsidies. The latest updates to the EEG in 2023 include ambitious targets to achieve 80% of electricity generation from renewable sources by 2030, increased auction volumes for wind and solar capacity, and a faster permitting process for renewable energy

[38] https://www.bmwk.de/Redaktion/DE/Schlaglichter-der-Wirtschaftspolitik/2022/10/05-neuer-schwung-fuer-erneuerbare-energien.html

[39] https://www.gesetze-im-internet.de/enwg_2005/inhalts_bersicht.html

[40] https://www.bmwk.de/Redaktion/EN/Publikationen/discussion-paper-electricity-2030.pdf?__blob=publicationFile&v=2

[41] https://www.bsi.bund.de/EN/Das-BSI/Auftrag/Gesetze-und-Verordungen/Smart-Metering-GDEW-MsbG/smart-metering-gdew-msbg.html

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projects. These enhancements reflect Germany's commitment to transitioning to a more sustainable energy future.[42]

National specifics for Revenue Streams - France

Costs
To be able to have Automatic DR as stated before, metering and command device needs to be installed in every household.

This represents the following investments for DR Operators:

- acquisition of end-users (finding and convincing them),
- hardware and
- installation of this hardware (to be sure that it is well installed and operational, i.e., well connected to the DR platform).

There are three operational costs for DR operators:

- Ensuring availability of bi-directional communication: the goal of domestic DR communication system is to ensure a continuous connection between the DR Platform and domestic appliances. Therefore, DR operators must make sure that equipment is always operational and is maintained whenever there might be technical failures. Therefore, an after-sales organisation must be built (including call centres and remote maintenance teams and onsite maintenance teams)
- Telecom costs: as bi-directional communication must always be available to the platform (and in order not to rely on home Wi-Fi which is not under aggregator responsibility) communication system like 4G or 5G might be used to ensure continuously communicating with the platform
- Market team: to monetise energy and capacity installed in every household, a dispatching centre must exist with the responsibility of placing orders on all different electricity markets.

Benefits for demand response operators:
DR services benefit service providers by enhancing competitiveness, profitability, and sustainability.

Support Green Transition: By offering energy-efficient solutions, service providers align with sustainability trends and capitalise on emerging opportunities in the green transition.

Monetised Benefits: DR services open new revenue streams and diversify income sources, driven by demand for sustainability and cost savings.

Increased Customer Loyalty: Delivering tangible benefits fosters stronger customer relationships and loyalty, leading to higher retention rates and recurring revenue.

Data management: DR services provide valuable data on customer energy usage, enabling providers to tailor offerings and enhance customer satisfaction.

42 https://www.bmwk.de/Redaktion/EN/Dossier/renewable-energy.html

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New Market Opportunities: Offering DR services opens new markets and business models, expanding reach and driving sustainable growth and profitability.

Finally, the calculation of revenues from DR on the electricity markets is very complex and highly volatile. This because both it's an open market and aggregation must be made on large scale and large number of households).

National specifics for Revenue Streams - Spain

Two revenue generation options

- Through a monthly fee according to the services offered.

Within the business model, the main idea can be to offer the product as a service which would be remunerated with a monthly fee that must be set to monetise the service of management and control of energy equipment. The service would be billed monthly to the client including in this product the chosen service model with the corresponding package and appropriate maintenance for the selected service.

- Premium (The most expensive) → Heat Pump (Installation and control) + Solar (Installation and control) + Recharging points (Installation and control) + Maintenance + Energy
- Control (Medium price) → Heat pump (control) + Solar (control) + Recharging points (control) + Maintenance + Energy
- Basic Electric mobility (Cheapest) → Recharging point (Installation and control) + maintenance + Energy
- Basic Solar (Cheapest) → Solar (Installation and control) + maintenance + energy
- Basic Heat pump (Cheapest) → Heat pump (installation and control) + maintenance + energy

This type of service, in the case of belonging to an energy company, could be included in the bill as a monthly service. By having this monthly control with the client, it is possible to have a more direct contact with them, knowing their consumption, habits, improvements that can be provided, products that they use more frequently, etc. This way they have a closer positioning.

- Through a sale-purchase agreement for the equipment and the solution.

Another way of selling the product can be defined in which the aim is to sell the product only and obtain a one-off fee and not to be recurrent. This business model would be more immediate but would not create dependence on the supplier's client as there would be no monthly contact and no benefits could be offered.

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3. Service Model Structure and Components

This chapter includes a description on the structure of the service model, the system of services offered and the role of the aggregator. The aggregator plays a key role in providing flexibility to the energy system by integrating and optimising energy consumption between different users.

A more extensive and general description of the role of the aggregator and the possibilities to work with this system are described in Deliverable D2.2 Smart EES Service Model Prototype. This deliverable includes only selected parts that are most relevant to the service model being developed and is elaborated in greater detail, discussing flexibility options, data usage and management, communication of energy flexibility needs, and interaction with the energy market. The benefits that the aggregator brings to households and the wider energy market have been analysed. This analysis has provided insights on how an efficient service structure and role of the aggregator can contribute to better management of energy resources and the achievement of sustainability goals.

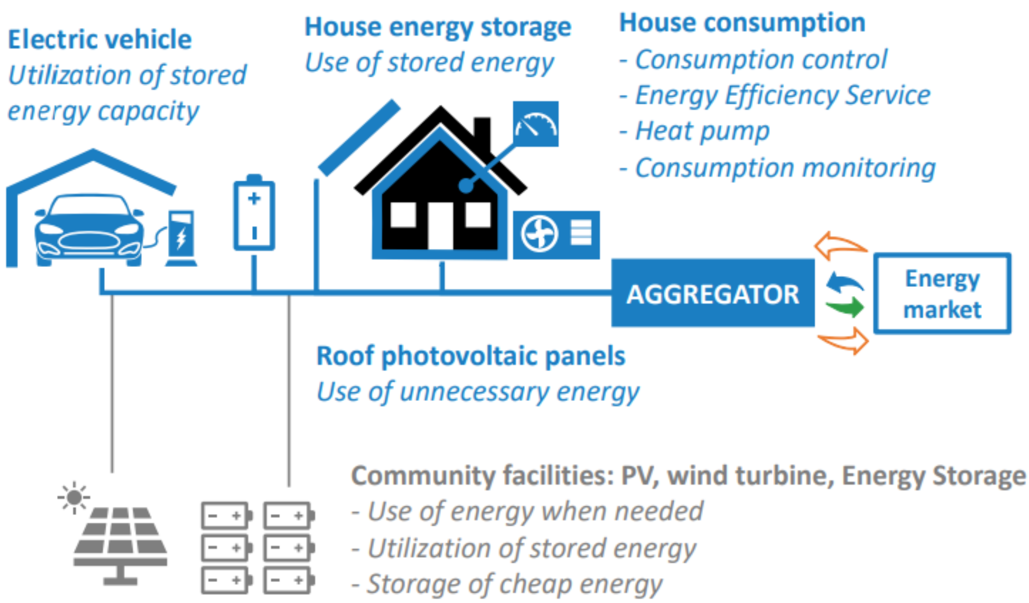

Figure 20 – Diagram of Smart EES Model Prototype designed by BungEES project

The creation of an aggregator-based service model was chosen because of the possibility of creating an entity that would pool flexibility and energy savings from different customers while allowing it to act as a middleman between end-users and the energy market or power system operators. One of the main objectives will be to optimise the management of energy consumption so that customers can benefit from savings while providing a service to stabilise the grid or reduce peaks in energy demand.

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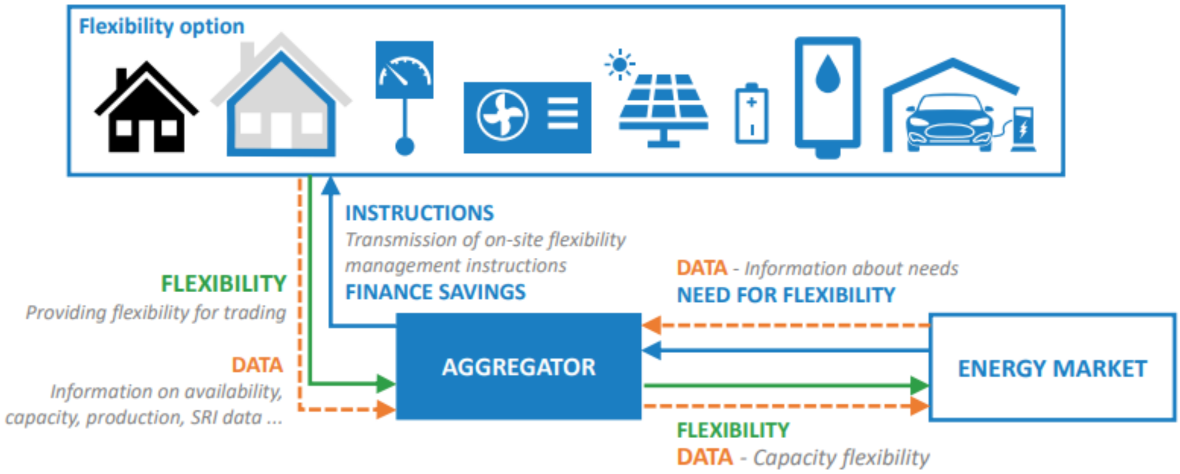

Figure 21 – Diagram of Communication in Smart EES Model Prototype designed by BungEES project

As a key player in the energy sector, the Aggregator communicates with various entities that play an important role in ensuring the stability and efficiency of the energy market. This communication takes place at several levels and involves different types of actors that contribute to the overall functioning of the energy ecosystem.

Entities with which the aggregator communicates:

The first type of entities that need to be contacted and communicated with are **end customers**, which include industrial enterprises, businesses, households and energy communities. In the design of the BungEES model, we aimed to reach primarily households, i.e. the residential sector (single-family homes and apartment buildings). These customers provide flexibility to the aggregator by managing their consumption or, in the case of the inclusion of local renewables, energy production. The key task is to convey information to households about the need to reduce energy consumption, according to the current requirements of the grid. Communication with these customers can be either directly, through the aggregator's systems, or indirectly, through IoT devices and smart meters that allow monitoring and optimisation of energy consumption.

Distribution System Operators (DSOs) and Transmission System Operators (TSOs) are another important entity. These operators are in charge of the stability of the power grid and need information on the available flexibility that aggregators can provide. DSOs and TSOs may require aggregated flexibility for load or frequency management purposes on the network. Communication with these entities is usually through standardised interfaces that allow the provision of flexibility or through market platforms that facilitate energy trading. Thus, depending on the actual requirements, the aggregator can offer energy flexibility through aggregated customers, reduce energy consumption or offer generation/use of stored energy as needed.

A) Data on Energy Consumption and Production
   - Historical data on the consumption/production of individual customers.
   - Real-time consumption and production data (from smart meters, IoT devices).
   - Predictions of consumption and production based on machine learning and AI.

B) Data on Available Flexibility

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- Which devices can be regulated (e.g., heat pumps, photovoltaic systems, batteries, industrial processes).
- Response speed and volume of flexibility available at a given moment.
- Constraints (e.g., customer comfort, technological limits of devices).

C) Market and Price Data
- Electricity prices on the day-ahead market, intraday market, and on regulation energy markets.
- Demand for flexibility in individual markets.
- Opportunities for optimizing the aggregator's profit.

D) Network Data and Requirements from Network Operators
- Information on the load of the distribution and transmission systems.
- Requirements for reducing or increasing load in specific parts of the network.

Based on this data, which must be communicated with minimal delay, it is possible to respond to demand and offer energy flexibility, ensuring the stability of the energy grid or reducing peaks by decreasing the energy consumption of aggregated customers.

3.1. EES packages and integrated services

Since it is not possible to meet the needs of a wide range of customers with a single fixed offer—each having specific requirements for consumption, production, and flexibility, as well as offering different options for energy flexibility—it has been decided to create a system of Energy Service Packages (EES). This system will allow customers to assemble a group of services according to their own needs and preferences, ensuring optimal utilization of their flexibility while maximizing benefits for the entire energy system.

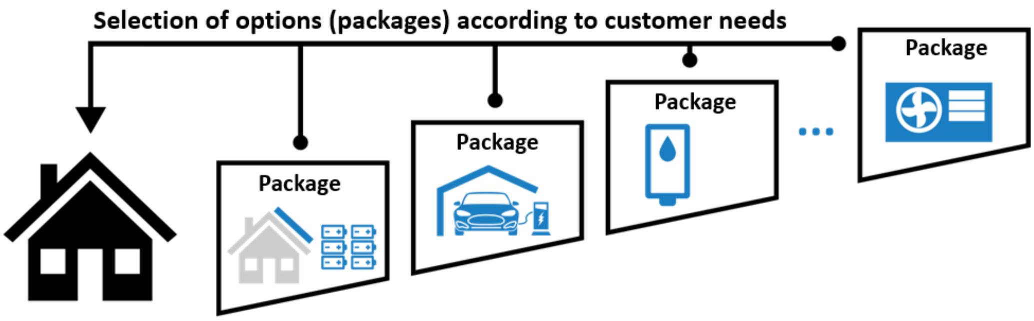

Figure 22 - Scheme of EES service packages

The schematic diagram illustrates the principle of meeting customer demands. Detailed descriptions of the individual packages and services are outlined below. A comprehensive description of non-energy services is provided in Deliverable D2.4 Catalogue of Non-Energy Services.

An individual approach is necessary due to the differing capabilities of customers. For example, households can offer flexibility through the management of appliances (e.g., heat pumps, air conditioning, photovoltaic systems with batteries), while large companies can regulate entire operations. Each customer can select services that align with their capabilities and technologies (e.g., demand management, trading excess energy, services for grid stability). Customers can start with a simple package and gradually add more services based

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on their experiences and changing needs. Furthermore, the packages facilitate the integration of new technologies; for instance, when acquiring an electric vehicle, it can be incorporated into the potential for energy flexibility through a package. Each customer can set their level of flexibility to achieve maximum financial benefits without compromising their comfort or operational needs.

The following subsections provide a closer look at the proposed service packages, which have been divided into three main blocks for easier navigation: Energy Efficiency Service Packages, Energy Management Service Packages, and Non-Energy Service Packages. The services in the Energy Efficiency category, along with those in Energy Management, have the greatest impact on energy flexibility.

☐ **Package Name**
Description of the Basic Parameters of the Package

Figure 23 - Diagram of the Package Description System

3.1.1. Energy Efficiency service packages

Energy Efficiency Service Packages help reduce the overall energy consumption in buildings. This is important not only for lowering energy costs but also for protecting the environment, as lower energy consumption means reduced greenhouse gas emissions. Investments in energy-efficient measures often pay off in the form of lower energy bills. Long-term savings can significantly contribute to the return on investment and improve the economic situation of households.

☐ **Increasing the energy efficiency of the building envelope**
The package focuses on improving the overall energy performance of the building by increasing the energy efficiency of the building envelope. It is a fundamental package, and evaluating the energy efficiency of the building envelope should be a basic step before designing additional services and measures. Energy-efficient buildings have a lower energy demand, which leads to reduced energy consumption and increased comfort for occupants. Results are achieved through the implementation of measures such as insulating exterior walls, roofs, and floors, as well as replacing windows and doors. Additionally, the energy efficiency of the distribution systems within the building is enhanced. The main benefit is a reduction in energy bills for the customer.

☐ **Insulation of the building envelope**
This service involves adding or upgrading insulation materials in walls, roofs, and floors to minimize heat loss or gain. The primary objective is to create a more thermally efficient building, which leads to significant energy savings. Users benefit from enhanced comfort, reduced energy costs, and increased property value.

☐ **Replacement of window openings**
This package includes the installation of energy-efficient windows that provide better thermal performance compared to traditional windows. The goal is to improve insulation, reduce drafts, and enhance natural light. Users will experience improved

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comfort, lower heating and cooling costs, and a more aesthetically pleasing environment.

- **Installation of a modern energy efficient heating source**

  This service focuses on replacing outdated heating systems with modern, energy-efficient alternatives, such as heat pumps or condensing boilers. The aim is to provide effective heating while minimizing energy consumption. Users benefit from lower energy bills, improved heating performance, and a reduced environmental impact.

- **Installation of an energy efficient power supply and hot water storage tank**

  This package involves upgrading the power supply system and installing an energy-efficient hot water storage tank. The goal is to optimize energy use and ensure a reliable supply of hot water. Users can expect increased energy savings, improve hot water availability, and enhanced overall system efficiency.

3.1.2. Energy management service packages

Renewable Energy

- **Renewable source Installation**

  Installation of renewable energy sources such as solar panels (in exceptional cases, wind turbines or geothermal systems may also be used). Ensuring the use of natural and renewable resources for energy production. Designing the performance of the source considering the technical condition and operation of the building.

- **Installation of high efficiency appliances/technologies**

  Installing high-efficiency appliances and technologies that reduce energy consumption. This includes home appliances, electrical replacements, combinations in conjunction with energy efficient lighting, air conditioning and heating systems that help reduce energy costs and greenhouse gas emissions.

- **Installation of water waste reduction**

  Focus on reducing water waste and wastewater recovery. May include installation of water saving taps, shower heads to reduce water demand, also installation of rainwater harvesting systems, use of grey water to reduce water waste in the building.

- **Battery Storage Solutions**

  The design and installation of battery storage systems that store energy generated from renewable sources for later use. This increases the potential for renewable energy use (in combination with the installation of RES), allows more efficient use of the energy produced, helps with grid stability and reducing energy flows.

- **Microgrid Design and Implementation**

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This service focuses on the design and implementation of microgrids, which are small, local energy networks that can operate independently of the main grid. Microgrids increase energy security and enable efficient use of local energy resources.

- [ ] **Community Energy Projects**
  This service involves planning and implementing renewable energy projects at the community level. Projects may include community solar farms, wind farms or other initiatives that promote local sustainability and reduce energy costs for residents.

Smart Technology Installation

- [ ] **Installation of Smart Lighting Systems**
  Design and installation of intelligent lighting and sensors and meters that provide automatic adjustment of lighting intensity and timing to user needs and natural light. These systems increase energy efficiency and reduce electricity costs while providing optimal lighting for different spaces.
- [ ] **Install sensors – Daylight Harvesting Systems**
  Design and installation of sensors for daylighting systems that automatically control artificial lighting based on the availability of natural light. This reduces energy consumption and improves occupant comfort, as lighting is optimised according to current conditions.
- [ ] **Installation of Smart Thermostat**
  This service includes the installation of smart thermostats that allow users to efficiently control the heating or cooling of the space they use. According to set scenarios and user needs, they automatically adjust the temperature, which contributes to energy savings and increases comfort and ease of use.
- [ ] **Installation of EV Charging Stations**
  Installation of charging stations for electric vehicles. Ensuring convenient and efficient charging of vehicles. Combined with RES and battery systems, this will allow charging using renewable energy and maximising the use of this generated enegy.

3.1.3. Non-Energy service packages

Air Quality and Ventilation

- [ ] **Ductwork Design and Installation**
  Design and installation of air handling systems that efficiently distribute heated or cooled air in buildings.
- [ ] **Installation of smart air quality meters**
  Installation of smart air quality meters that monitor levels of pollution, humidity and other factors affecting indoor air quality. These devices provide users with valuable information and allow them to take action to adjust the operation of the HVAC system and improve a healthy indoor environment.

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☐ **Installation of filters to improve air quality**

Installing filters and equipment that remove dust, allergens and other pollutants from the air. Quality air filtration contributes to better occupant health and improves overall indoor air quality.

☐ **Installation of Energy Recovery Ventilators**

Design and installation of waste air heat recovery units, either as stand-alone units or as part of an air handling system. The aim is to provide fresh air and minimise the heat loss that occurs during air exchange.

☐ **Installation of Smoke and CO2 Detectors**

Installing smoke and carbon dioxide (CO2) detectors to ensure the safety of residents by providing early warning of dangerous levels of smoke or CO2 in the air.

Maintenance and Inspections

☐ **Regular Equipment maintenance**

Providing regular maintenance, cleaning and repair of equipment to ensure optimum functionality, prolong service life and prevent breakdowns.

☐ **Predictive Maintenance Analytics**

The service uses advanced analytics tools and technologies such as sensors and IoT to predict potential equipment failures based on the data collected. Predictive maintenance allows you to schedule maintenance at the optimal time, reducing repair costs and minimizing downtime.

☐ **Emergency Repair Services**

Providing prompt and efficient assistance with unexpected equipment failures. A team of experts is on hand to ensure a speedy repair and minimise the impact on operations.

☐ **Regular Equipment Inspections and testing**

This service includes regular inspection and testing of equipment to ensure that it meets safety and operational standards. Inspections help identify potential problems before they become serious and ensure that equipment is operating efficiently and safely.

Monitoring and Reporting

☐ **Monitoring and Reporting**

This service includes real-time monitoring of the performance and efficiency of energy systems and equipment. Using advanced technology and software tools, data on energy consumption, indoor environment, emissions and other indicators are collected and analysed. This information is used to produce regular reports that provide an overview of performance and identify areas for economic or environmental improvement.

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Financial and Grant Assistance

☐ **Implementation of Payment Assistance Programs**

Providing assistance with financing energy efficiency measures or non-energy measures. The form of the service can range from providing guarantees to co-financing.

☐ **Cost-Benefit Analysis for Energy Projects**

Conduct cost-benefit analyses for energy projects to help assess the cost-effectiveness of energy efficiency and renewable energy investments, evaluating potential savings, implementation costs and long-term benefits.

☐ **Grant Application Assistance**

Support in the preparation and submission of grant applications for energy efficiency and sustainability measures, assistance in identifying suitable grant opportunities, preparing the necessary documentation and optimising applications to increase the chances of success.

☐ **Financial Modelling for Energy Investments**

This service includes the creation of financial models for energy project investments, which allow to analyse different scenarios and predict the return on investment. The modelling includes factors such as costs, revenues, savings and risks associated with the implementation of measures.

Education and Workshops

☐ **Workshops on Energy Efficiency**

Organising workshops and training sessions to raise awareness of energy efficiency and sustainable practices. Participants will learn about the latest trends, technologies and strategies they can implement in their homes. Working with local governments or communities.

☐ **Development of Educational Materials**

Creating educational materials, such as brochures, presentations and online courses, that inform about energy efficiency and sustainability. The materials are designed to be accessible and understandable to the general public and promote awareness in this area.

Sustainability and Certification

☐ **Sustainability Assessments**

This service includes the sustainability assessment of measures or projects, which assesses their impact on the environment, the economy and society. The assessment helps to identify strengths and weaknesses and suggests measures to improve sustainability.

☐ **Preparation for Certification Applications**

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Providing support in the preparation of applications for energy efficiency and sustainability certifications such as LEED, BREEAM or ISO 50001.

3.2. National Specifics - National specifics for package selection

The following chapter focuses on the potential differences and needs that require a different approach among individual countries. Each country has its specific conditions that influence the selection of services and technologies suitable for the given context. These national specifications play a key role in determining which services and technologies will be the most effective and appropriate for local needs.

National specifics for package selection - Czechia

In the Czech Republic, the Energy Performance Guarantee (EPC) method is used in the field of energy savings and modernisation of energy systems. This method allows energy-saving measures to be financed from the energy cost savings achieved. Since the 1990s, more than 250 EPC projects worth almost CZK 3.6 billion have been implemented, resulting in energy savings worth CZK 4.1 billion.[43]

In 2024, an amendment to the LEX RES III energy law was adopted, bringing new rules to the electricity market. The amendment includes major changes for electricity storage, the provision of flexibility services and their aggregation. The aim is to enable consumers to better manage their energy consumption and reduce their electricity bills. The law also simplifies the authorisation of smaller photovoltaic and self-consumption sources.[44]

There has been a significant shift in energy sharing with the Lex RES 2 law, which allows energy sharing between households, municipalities and businesses. Although the law is effective as of January 2024, practical energy sharing will only be possible after the Energy Data Centre starts its operations on 1 July 2024.[45]

In the field of electromobility, infrastructure for charging electric vehicles is being developed, which supports sustainable transport and reduces greenhouse gas emissions. Practical experience shows that investment in charging stations and the promotion of electromobility are key to the further development of this segment in the Czech Republic.

The Czech Republic is gradually implementing legislative and practical measures towards energy efficiency, sustainability and modernisation of the energy market, which brings new opportunities for consumers and businesses.

[43] https://www.apes.cz, *(in CZ language)*

[44] https://energie21.cz/nova-pravidla-trhu-s-elektrinou-ochrani-spotrebitele-a-podpori-uspory-akumulaci-a-flexibilitu *(in CZ language)*

[45] https://www.fbadvokati.cz/cs/clanky/9600-lex-oze-2-se-i-diky-expertize-frank-bold-stal-zakonem-roku-umoznuje-sdileni-energie-domacnostem-obcim-i-firmam *(in CZ language)*

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National specifics for package selection - Slovakia

Since 1991 and based on the adoption of the Resolution of the Government of the Slovak Republic No. 493 of 10 September 1991, Slovakia has been improving energy efficiency of buildings, starting with thermal insulation of multi-family buildings. Since then, most apartment buildings, often made of prefabricated panel segments, and many family houses, more than 460 thousand family houses and multi-family buildings accounting for 671 thousand apartments in total, have been insulated at least on 25% of their envelope (definition of complex renovation at that time) to achieve savings on energy costs, and their old windows were replaced with new ones. These construction measures were mostly used to ensure energy savings. They were also based on the climatic conditions of Slovakia. Its territory is divided into three climatic zones – warm, moderately warm and cool. Up to 78% of the territory of Slovakia consists of hills and highlands.

After this initial, approximately 20-years long period, the next stage of increasing the energy efficiency of buildings and other sectors takes place through the introduction of innovative modern technologies for energy saving – especially solar heat collectors, photovoltaics and heat pumps. Currently, a less used technology in Slovakia are wind turbines. In the field of thermal energy, a survey of geothermal energy potential was also carried out, which has a certain potential for Slovakia and initial projects for its use are being implemented in the eastern part of the country. With the development of these technological solutions, prosumers are emerging in regions of Slovakia.

The amendment to Act No. 251/2012 Coll. on Energy, which became valid on 1 October 2022, introduced new terms into Slovak legislative, namely "energy community" and "community producing energy from renewable sources". These entities can have a diverse legal form within the Slovak Commercial Code, or they can be non-profit organizations or civil associations.

Although these changes in regulatory framework already to accommodates the flexibility trading as well as the independent aggregator, the market in the residential sector did not develop yet. The Slovak competent authorities, however, implemented the key steps to allow the market to develop in business sector and lately also for participation of aggregators and smaller prosumers.

In this respect and since autumn 2023, electricity in Slovakia has been managed through the newly created Energy Data Centre (EDC) data hub, operated by the state's short-term electricity market operator, OKTE. OKTE began its activities in the Slovak Republic on January 1, 2011. It is a subsidiary of the transmission system operator, Slovenská elektrizačná prenosová sústava (a.s.), and is a regulated entity under the authority of the Regulatory Office for Network Industries (URSO). In its services, OKTE addresses all electricity market participants. The scope of the company's activities is defined by both European and national legislative documents. OKTE organizes and evaluates the organized short-term cross-border electricity market and ensures the settlement of imbalances within Slovakia. It also administers the collection of measured data, central invoicing of fees related to electricity system operations, and the reporting of transactions concluded on the wholesale electricity and gas market (REMIT). Furthermore, OKTE organizes and settles support for electricity generation from renewable energy sources and high-efficiency cogeneration. Additionally,

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OKTE handles activities related to the issuance, transfer, recognition, application, and cancellation of guarantees of origin for electricity from renewable energy sources and for electricity produced by high-efficiency cogeneration, as well as organizing the market for issued guarantees of origin.

The EDC project was launched at the end of January 2023 and has been operational since October 1, 2023, following an update to the energy market rules. One of the features offered is electricity sharing. Currently, energy sharing on the market and smart energy services are at a relatively early stage in Slovakia. Electricity can be shared at individual supply and delivery points, regardless of the electricity supplier. Additionally, there are no fees for sharing electricity through the OKTE EDC, though energy distribution companies charge fees for using the distribution grid. To use electricity sharing via OKTE, a supply point must be equipped with continuous metering. The value of the energy consumed is recorded and evaluated at regular intervals, with each interval lasting 15 minutes.

Conditions for connecting to the system:

- registration with the EDC;
- performing continuous metering;
- the collection point is not allowed to be included in the mandatory purchase or in another shared group;
- the existence of an 'active customer' or 'energy community' as a separate entity within the sharing group. The electricity producer is obliged to provide the Office, pursuant the Act No. 251/2012 Coll. on Energy, by 30 May each year with data for the previous year, expected data for the current year and planned data for the following year on electricity production in its own electricity production facilities, own consumption of electricity produced during electricity production, other self-consumption of electricity and supply of own electricity.

National specifics for package selection - France

In France, the energy transition is a major priority, supported by various regulatory frameworks and incentives aimed at decarbonization, energy efficiency, and renewable energy deployment. The national strategy is strongly influenced by the objectives outlined in the Multiannual Energy Plan (Programmation Pluriannuelle de l'Énergie, PPE) and the National Low-Carbon Strategy (Stratégie Nationale Bas-Carbone, SNBC), which set ambitious targets for reducing greenhouse gas emissions and increasing the share of renewable energy in the national mix.[46]

Energy Flexibility and Demand Response

France has a well-established demand response market, primarily driven by the efforts of Réseau de Transport d'Électricité (RTE), the national transmission system operator. The country allows independent aggregators to participate in the electricity market without requiring supplier consent, fostering a competitive landscape for flexibility services. The NEBEF (Notification d'Échanges de Blocs d'Éffacement) mechanism enables demand-side

46 https://www.ecologie.gouv.fr/sites/default/files/documents/Synth%C3%A8se_EN_PPE.pdf

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response to be sold on the wholesale market, providing consumers with opportunities to monetize their flexibility.[47]

With the increasing integration of renewable energy, France is focusing on enhancing grid flexibility. The Capacity Market plays a key role in ensuring security of supply, with demand-side response being a crucial component of this system.

Energy Communities and Self-Consumption
France has taken significant steps to support energy communities and collective self-consumption. The Energy Transition Law established a framework for self-consumption, allowing individuals and businesses to share locally produced electricity within a defined geographical area. Further legislative advancements, including the Climate and Resilience Law, have strengthened support for citizen-led renewable energy initiatives and energy-sharing models.[48]

In recent years, collective self-consumption projects have expanded, particularly in urban areas and industrial zones. The regulatory environment continues to evolve, with efforts to simplify administrative procedures and encourage participation from a broader range of stakeholders.

Renewable Energy and Storage
As part of the France 2030 national investment plan, the French government will invest EUR 1 billion in renewable energy innovation projects. The eventual aim is to increase the renewable power installed capacity by ten times by 2050, up to 100 GW. Offshore wind farms will represent 40 GW of this installed capacity.[49]

Battery storage is also gaining attention as a key enabler of grid stability and self-consumption optimization. Although storage regulation is still under development, pilot projects integrating storage with distributed renewable energy sources are increasing. Additionally, France is investing in large-scale hydrogen storage solutions as part of its hydrogen strategy.

Electromobility and Charging Infrastructure
France has a strong focus on electric mobility, with a national target of having 7 million public and private charging points by 2030. The country offers financial incentives for electric vehicle (EV) adoption, including purchase subsidies and tax credits. The ADVENIR program supports the deployment of charging stations, with specific provisions for residential, commercial, and public infrastructures.[50]

To further enhance EV grid integration, France is exploring vehicle-to-grid (V2G) technologies, allowing EVs to provide flexibility services. Several pilot projects are underway to assess the feasibility and economic viability of bidirectional charging solutions.

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47 https://www.services-rte.com/en/learn-more-about-our-services/participate-nebef-mechanism

48 https://www.legifrance.gouv.fr/loda/article_lc/LEGIARTI000031048231

49 https://www.iea.org/policies/15025-france-2030-investment-plan-investment-in-renewable-energy-innovation

50 https://advenir.mobi/

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Heat Pumps and Building Decarbonization

France has one of the largest markets for heat pumps in Europe, with significant government support for their deployment. The "MaPrimeRénov'" subsidy scheme provides financial assistance for heat pump installations in residential buildings.[51]

Additionally, the Energy Savings Certificates (CEE) program mandates energy suppliers to fund energy efficiency measures, including heat pump installations.[52]

Smart heating solutions are gaining traction, with the integration of smart thermostats and IoT-based energy management systems enabling optimized energy consumption. These advancements contribute to France's broader objective of achieving carbon neutrality in the building sector by 2050.

National specifics for package selection - Spain

Regulation in Spain is not yet ready to accommodate the flexibility as well as the independent aggregator. It is estimated that the regulation for the independent aggregator will be in place by the end of 2025. The ENTRA association, of which Plenitude is one of the partners, is working on the development and creation of a roadmap for flexibility to be implemented by 2025.

On the other hand, the concept of energy communities has been developed in Spain. These are terms that are in force, in Spain the transposition of the energy community has been carried out.

In Europe, there are two different concepts: Renewable Energy Communities (RECs) according to EU Directive 2018/2001, and Citizen Energy Communities (CECs) according to EU Directive 2019/944.

The European regulation introduces two concepts of what is understood as an energy community:

- Citizen Energy Community, CEC (EU Directive 2019/944, on common rules for the internal market in electricity, Art. 16).
- Renewable Energy Community, REC (EU Directive 2018 / 2001, promotion of the use of energy from renewable sources, Art. 22).

Solar with batteries

In 2023, a historical maximum was reached in Spain with a photovoltaic coverage of 14%, which is representative enough to take this energy source as the energy source with the most development in the energy sector. In 2023, the installation record set in 2022 was surpassed.

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51 https://www.maprimerenov.gouv.fr/prweb/PRAuth/app/AIDES/BPNVwCpLW8TKW49zoQZpAw*/!STANDARD

52 https://www.ecologie.gouv.fr/politiques-publiques/dispositif-certificats-deconomies-denergie?utm_source=chatgpt.com

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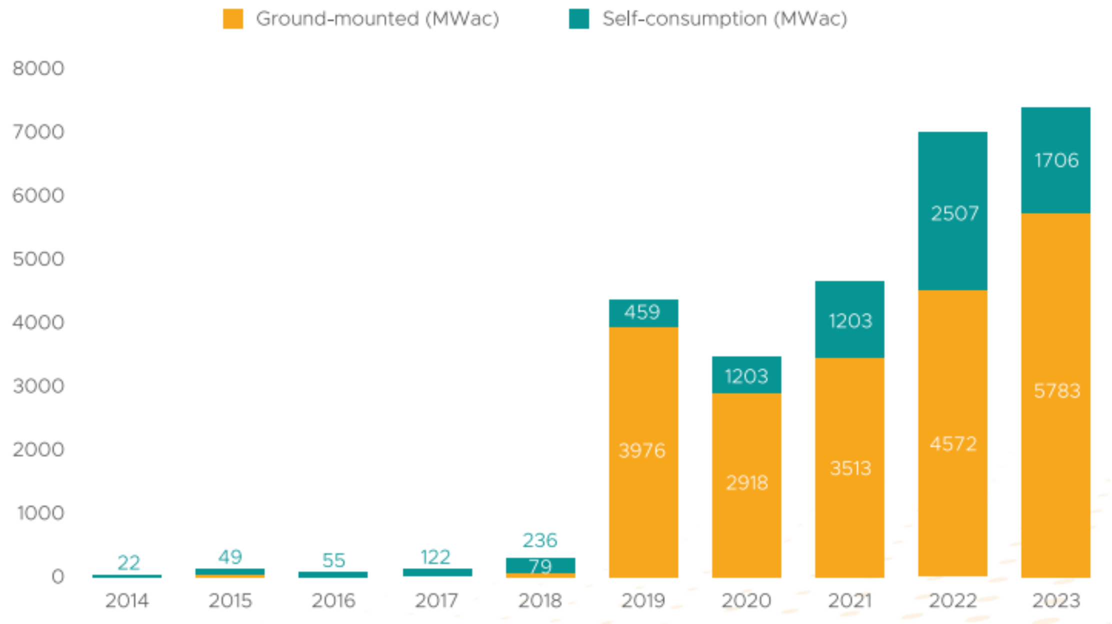

Figure 24 – Trend in photovoltaic solar power capacity in Spain (Source: Red Eléctrica de España and UNEF)[53]

With this graph we can see the evolution of photovoltaic which represents an essential part for the implementation of the same technology with the BungEES solution. This type of solution, if supported by storage batteries, gains benefits for the customer by allowing greater independence from the grid, thus giving some flexibility when consuming, being a key point in the electrification of the sector.

The objective set by the PNIEC (National Integrated Energy and Climate Plan), is the following, increasing the installed photovoltaic capacity values.

Table 13 – Objectives of Spain National Integrated Energy and Climate Plan

	MITECO – NECP 2021-2030 (GW)	Other documents Roadmaps/Strategies (GW)	UNEF Proposal 2023 (GW)	Draft NECP 2023-2030 (GW)
Photovoltaic	**39**		**70-80**	**76**
Ground-mounted			55-65	57
Self-consumption		9-14*	15	19
Storage	**17.6**	**20** (including EVs)**	**24.5**	**22**
Pumping (pure + mixed)	9.5		15.1	
Electrochemical			8	18.5
Behind-the-Meter	2.5	0.4	1.4	
Thermoelectric	5.6			3.5
Hydrogen		**4*** **	**5.8-15**	**11**

53 ANNUAL REPORT 2024_UNEF, https://www.unef.es/en/recursos-informes?idMultimediaCategoria=18

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** Self-consumption Roadmap (2021)*
*** Storage Strategy (2020)*
**** Hydrogen Roadmap (2020)*

Heat pump

Currently, Spain has been analysed according to data from the EHPA and Eurostat that Spain had 31 heat pumps per 1,000 inhabitants in 2023. In this year, around 209,000 heat pumps were sold, bringing the total figure to around 1.5 million heat pumps. With all this in Spain is at the tail of heat pumps with a score of 51.

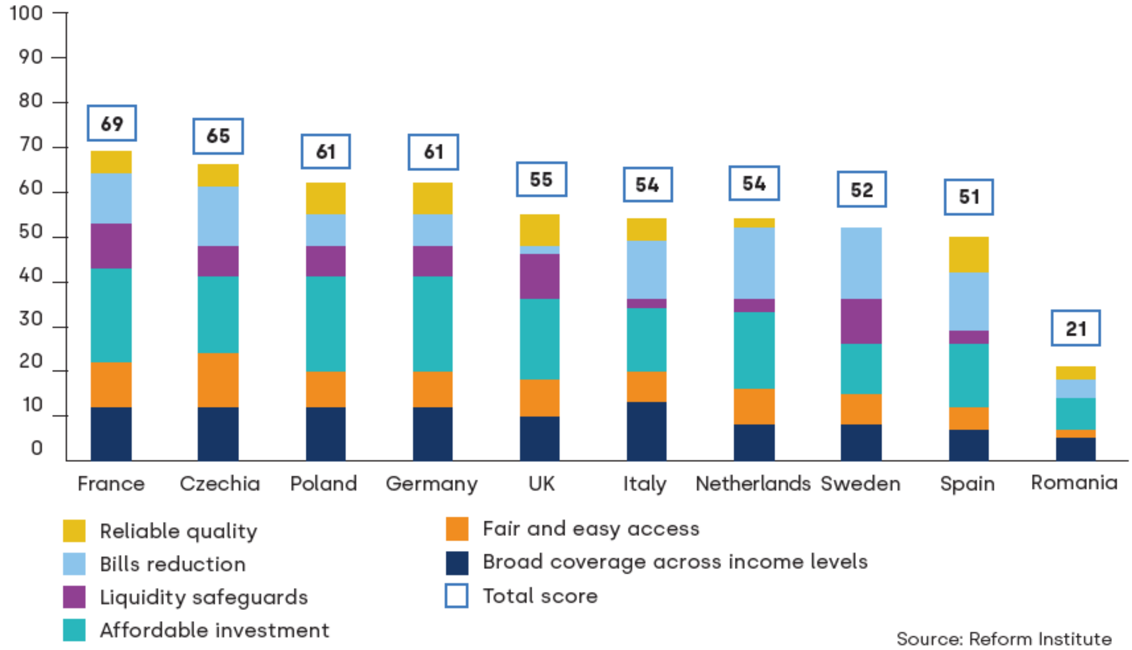

Figure 25 – Heat pumps per 1,000 inhabitants (Source: Reform Institute)

The recommendations for heat pumps in Spain are:

- Increase in the amount of subsidy available for housing on the purchase of heat pumps.
- Improve the consumer experience with better information about the subsidy scenarios.
- Implement a system where grants are awarded directly to initial costs
- Monitor installers to ensure high quality

In Spain, sales of heat pumps have been increasing from 2019 to 2023, with a growth of 13%. The subsidy system found in independent Spain in each region complicates the market. The heat pump policies are then listed by category.

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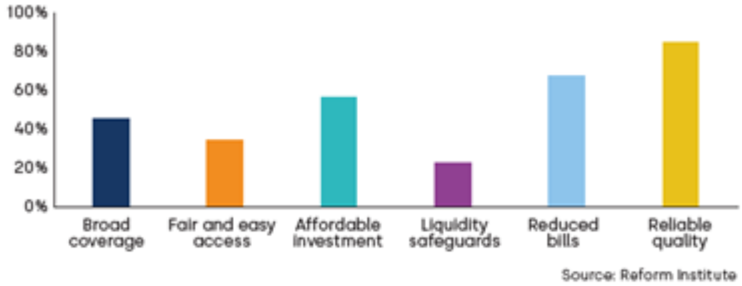

The high degree of decentralization in Spanish policy is unique and affects the grants processed on the Spanish market, currently there are the following points of subsidy:

- Energy rehabilitation program for existing buildings in municipalities of demographic challenge (PREE 5000), governed by Royal Decrees 691/2021 and 1178/2023;
- Incentive program 6: realization of thermal renewable energy installations in the residential sector, governed by the Royal Decree 477/2021;
- Program of assistance to the building rehabilitation actions governed by the Royal Decree 853/2021;
- Program of assistance to the actions of improvement of energy efficiency in houses, governed by the Royal Decree 853/2021;

Even so, analyzing the heat pump sector and the goal of electrification by 2050, knowing that it is a product that is currently under development and in the implementation phase in Spain, in addition to its great value for generating flexibility due to the possibility of acting on and off, it is considered very interesting to integrate it into energy services.

Electric Mobility

During the first half of 2024 it has been seen that in Spain the electric vehicle fleet represents 1.4%, far from the targets set for 2030 in which it is expected that there will be 5.5 million.

Currently in Spain there are just over 34,000 public charging points in operation, despite the progress made in Spain we are behind in terms of the targets for the installation of charging points, which are expected to have 340,000 charging points by 2030.

The charging infrastructure at the end of 2023 in Spain was behind the targets set for electric mobility, there is a total of 30,350 charging points for the public road, which are distributed as follows:

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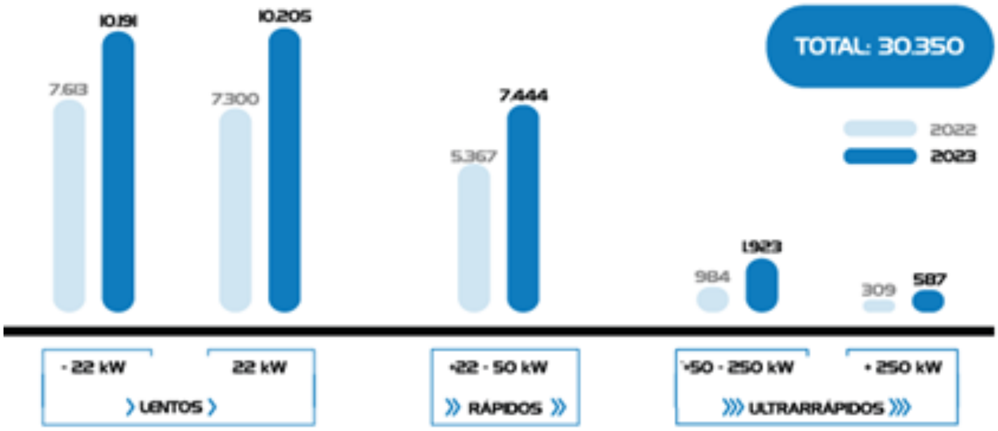

Currently in 2025, the electric mobility aids are stopped with the MOVES III plan, it is expected that the same plan will be updated or the creation of a MOVES IV plan.

National specifics for package selection - Portugal

Selected EES packages

- **Reduction of energy consumption, reduction of energy costs -> Through aggregation services/energy communities and, solar PV.**

The Portuguese regulation for the electric sector is available at the Portuguese Energy Sector Regulator ERSE[54] (Entidade Reguladora do Setor Elétrico em Portugal in Portuguese). The regulation available (see foot note) defines the organization and operation of the national electricity system. Within this regulation the role, duties and responsibilities of aggregator and last resource aggregator are defined. These two entities can be defined as:

Aggregator - The activity of electricity aggregation, which consists of combining consumption flexibility, stored electricity, electricity produced or consumed by multiple customers, for purchase or sale on electricity markets and/or by bilateral contracting, is carried out under free competition and is subject to registration, under the terms of section ii of this chapter.

Last resource aggregator - The activity of the aggregator of last resort, which consists of the obligation to purchase electricity from renewable energy producers and self-consumers who inject surplus energy into the RESP, as well as the purchase of electricity from producers who benefit from guaranteed remuneration schemes or other subsidised remuneration support schemes, is regulated and subject to a licence, under the terms of section iii of this chapter.

54 ERSE- Entidade Reguladora do Setor Elétrico em Potugal, https://www.erse.pt/media/0zvcv5ou/legisla%25C3%25A7%25C3%25A3o_energia_final_21mar2022.pdf

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At the website of the National General Directorate of Energy[55] there a list of companies that are qualified to develop the aggregation activity in Portugal. More than 50 companies are registered as aggregators, but it is not clear how many are working in that activity.

Concerning energy communities in 2019 Portugal introduced a framework (decree-law DL 162/2019) for self-consumption of renewable energy on individual and collective level and Renewable Energy Communities (REC)[56]. This decree law partially transposes the Renewable Energy Directive (REDII). Previously, self-consumption was limited to the individual level (DL 153/2014). Since January 2020, individual and collective self-consumption projects and projects for collective self-consumption in RECs are possible as far as they have a smart energy metering system and are installed at the same voltage level. The 2019 decree law adopts the major lines of the REDII in terms of membership, possible activities etc. and the need to form a legal person. Network tariffs for self-consumption using the public network are already in place, currently regulated by the Self consumption regulation establishing the methodology (RAC, Regulation nº 266/2020) and the Directive nº 1/2021 establishing the specific tariff levels. For collective self-consumption schemes connected by the public power grid the tariff for the self-consumed energy is calculated considering only the tension level used (for self-consumed energy e.g. within a REC on low voltage, only the low voltage network tariffs are used). If a self-consumption installation is located at a voltage level where reverse flows occur (i.e. from lower to higher voltage levels), the deduction of network use tariffs of higher voltage levels might be only partial. However, in practice, this is so far negligible. In June 2020, a new law was published that exempts collective self-consumption schemes to different extents from paying an element of the network charges called Costs of General Economic Interest (CIEG in Portuguese). For individual self-consumption projects, 50% of CIEG costs are discounted, for collective self-consumption (including in but not limited to RECs) 100%. The CIEG are the costs of energy policy, environmental or general economic interests associated with the production of electricity and the costs of sustainability of markets (Ministry order n.º 6453/2020).

- **Reduced water consumption/waste -> Using high-efficiency appliances, namely washing machines and dishwashers**

Currently in Portugal there are no specific programmes targeting this issue, only one energy supplier (EDP Comercial) has its one program where clients can purchase this type of appliances (washing machines and dishwashers) and pay for them in soft monthly instalments with no interest. There is a huge opportunity for this service that both promotes the sales of high-efficiency appliances and helps to support the efforts of reducing wasted drinking water. Indirectly saving water also creates energy savings in water transport and purification systems.

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55 https://www.dgeg.gov.pt/pt/areas-setoriais/energia/energia-eletrica/atividades-e-profissoes/no-setor-eletrico-nacional/agregadores-de-eletricidade-em-regime-de-mercado/

56 Energy communities in Portugal https://energy-communities-repository.ec.europa.eu/document/f3380445-13fe-4bf3-a363-99c69643e7b2_en

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- **Electricity storage -> Battery storage systems**

Like most member states, Portugal has no specific legislation on storage, and its use is covered by legislation on electricity generation and self-consumption. In Portugal the strategy used in buildings to store energy lies on two approaches:

charging the storage system directly from the grid in periods where the electricity prices are lower (during the night);

Using a solar system, which can directly charge the storage systems or using the surplus energy not consumed in the building to charge the storage systems.

The most cost-effective way to use the energy harvested by the storage systems is to consume it locally in the building rather than selling into the grid because the available feed-in tariff is not attractive. The feed-in tariff is 80% lower than the average consumption tariff. Due to this fact, in Portugal B2G is still not attractive and is low-profitable for buildings but it is a cost-effective solution to reduce the building peak demand from the grid. There is information regarding the use of battery storage systems at energy community level.

In 2024 the Portuguese Recovery and Resilience Fund opened a call for proposals for network and storage flexibility[57]. This grant aims to install at least 500 MW of energy storage capacity in the electricity grid (both at the transmission and distribution levels) by the end of 2025.

The eligible projects for financing can go up 30 million euros (up to 20% of the eligible costs can supported by the environmental fund). This call for proposals was launched to respond to the growing need to optimize and manage the electricity grid with flexibility, especially in light of the current geopolitical situation and its impacts on the energy markets. The installation of these storage systems will be battery-based, and their capacity must be allocated in such a way that maximizes the viability of potential interest within the framework of the previously allocated injection capacity reserve in the Public Service Electricity Grid. This call has a budgetary capacity of 99.75 million euros and was launched through the Environmental Fund. The call for proposals was closed in September2024 and the applications results were just made public available on January 7, 2025. 43 projects have received the green light for funding, depleting the entire environmental fund budget allocation of 99.75 million euros.

- **Improved heat pump control and indoor air quality, as well as comfort -> Using smart thermostats to improve indoor living standards and create flexibility through an accurate control of the heat pumps**

The use of smart thermostats will allow to remotely control heat pumps, avoid miss-use and monitor indoor air quality. This equipment will allow to have a more accurate management of indoor temperature and humidity, respond to power signals in high demand periods and avoid potential grid instability. The remote management of heat pumps will allow to create a new flexibility market segment due to fact that heat pump number are rapidly growing across Europe, in line with the EU strategy for building electrification and decarbonization. The

57 https://recuperarportugal.gov.pt/2024/07/31/aberto-aviso-para-armazenamento-de-energia/

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interoperability of this combined system (heat pump + smart thermostat) can also be complemented with other IoT devices (e.g. occupancy sensors, etc.) to avoid having heat pumps connected in periods without building occupancy. Additionally, smart thermostats have the capability of integrating legacy appliances (e.g. older heat pumps that are not smart ready) to improve its operational efficiency.

- **Electromobility -> The number of publicly available charging points is not growing at the same pace as Electric Vehicles (EVs).**

In Portugal there was a national charging infrastructure named Mobie Network[58] supported by the Government of Portugal. This network started with a small number of chargers around 150 in 2015. More recently the Mobie Platform integrated other partners such as energy suppliers, charging point operators, charging point holders and manufactures, etc. The Mobi.E Network, or National Electric Mobility Network, is a network of electric vehicle charging stations for universal access, interoperable and centred on the user. Currently, this network has more than 8000 charging points (in 4450 charging stations) nationwide, with more than more than 2.000 being fast or ultra-fast charging points (higher than 22kW). According to data from January 2024 in Portugal almost 400.000 battery charging procedures were made in that month which represented a 62% increase when compared to January 2023;

The charging infrastructure is also being developed with private support (e.g. hotels, petrol stations, shopping centres, etc.) and street parking charging station available in most of the medium/large cities, as well as in the coastal regions. In the interior part of the country there are less charging station available, however there is a significant increase in the number of chargers being installed in supermarkets and petrol stations which allows to say that at this moment there is an easy access to charging stations all across the country. However, due to the expected increase in the stock of EVs in the Portuguese roads it is likely that in specific locations and periods of time (mainly during summer holidays) the number of charging will increasingly be insufficient over the next years: The next figure presents a short summary on the latest available data on the Portuguese EV charging infrastructure.

4. Testing the compatibility and data analysis

Testing the compatibility of the proposed service model is being conducted within the BungEES project through pilot projects implemented in several European countries. This process is crucial for ensuring the effectiveness and adaptability of the proposed model to the various conditions and specifics of individual countries.

The pilot projects serve as practical testing platforms where the proposed measures are verified under real conditions. The insights gained from these projects allow for the gradual improvement of the model to better meet the needs and requirements of individual countries

During testing, various factors that may influence the results and effectiveness of the proposed measures within the energy-efficient service model are taken into account.

[58] Mobie Network - https://www.mobie.pt/en

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Different countries have varying energy resources, which can affect the efficiency of the proposed measures. Local climate can significantly impact the performance and effectiveness of the proposed measures. The types of technologies available and used in each country play a key role in the success of implementation. At the same time, the offered services and technologies must be adapted to the technologies in use to ensure compatibility. User habits and preferences may vary, which must be considered in the design and implementation of measures.

Experiences gained from bilateral meetings with users and experts are also a valuable source of information. Users and experts can provide valuable insights and recommendations that can lead to further improvements of the model.

4.1. Model refinement through testing

Pilot project in Czechia & Slovakia

A pilot project is underway in the Czech Republic, and the tracking of suitable objects and their analysis is currently being completed. Lists of buildings and their existing descriptions are being compiled and evaluated. Suitable buildings are identified, and the owners/users of the buildings are contacted. For the selected buildings, existing technologies are identified and their potential for a pilot project is analysed and evaluated. Installation of the technical equipment in the buildings will take place in February 2025. After installation, the pilot project will enter the next phase where monitoring and analysis of the monitoring data will take place. Based on the evaluation, the market potential in the Czech Republic and Slovakia will be calculated.

Update 02/2025: The selection of suitable locations and communication with property owners has taken place. Communication occurred from August to December 2024. Pilot installations were carried out in Prague and its surroundings, where there is a high concentration of residential buildings and suitable technical conditions.

- Total number of contacted owners/institutions: 10+;
- Declined participation: only 1 owner;
- Currently implemented installations: The pilot project was implemented in five different types of buildings: 2 family houses, 2 apartment buildings, and 1 hotel.

The following technologies were included in the pilot project:

- Heat pumps – one of the key elements in modernizing heating systems with high energy-saving potential. In the Czech environment, subsidy programs for replacing old heat sources with heat pumps are regularly announced;
- Water heaters;
- Storage stoves.

Unlike pilot projects conducted in other European countries, air conditioning systems were not tested in the Czech Republic. This decision is based on the lower usage of such devices in Czech households and the limited potential for broader application within energy-flexible services.

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Implementation is taking place throughout February 2025. During the installation, very important data and new insights are being collected for adjustments to the model. The final evaluation of the data will take place in April to May 2025. Several technical limitations had to be considered within the pilot project, which affected the selection of locations and the feasibility of installations:

- Minimum power consumption of appliances over 1 kW;
- Requirement for a three-wire electrical installation;
- Availability of electrical installation schematics and spatial limitations for the placement of equipment;
- Design and implementation of a new distribution board for each location.

Pilot project in Spain

In Spain, a pilot project is being carried out with 15 customers in the residential sector to test the concept of flexibility as a service. For the realization of this project, we are collaborating between the companies that are part of BungEES like ViaEuropa for the coordination and verification of the processes, Voltalis for the deployment of its services in Spain, Plenitude for the search of customers in Spanish market and the collaboration of Plenitude with installers in Spain for the facilitation of the installation work to its partner Voltalis.

This project has been prepared based on different climatic zones existing in Spain, the Iberian Peninsula is in an area of temperatures that are not of a homogeneous climate having a mix of different climatic areas.

In Spain, according to Köppen's classification of climatic zones, there are seven different climatic zones: Continental Mediterranean, Coastal Mediterranean, Semi-arid Mediterranean, Continental Oceanic, Coastal Oceanic, Mountain Climate, and Subtropical.

Figure 26 Köppen climate clasification

Pilot projects have been carried out in two areas located in Cantabria and Cataluña, representing two different climatic zones. The climate in the Cantabria area is a temperate climate without a dry season and with mild summers. This climate is classified as type Cfb. On the other hand, there is a different climate in Lloret de Mar, which is a humid subtropical climate classified as Cfa. This climate is close to the Mediterranean climate and is characterized by cold winters, hot summers, and variable autumns and springs in terms of both temperatures and precipitation.

4.2. Testing Against Available Technologies

In the ongoing study in Spain, various brands and models of air conditioners and heat pumps are being analyzed. The air-air heat pump units under examination include models from Mundo Clima, Mitsubishi, and Toshiba. During the study, a request was made to Mundo Clima for an additional circuit board to configure its connection with the Voltalis device.

Regarding heat pumps, the study included models from Baxi and Panasonic, both of which are fully compatible with the Voltalis solution. The specialized technicians successfully understood their functionality.

Connectivity was established at all sites without any issues, thanks to the availability of a stable telephone network in all the homes. This study aims to assess Voltalis equipment within the residential market in Spain, following its deployment there. The following equipment were used in the installation:

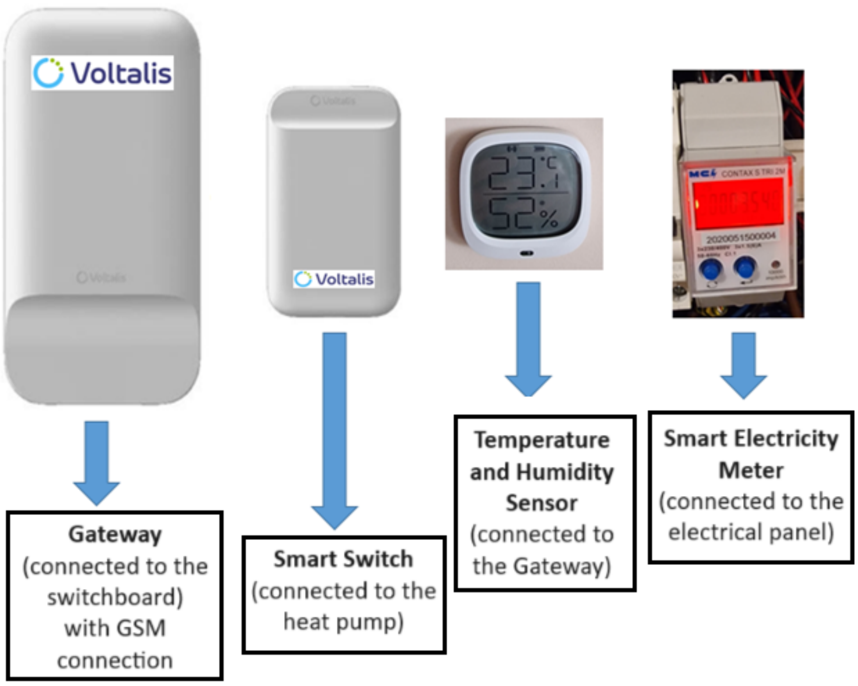

Figure 27: Voltalis Solution Devices.

- **Gateway:** This device connects to the internet via GSM, receiving commands from the Voltalis aggregation platform and transmitting them to each Smart switch. It also sends data from smart switches and energy meters to the aggregation platform.
- **Smart switch:** This device connects to the electrical equipment and communicates with the heat pump. Additionally, it sends commands to the heat pump.
- **Smart electricity meter:** This device measures the electricity consumption of the heat pump. There are 2 models of this device, for single phase and three phase configurations.

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- **Temperature and Humidity Sensor:** This device sends information namely temperature and humidity of the house to the gateway, which relays this information to Voltalis platform.

The installation process can be defined in the following steps:

- Site Check/verification
- Preparation of the electrical switch board to accommodate all the devices above mentioned;
- Installation and configuration of the Gateway;
- Installation of the smart switch on the heat pump and pairing it with the Gateway;
- If necessary, programming the heat pump;
- Perform tests to verify correct operation and remote access through the Voltalis platform;
- Provide training to the pilot house owners on the use of the Voltalis platform.

4.3. Consideration of physical constraints

When offering energy efficiency services, one may encounter a number of obstacles and barriers that can affect the success of the services provided. One of the main factors is **spatial constraints within the buildings**. Particularly in older structures, technical rooms may not have been considered during the design phase, or the layout may be inadequate or require structural modifications. The physical dimensions and arrangement of buildings can significantly limit the possibilities for installing new systems. For example, if the space for placing equipment is insufficient, it may be difficult to implement modern technologies that require specific conditions for effective operation. These limitations can lead to the necessity of seeking alternative solutions, which may prolong the project timeline and increase costs.

Similar problems can arise when installing ventilation systems. Old buildings often **lack sufficient space for the installation** of modern HVAC systems. It can be challenging to find suitable locations for air ducts, units, and other components, which may require creative solutions or adjustments to the existing layout. Older buildings may have specific structural elements, such as load-bearing walls, beam constructions, or historical details, that can restrict the possibilities for installing ventilation systems. It is important to ensure that the installation does not compromise the structural integrity of the building.

Another significant barrier is the **technical compatibility of systems**. New equipment required for providing services may not be compatible with existing technologies. This may necessitate not only modifications to existing measures but also expansions or even replacements of additional equipment. Such changes can be costly and time-consuming, which may deter potential customers from investing in energy efficiency. Just as technology compatibility is crucial, it is also important to monitor the compatibility between new technologies and existing technical installations. For example, when replacing a heat source, it is necessary to consider the requirements for the distribution systems. Heat pumps typically operate at lower heating water temperatures than, for instance, original coal boilers. While coal boilers can supply water at temperatures of 70-80 °C, heat pumps often function

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effectively at temperatures around 35-55 °C. This may require adjustments in the distribution system to ensure effective heat distribution. Given the lower temperatures used by heat pumps, different types of radiators or underfloor heating may be needed. For instance, underfloor heating is often more suitable for heat pumps as it allows for efficient heating at lower temperatures. The piping and distribution systems may need to be resized to meet the specific flow and pressure requirements of the heat pump system. This may involve replacing existing pipes with larger diameters or using different materials that better suit the new system.

Connecting to the public electricity grid presents another barrier. Limitations on connecting additional renewable sources, such as photovoltaic systems, to the public electricity grid may result from efforts to maintain grid stability. In many cases, modernization or expansion of the grid is necessary to support new technologies and ensure their effective integration. This need can lead to additional costs and delays in project implementation.

The **availability of technology** is another factor that can influence the offering of energy efficiency services. While it is assumed that there are minimal differences in technology availability within the EU due to the open market, in practice, there may be regional specifics that affect the supply and availability of specific technologies. This may mean that some innovative solutions are not easily accessible in certain areas, which can limit the possibilities for implementing projects aimed at increasing energy efficiency.

4.3.1. Advanced Analytics Capabilities

In certain installations, challenges were encountered where two devices were connected to the same breaker, preventing the accurate implementation of Voltalis technology. This configuration led to invalid readings from the measurement device, as other connected devices interfered with the direct measurement of the target appliance's energy consumption. To achieve precise measurement and control, it is essential to have a separate circuit for each device, often necessitating additional modifications to the existing in-house wiring.

Moreover, access to some indoor appliances was restricted due to their placement within roofs or walls. Addressing these access issues would have required significant structural alterations, which were not acceptable to the clients.

4.4. Understanding Consumer Journeys

In today's world, where we are increasingly focused on sustainability and environmental protection, services aimed at energy efficiency are becoming a key tool for households that want to optimize their energy consumption. The use of modern technologies and strategies in energy savings and energy flexibility allows users to better respond to dynamic changes in the energy market and contribute to the protection of our planet.

Among the main motivations for users to consider energy efficiency services are:

Energy Cost Savings
One of the fundamental reasons for utilizing these services is the reduction in energy needs and the associated savings on energy costs. Users who invest in energy-efficient technologies, such as LED lighting, efficient appliances, or quality insulation, can expect a significant

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decrease in their monthly energy expenses. Energy-efficient devices and technologies often require less maintenance and have a longer lifespan. For example, modern high-efficiency appliances are designed to operate more efficiently and have a lower likelihood of failure, which reduces repair and replacement costs.

Increased Comfort
Enhancing comfort is another key reason why users opt for energy efficiency services. Energy-efficient heating, cooling, and ventilation systems ensure that the indoor environment is pleasant and stable. Quality building envelope insulation increases thermal comfort and reduces cold radiation from cold walls. Energy-efficient buildings often include high-quality insulation materials that help reduce outside noise, creating a quieter and more pleasant environment for work, relaxation, and family life. Modern energy-saving lighting, such as LED bulbs, not only saves energy but also provides better light quality. Users can easily adjust the intensity of the lighting to create a pleasant atmosphere according to their needs and preferences. Modern temperature control technologies help maintain optimal temperatures in the home, ensuring that heating and ventilation systems adapt to user requirements and respond quickly to changes, contributing to the comfort of residents.

Environmental Protection
Many users may be motivated to change for environmental reasons. The main benefit of the services offered is the reduction in energy consumption, which directly leads to lower greenhouse gas emissions, such as carbon dioxide (CO2). These emissions are a major factor in global warming and climate change. When users invest in energy-efficient technologies, such as renewable energy sources (e.g., solar panels) or efficient appliances, they contribute to the overall reduction of emissions and climate protection. By reducing energy consumption, the demand for fossil fuels, such as coal, oil, and natural gas, is also decreased. These resources are not only depleting, but their extraction and combustion have devastating impacts on the environment, including air and water pollution. Including the installation of renewable energy sources among the measures taken contributes not only to reducing the use of fossil fuels but also leads to self-sufficiency and reduces both the user's energy dependence and the state's dependence on energy imports.

Engagement in Energy Flexibility Principles
Just as increasing energy efficiency leads to reduced energy costs, utilizing energy flexibility and timing consumption also leads to lower costs. Energy flexibility allows users to optimize their energy consumption based on real-time energy prices. Users can take advantage of cheaper tariffs during periods of low demand, thereby reducing their energy bills. Users can store excess energy generated during sunny or windy periods and use it later, increasing their energy independence. Users who participate in flexible programs can contribute to stabilizing the energy grid, which enhances the reliability of energy supply and reduces the risk of outages.

Other motivations may include:

- **Increased Property Value**: Investments in energy-efficient technologies and renovations can increase property value, making it more attractive for future sale or rental.

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- **Access to Grants and Subsidies**: Users may have the opportunity to receive financial support for implementing energy-saving projects.
- **Education and Awareness**: Utilizing these services can provide users with valuable information and knowledge on how to manage energy more efficiently and what technologies are available.

4.4.1. Consumer Usage Patterns

Plenitude has access to customer consumption data, which is provided by the distributor. Although this data is not received in real-time, it enables Plenitude to identify consumption patterns across different areas, segmented by periods and days. This historical data allows for the forecasting of future consumption for customers.

However, in the pilot project with Voltalis, not all participants were Plenitude customers. Consequently, it was not possible to collect energy consumption data or analyse consumer usage patterns before the installation of the Voltalis device.

Additionally, Voltalis remotely monitors clients' energy consumption through its connected technology. It can also send commands to temporarily pause device operations, enabling clients to achieve energy savings without any impact on the client’s comfort.

5. Assessment of NEBs and other non-energy services to be integrated in the smart EES package

In the previous chapters, possible services for the EES model expanded with energy flexibility have been selected and described. A detailed description and summary of the activities carried out within Task T.2.5 are provided in Deliverable D2.4, which focuses on the development of a Catalogue of Non-Energy Services for integration into smart energy efficiency (EE) services. The aim was to identify technical solutions used within energy savings performance contracts to assess non-energy benefits that are not sufficiently described at the national or European level. The catalogue provides a comprehensive overview that details and evaluates NEBs that can be transformed into services, along with other related NEBs. The primary goal of the catalogue is to support providers of smart energy services in improving their business and financial models. By incorporating these NEBs and non-energy services into their commercial offerings, providers can diversify and enhance the value proposition of their services, which is expected to lead to more innovative and attractive offerings for customers.

5.1. NEBs as services with own revenue streams.

In the area of energy efficiency and sustainability, the focus is mostly on the concept of energy savings and the associated financial savings, with an expanding view to include the concept of "Non-Energy Benefits" (NEB), which are benefits that are not directly related to energy savings but arise as a side effect of implementing energy efficiency measures. These benefits can range from improved air quality and reduced maintenance costs to increased user comfort and economic benefits for local communities.

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This sub-chapter will focus on how NEBs can be provided as stand-alone services and can become the subject of service offerings. NEBs become not only a benefit to the user but also a significant source of revenue for service providers.

5.1.1. Monetisation of NEBs

Within the NEBS, different services have been proposed, including payment protection services and technical services for the maintenance of household appliances.

As far as payment protection is concerned, the benefits can be detailed below, being a service that provides the client with a monthly payment of a residual amount to protect a series of bills in case of unemployment, sick leave, hospitalisation, illness, etc. The monthly payment is a value of around one euro per month, so for the client it is not a large monthly outlay, but he obtains a great value service to be able to protect some type of bill in case he has no income like electric bills, water bills or other type of periodic bills.

On the other hand, it is possible to offer the customer maintenance services for household appliances, thus having a small monthly cost for the customer to cover the repairs of this type of appliances such as refrigerators, dishwashers, ovens, air conditioners, etc., being interesting for customers and that they do not have to worry about the maintenance of their appliances. This is a product that can be included very well in the general service of FlexiSmart Home as it could develop comprehensive maintenance for all products and cover the needs of the customers.

Non-Energy Benefits (NEBs) of energy-efficient measures represent a wide range of positive impacts that go beyond mere energy savings. These include improvements in indoor environmental quality, increased productivity, reduced greenhouse gas emissions, and enhanced public health. Although these benefits have clear value, their financial expression and inclusion in economic analyses is not straightforward.

Monetizing NEBs poses a challenge primarily due to their diversity and difficult measurability. Many of these benefits manifest indirectly and over the long term, complicating their valuation. Nevertheless, various approaches exist to quantify these values and integrate them into decision-making processes.

The following monetization methods are particularly suitable for assessing and monetizing non-energy benefits:

Willingness-to-Pay, Increased Attractiveness
This method is based on observing user/customer behavior and their willingness to pay for certain services. In the case of energy services, it is possible to track the difference in customers purchasing services at certain prices and, based on observations, establish a higher or lower price. Non-energy benefits and services will, in this case, serve as a complement to energy services, which can be more easily monetized, while also being the main focus for the customer.

Value of Time
This is based on the assumption of time savings and the valuation of time based on local or national economies. Within the offered services, it is particularly suitable for services related to the installation of technical devices that facilitate control, clarify provided information, or

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replace technology with simpler and less time-consuming alternatives. Monetization then occurs based on the potentially saved time.

Cost of Illness
This method quantifies financial savings associated with a decrease in health issues due to energy measures. For example, a reduction in the incidence of respiratory diseases due to better air quality can lead to lower healthcare costs. In connection with services offered for residential buildings, this is relevant but difficult to track; detailed data would need to be available to determine benefits in terms of time savings, healthcare costs, and so on.

Reduction in Maintenance Costs
New technologies and materials that are part of energy-saving measures often require less maintenance than older systems. For instance, modern boilers and air conditioning units have longer lifespans and lower service demands. Savings on maintenance can be quantified as a reduction in repair and regular maintenance costs, which increases the overall profitability of investments in energy-efficient solutions; this profitability can be offset by increased service prices and a certain type of monetization of benefits.

5.2. Cost and revenue analysis of selected services for detailed service model

The aim of the case studies was to find and assess, from a practical point of view, the costs for the proposed measures and the associated services offered, and also to show possible sources of revenue to finance the implementation of the cost-saving measures and profit.

On the sheet of each case study is a detailed list of services and the related cost-saving measures implemented, a cost calculation based on the available data and knowledge of the consortium, and a revenue calculation.

Description of the case study object

For the case studies, two basic types of buildings were selected: a family house and an apartment building. The size and technical parameters of the buildings were chosen based on knowledge as typical representatives of buildings in Europe. Any differences from the case study buildings are described separately for each country.

Table 14 – Parameter of case study buildings

Parameters of buildings	Family house	Apartment house
Width	10.5	15.5
Length	8.5	18
Height	6	16.5
number of floors above ground	2	5
External volume of the heated part	439	4615
External Wall area	141	923
Roof area	64	252
Area of opening fillings (windows + doors)	32.4	196
floor area	90	279
area of envelope structures	327.4	1650
energy reference area	180	1393

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building form factor A/V	0.745786	0.35753
total internal floor area	158	1305

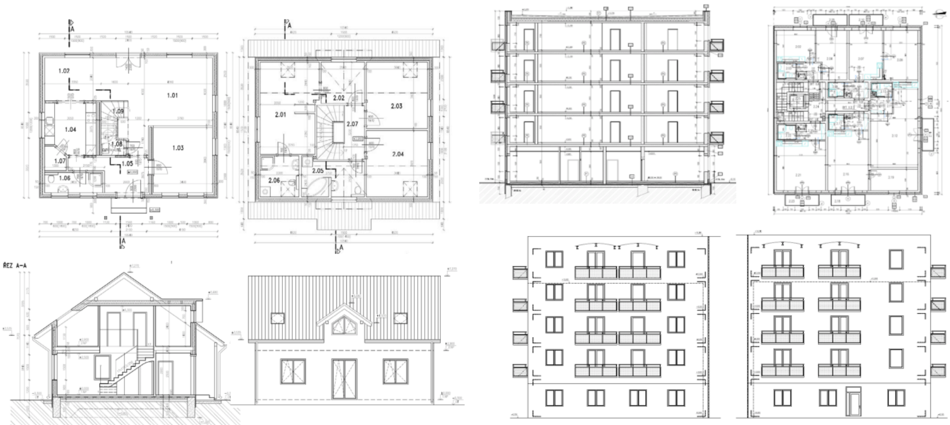

Figure 28 – Scheme of case study buildings

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Case study - Czech Republic - Family House					
Description of proposed measures and services					
- Insulation of the building envelope and replacement of the window openings. *Increase in average heat transfer coefficient* $U_{window} = 1.2\ W/m^2K$, $U_{wall} = 0.25\ W/m^2K$, $U_{roof} = 0.16\ W/m^2K$ *Reduction of annual heat demand HD1 = 45 MWh/year >>> HD2 = 7.11 MWh/year* - Replacement of heat source - Installation of heat pump - Installation of smart meters - Management of permits and supervision, administrative tasks for obtaining subsidies					
Costs					
> Costs and revenues are considered from the perspective of the service provider					
Initial investment to provide services					
- Building modifications (insulation of the building envelope)				53 700	€
- Replacement of building openings				11 350	€
- Purchase of technical equipment (heat pump, sensors)				4 800	€
- Management (salaries and material)				800	€
Additional costs per year (in the course of service provision)					
- Equipment maintenance costs (materials and salaries)				40	€/year
Revenues					
Initial income from the customer (co-investment)					
-				0	€
Granted subsidies					
- New green savings programme				34 900	€
Regular monthly revenues					
- Regular payment for maintenance service				96	€/year
Revenue from energy savings					
Energy cost savings after measures and services				4140	€/year
(Difference between the original situation and after the implementation of the savings measures)					
Electricity	-7 MWh/year	180	€/MWh	-1 260	€/year
Gas	45 MWh/year	120	€/MWh	5 400	€/year
Simple payback period				**8.52**	**Years**
ROI 5 years				-20.8	%
ROI 10 years				8.7	%
ROI 20 years				38.2	%

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Case study - Czech Republic – Apartment Building						
Description of proposed measures and services						
- Insulation of the building envelope and replacement of the window openings. *Increase in average heat transfer coefficient* $U_{window} = 0.8\ W/m^2K$, $U_{wall} = 0.18\ W/m^2K$, $U_{roof} = 0.15\ W/m^2K$ *Reduction of annual heat demand HD1 = 265 MWh/year >>> HD2 = 27 MWh/year* - Replacement of heat source - Installation of heat pump - Installation of a central air condition unit with heat recovery - Installation PVE panels on roof - Installation of smart meters - Management of permits and supervision, administrative tasks for obtaining subsidies						
Costs						
> Costs and revenues are considered from the perspective of the service provider						
Initial investment to provide services						
- Building modifications (insulation of the building envelope)					264 800	€
- Replacement of building openings					86 000	€
- Purchase of technical equipment (heat pump, sensors)					12 160	€
- Installation of Ventilation systems					34 192	€
- Replacing light sources with energy-saving LEDs					18 400	€
- Management (salaries and material)					1 440	
Additional costs per year (in the course of service provision)						
- Equipment maintenance costs (materials and salaries)					956	€/year
Revenues						
Initial income from the customer (co-investment)						
-					0	€
Granted subsidies						
- New green savings programme					181 480	€
Regular monthly revenues						
- Regular payment for maintenance service					1 200	€/year
Revenue from energy savings						
Energy cost savings after measures and services					26 940	€/year
(Difference between the original situation and after the implementation of the savings measures)						
Electricity	-27	MWh/year	180	€/MWh	-4 860	€/year
Gas	265	MWh/year	120	€/MWh	31 800	€/year
…		MWh/year		€/MWh	0	€/year
Simple payback period					**8.66**	**Years**
ROI 5 years					-23.6	%
ROI 10 years					8.5	%
ROI 20 years					39.9	%

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Description of the case study object in Slovakia

Initial state

Type of building: Family building
Dimensions (WxLxH): 8,71 x 9,67 x 8,22 m
Window area: 21,28 m2
Wall area: 143,3876 m2
Roof area: 109,14 m2
Annual heat demand: 5500kWh electrical energy + 3500 kWh gas + 1,5m3 wood
Energy reference area: 168,46 m2 - floor area

Number of floors: 2
Number of residents: 2

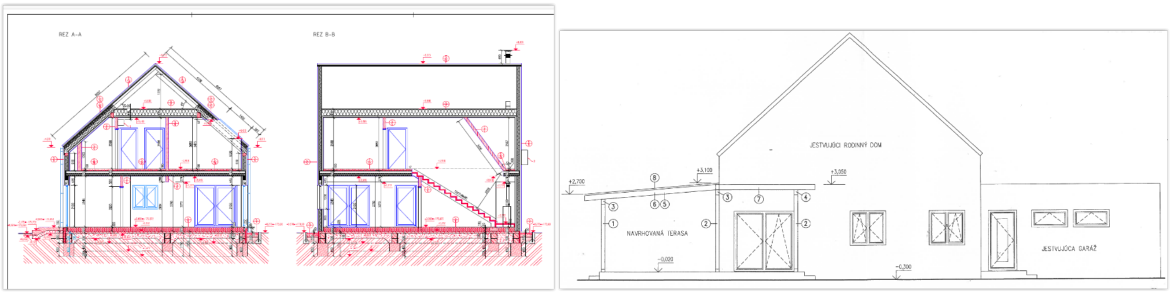

Figure 29 - illustration of the object

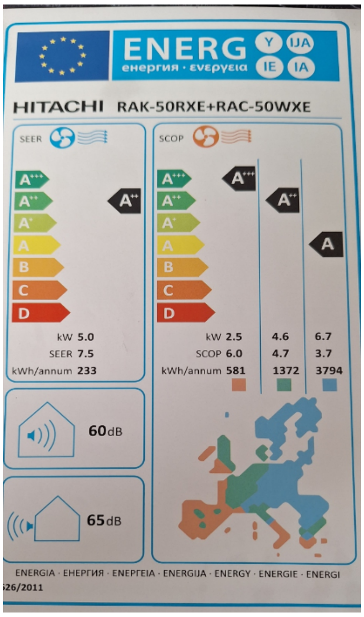

Figure 30 - Energy label for the installed Hitachi air conditioning unit

Specification of costs

PV: total number of panels: 9x 440Wp and 14x475Wp with maximum power Ppmax 3960 + 6650 Wp
Battery storage: 3x DEYE SE-G5.1 Pro-B with a total capacity of 15.3kWh
Air conditioning: indoor unit RAK-50RXE, outdoor unit RAC-50WXE. Cooling capacity 5 kW and heating capacity 6.7.

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Case study - Slovakia – Family House		
Description of proposed measures and services		
- Currently the family house is heated by gas. Measures: Photovoltaic power plant Battery storage Air-conditioning for cooling and heating at times without temperature below zero.		
Costs		
> Costs and revenues are considered from the perspective of the service provider		
Initial investment to provide services		
- Purchase of PV system with capacity on the DC side of 10 610kWp with an expected output power on the AC side of 9 550W	9 827.52	€
- Purchase of 3x5.1kWh battery storage	3 960	€
- Buying a Hitachi air conditioning unit	2 100	€
Revenues		
Granted subsidies		
- Subsidy	2 000	€
Regular monthly revenues		
- On photovoltaics per month it is estimated to save €76.50 from €84.75 monthly payment for electricity	1 200	*€/year*
- Savings on gas estimated at €6.25 per month		
Simple payback period	**13.99**	**Years**
ROI 5 years	-56.2	%
ROI 10 years	-24.9	%
ROI 20 years	6.3	%

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Case study - France - Family House					
Description of proposed measures and services					
- Insulation of the building envelope and replacement of the window openings. *Increase in average heat transfer coefficient* *U_{window} = 1.9 W/m²K, U_{wall} = 0.3 W/m²K, U_{roof} = 0.19 W/m²K* *Reduction of annual heat demand HD1 = 45 MWh/year >>> HD2 = 11.8 MWh/year* - Replacement of heat source - Installation of heat pump of 8 kW (thermal power) with a SCOP = 3.29 (at 55°C for circulating water)					
Costs					
> Costs and revenues are considered from the perspective of the service provider					
Initial investment to provide services					
- Building modifications (insulation of the building envelope)				40 000	€
- Replacement of building openings				8 500	€
- Purchase of technical equipment (heat pump, sensors)				7 490	€
Additional costs per year (in the course of service provision)					
- Heat pump maintenance yearly contract				250	€/year
Revenues					
Granted subsidies					
-				5 000	€
Revenue from energy savings					
Energy cost savings after measures and services				4140	€/year
(Difference between the original situation and after the implementation of the savings measures)					
Electricity	11 MWh/year		216 €/MWh	2 376	€/year
Gas	45 MWh/year		124,12 €/MWh	5 585	€/year
…	MWh/year		€/MWh	0	€/year
Simple payback period				**6.61**	**Years**
ROI 5 years				-21.7	%
ROI 10 years				44.7	%
ROI 20 years				108.3	%

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Case study - France – Apartment Building					
Description of proposed measures and services					
- Insulation of the building envelope and replacement of the window openings. *Increase in average heat transfer coefficient* *U_{window} = 1.5 W/m^{2}K, U_{wall} = 0.25 W/m^{2}K, U_{roof} = 0.15 W/m^{2}K* *Reduction of annual heat demand HD1 = 265 MWh/year >>> HD2 = 27 MWh/year* - Replacement of heat source - Installation of heat pump of 70 kW					
Costs					
> Costs and revenues are considered from the perspective of the service provider					
Initial investment to provide services					
- Building modifications (insulation of the building envelope)				262 000	*€*
- Replacement of building openings				47 700	*€*
- Purchase of technical equipment (heat pump, sensors)				30 000	*€*
- Installation of Ventilation systems				40 000	*€*
Additional costs per year (in the course of service provision)					
- Equipment maintenance costs (materials and salaries)				500	*€/year*
Revenues					
Granted subsidies					
-				9 000	*€*
Revenue from energy savings					
Energy cost savings after measures and services				38 723	*€/year*
(Difference between the original situation and after the implementation of the savings measures)					
Electricity	27	MWh/year	216 €/MWh	5 832	*€/year*
Gas	265	MWh/year	124 €/MWh	32 892	*€/year*
…		MWh/year	€/MWh	0	*€/year*
Simple payback period				**9.70**	**Years**
ROI 5 years				-47.0	%
ROI 10 years				3.0	%
ROI 20 years				52.3	%

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Case study - Portugal - Family House						
Description of proposed measures and services						
- Insulation of the building envelope and replacement of the window openings. *Increase in average heat transfer coefficient* *U_{window} = 1.2 W/m²K, U_{wall} = 0.25 W/m²K, U_{roof} = 0.16 W/m²K* *Reduction of annual heat demand HD1 = 45 MWh/year* - Replacement of heat source - Installation of heat pump - Management of permits and supervision, administrative tasks for obtaining subsidies						
Costs						
> Costs and revenues are considered from the perspective of the service provider						
Initial investment to provide services						
- Purchase of technical equipment (heat pump, sensors)					6 000	*€*
- Replacement of building openings					5 184	*€*
Additional costs per year (in the course of service provision)						
- Equipment maintenance costs (materials and salaries)					50	*€/year*
Revenues						
Granted subsidies						
-					7 500	*€*
Revenue from energy savings						
Energy cost savings after measures and services					850	*€/year*
(Difference between the original situation and after the implementation of the savings measures)						
Electricity	-10	MWh/year	290	€/MWh	-2 900	*€/year*
Gas	25	MWh/year	150	€/MWh	3 750	*€/year*
...		MWh/year		€/MWh	0	*€/year*
Simple payback period					**4.61**	**Years**
ROI 5 years					2.8	%
ROI 10 years					36.9	%
ROI 20 years					69.7	%

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Case study - Portugal – Apartment Building							
Description of proposed measures and services							
- Insulation of the building envelope and replacement of the window openings. - Replacement of heat source - Installation of heat pump - Installation of smart meters							
Costs							
> Costs and revenues are considered from the perspective of the service provider							
Initial investment to provide services*							
- Building modifications (insulation of the building envelope)						35 250	*€*
- Replacement of building openings						31 360	*€*
- Purchase of technical equipment (heat pump, sensors)						81 000	*€*
Additional costs per year (in the course of service provision)							
- Equipment maintenance costs (materials and salaries)						500	*€/year*
Revenues							
Granted subsidies**							
-						121 250	*€*
Revenue from energy savings							
Energy cost savings after measures and services						3 500	*€/year*
(Difference between the original situation and after the implementation of the savings measures)							
Electricity	-50	MWh/year		290	€/MWh	-14 500	*€/year*
Gas	120	MWh/year		150	€/MWh	18 000	*€/year*
…		MWh/year			€/MWh	0	*€/year*
Simple payback period						**8.79**	**Years**
ROI 5 years						-7.6	%
ROI 10 years						2.4	%
ROI 20 years						12.0	%

**Initial investment to provide services*
Considering air to air heat pumps (3 units per apartment and a total of 15 apartments- 3 per floor)

***Granted subsidies*
7500€ is the maximum amount for granted subsidies per apartment (for windows and heat pumps) and the building can have a grant up to a maximum of 8750 for insulation improvement in the facades

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Case study - Germany - Family House		
Description of proposed measures and services		
- Installation of Air-source heat pump in family house to provide heating services - Heat pump capacity: Approx. 10 – 12 kW based on annual heat demand and building size.		
Costs		
> Costs and revenues are considered from the perspective of the service provider		
Initial investment to provide services		
- Purchase of technical equipment (heat pump, sensors)	35 000	€
Revenues		
Granted subsidies		
- Subsidies for Heat pump	17 500 – 20 000	€
Revenue from energy savings		
Electricity price (2025): Approx. €0.30/kWh. Gas price (2025): Approx. €0.12/kWh. Annual electricity consumption: "Electricity consumption"="Heat demand" /"COP" =21,240/3.5=6,069 "kWh/year" (COP=3,5 assumption) Annual electricity cost: "Cost"=6,069×0.30=€1,821 Annual gas consumption: "Gas consumption"="Heat demand" /"Efficiency" =21,240/0.9=23,600 "kWh/year" (Efficiency=90%) Savings="Gas cost"-"Electricity cost"=€2,832-€1,821=€1,011 "Payback period"=€35,000/€1,011=34.6 "years" (Without subsidies) "Payback period"=€17,500/€1,011=17.3 "years" (With subsidies)		
PVE installation		
If paired with solar PV to reduce electricity costs by ~30%, annual savings increase to ~€1,300–€1,500/year.		
Payback period (without subsidies)	**34.6**	**Years**
Payback period (with subsidies)	**17.3**	**Years**
Payback period (with subsidies) – with PV savings	**11.7**	**Years**

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List of services in the case studies

- Insulation of the building envelope and replacement of the window openings
- Replacement of heat source - Installation of heat pump
- Installation of smart meters
- Management of permits and supervision, administrative tasks for obtaining subsidies
- Installation PVE panels on roof
- Battery storage
- Installation of a central air condition unit with heat recovery

Benefits of provided services

Insulation of the building envelope and replacement of window openings	▪ Reduction of heat loss in the building ▪ Lower heating and cooling costs ▪ Increased living comfort (fewer temperature fluctuations, elimination of drafts) ▪ Better acoustic insulation ▪ Increased property value
Replacement of heat source - Installation of a heat pump	▪ Significant reduction in heating and hot water costs ▪ Use of renewable energy sources (e.g., electricity from PV) ▪ Higher energy efficiency compared to traditional boilers ▪ Lower CO_2 emissions, more environmentally friendly operation ▪ Compatibility with underfloor heating for enhanced comfort
Installation of smart meters	▪ Clear and detailed data on energy consumption ▪ Possibility to optimize consumption and reduce costs ▪ Automated real-time monitoring and control of energy use ▪ More accurate billing based on actual consumption ▪ Integration with other smart home technologies
Management of permits and supervision, administrative tasks for obtaining subsidies	▪ Time savings and reduced administrative burden ▪ Higher chances of obtaining subsidies, lowering investment costs ▪ Professional oversight of the entire process, minimizing errors ▪ Compliance with legal and regulatory requirements ▪ Faster project implementation
Installation of PV panels on the roof	▪ Reduced dependence on electricity suppliers ▪ Possibility of achieving energy self-sufficiency ▪ Significant reduction in electricity costs ▪ Environmentally friendly energy production, lower carbon footprint ▪ Ability to sell surplus electricity back to the grid
Battery storage	▪ Increased utilization of self-produced electricity ▪ Ability to store energy for use during peak demand ▪ Backup power supply in case of outages ▪ Reduced dependence on the distribution grid ▪ Better energy management and tariff optimization
Installation of a central air conditioning unit with heat recovery	▪ More efficient cooling and heating of the building ▪ Reduced thermal losses through heat recovery ▪ Improved indoor air quality, prevention of moisture and mold ▪ Enhanced comfort through stable temperature and air filtration ▪ Energy savings compared to conventional air conditioning systems

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Because of the combination of energy and non-energy services, energy savings are not always the main benefit. The following indicators show the dependence of the payback period of energy saving measures on the amount of the initial investment (including the reduction for subsidies) and the dependence of the subsidies provided on the amount of investment from energy saving measures.

Payback period on Investment

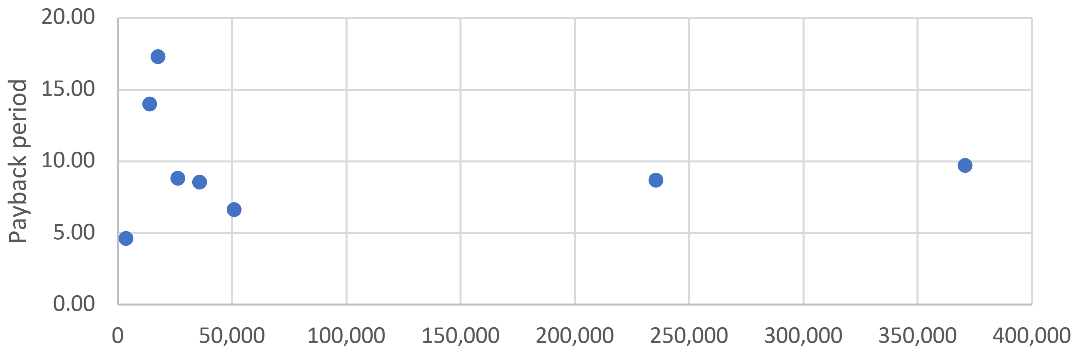

Figure 31 - Dependence of Payback Time on Investment

The case studies show that the return on investment is not primarily dependent on the amount of investment, but rather on the type of measure that is provided and the energy savings that are achieved. Energy savings and their monetisation have a much greater impact than the monetisation of non-energy services and their benefits. Their value is also clearer to the customer and it is possible that they will prefer visible energy savings in their decision making rather than non-energy benefits, whose benefits will be partly subjectively assessed and only visible after a longer period of time.

Subsidies on Investment

The graph of the dependence of subsidies on the initial investment needed shows a clear trend. Each country approaches the subsidy system individually.

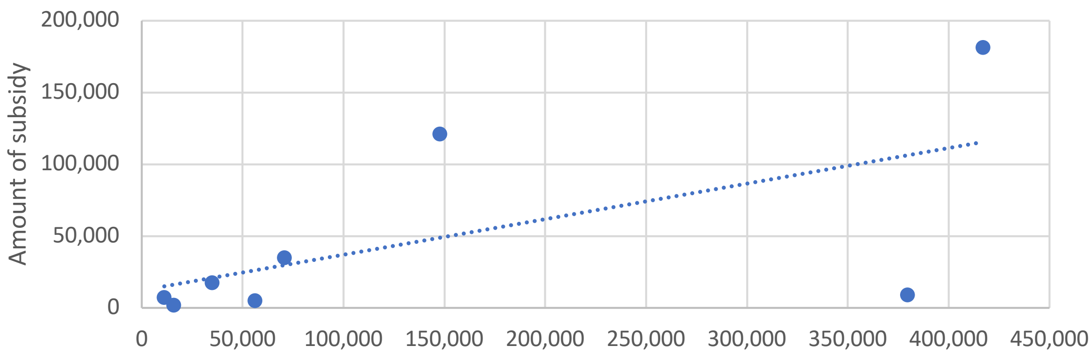

Figure 32 – Dependence of Subsidy on Investment

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5.3. Comparison of practice from case studies

One of the findings from the case study calculations was the varying preferences in technical and technological solutions among different countries. These differences can have a significant impact on the efficiency and sustainability of energy systems in various regions. An example of this can be seen in the approach to heating with heat pumps in the Czech Republic and Portugal.

In the Czech Republic, there is a preference for the installation of a single powerful heat pump (Air-to-water), which, in conjunction with a hot water storage tank and hot water distribution, forms part of the heating system. This approach is often favoured due to its efficiency and ability to meet higher heating demands in households, especially during the colder months. The installation of a single powerful unit also simplifies maintenance and ensures higher reliability, as users do not have to manage multiple units that may require varying levels of service.

In contrast, Portugal has a different approach, where smaller heat pump units are installed (for example, three for a family house, mostly air-to-air systems). This model is often preferred due to the milder climate, which allows for the effective use of smaller units. Distributing heating across multiple smaller devices can also provide greater flexibility and the ability to individually adjust temperatures in different rooms, which can be advantageous for users.

The differences in these preferences are important not only for varying costs and technological processes but also for subsequent maintenance, reliability, and user manageability. In the Czech Republic, where the installation of a single powerful heat pump is common, users can expect lower maintenance and service costs, as the focus is on one device. Conversely, in Portugal, where smaller units are used, users may face higher maintenance costs, as each unit may require separate attention and servicing.

This difference in approach also reflects cultural and economic factors that influence investment decisions in energy technologies. In the Czech Republic, there may be an emphasis on long-term efficiency and reliability, while in Portugal, there may be a greater focus on flexibility and adaptation to specific household needs. These preferences should be taken into account when planning and implementing energy policies and strategies in both countries to ensure maximum efficiency and user satisfaction.

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6. Conclusions from piloting

The following chapters summarizes the basic findings that were reached during the preparation of the pilot projects, their installation and launch. A comprehensive evaluation will be available after the pilot projects have been implemented. Data and analysis will be part of deliverable D3.7 Report on the outcome of testing and demonstrations.

Czechia & Slovakia

Currently, the installation has been completed, and monitoring of the first weeks of operation is underway. All data and their evaluation will be available only in April 2025. Although not all data is currently available, several insights can be highlighted that emerged during the installation and the first weeks of the pilot projects, revealing some very important findings.

Modern Heat Pumps
Heat pumps in the Czech Republic have seen significant growth primarily in the last two decades, which means that most installations utilize modern technologies, often with smart control. While this increases heating efficiency, it simultaneously complicates their integration into pilot projects focused on flexible consumption management. Older, less "intelligent" units are better suited for testing various control strategies.

Potential of Boilers for Water Heating
Unlike heat pumps, electric or gas boilers are a widely used technology in the Czech Republic, making them ideal candidates for controlled consumption and optimization of electricity use. Properly managed water heaters can contribute not only to energy savings but also to increased utilization of electricity from renewable sources if their operation is adapted to the needs of the electrical grid and current supply.

Lack of Space in the Distribution Cabinet
During the initial surveys, it became clear that many electrical distribution cabinets are utilized to their maximum capacity, significantly limiting the possibility of integrating additional devices needed for energy consumption management. It can be assumed that this problem will be particularly pronounced in older family homes and apartment units, where the distribution boards were not designed to accommodate the additional space requirements brought about by smart technologies. Therefore, construction modifications are necessary to ensure the expansion of the distribution cabinet or to make it usable.

User Behaviour and Well-Balanced Heating
One of the unexpected findings was that some users already have their heating systems very well set up and optimize their consumption. This factor significantly reduces the potential for further energy savings and limits the use of smart consumption management systems. This indicates varying levels of household readiness for the implementation of smart energy services – while some households may benefit from automation, others have already achieved high efficiency through self-help. A solution may be to focus on differentiated management strategies, where technology is adapted to the individual needs of households. It is also advisable to consider connections with other aspects of flexibility, such as demand management in combination with photovoltaics or battery storage.

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Portugal

In Portugal two pilots are underway, one in the residential sector lead by Voltalis where flexibility-as-a-service is being testing through the control and management of air-to water heat pumps. The other pilot is led by ISR and is being developed at a tertiary sector building, namely at ISR headquarters. In this pilot the orchestration of different energy services is being tested to create flexibility. These services include air-to-air heat pumps with smart thermostats, photovoltaics system, building battery storage system and electric vehicle charging.

For the residential pilot the biggest barrier or constraint was to find houses in Portugal equipped with air-to-water heat pumps for space conditioning, due to the fact that it is not a common equipment in the country. In Portugal the most used type of heat pump is air-to-air. Additionally, finding people willing to let us install the Voltalis systems and/or with availability (between half a day to one day) to be at home to allow the installation was also a big constraint.

For the tertiary sector pilot at ISR building, the main challenge and constraint is the interoperability of the different systems. This was overcome with a defined procedure that guarantees that all the data is synchronized (e.g. some services have time restrictive schedules, e.g. heat pumps can only be used in off-peak periods, etc.). However, the team assured that the comfort conditions were not significantly affected due to these restrictions.

Despite the challenges and constraints encountered, the pilots are providing valuable insights on the consumer and energy services energy usage patterns, as well as on the effectiveness of the remote control and management of the energy services under test, both in the residential and tertiary sectors.

Spain

In conclusion, the BungEES project's Spanish pilot program, led by Plenitude in collaboration with various partners, successfully tested HVAC technologies in Cataluña and Cantabria, focusing on the integration of Voltalis' energy management solutions with residential heat pumps and air conditioning units. The project highlighted the importance of selecting appropriate regions based on climate and existing HVAC usage patterns, and it demonstrated the technical feasibility of deploying these systems across different climatic zones.

The pilot encountered some challenges related to installation constraints, particularly in homes with complex wiring or difficult access to indoor units. The project also revealed the need for isolated circuits of heat pumps for accurate energy monitoring, which sometimes required additional modifications.

Despite these challenges, the pilot provided valuable insights into consumer energy usage patterns and the effectiveness of remote energy management technologies in the residential sector. The successful communication and coordination efforts by Plenitude, alongside the technical expertise of Voltalis and other partners, ensured that the pilot not only tested the technology but also engaged consumers effectively, paving the way for broader adoption of energy flexibility services in Spain.

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