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Smart EES Service Model Prototype

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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 the "Smart Energy Efficiency Concept Design" report developed earlier in the BungEES project, where the concept and the design of the Smart EES model was formulated. The outputs of this work are thematically divided between D2.1 and D2.2. D2.1 primarily deals with the initial design and data collection.

This document provides a comprehensive overview of various energy service models (EES) across several European countries, identifies customer needs, and proposes business models and technologies suitable for smart energy services.

The aim of the document is to present examples of national EES models through detailed analysis of EES models in Slovakia, the Czech Republic, Portugal, France, Spain, and Germany. This section also identifies common key components and compares models between countries. The comparison includes an analysis of key customer requirements and expectations from energy services.

The main objective of the document is to describe the created prototype of the Smart EES Model, which was designed as part of the BungEES project during the work on WP2 and its respective tasks. The prototype model is a design based on existing models, enhanced with the necessary components to meet modern technologies and their capabilities, the strategic plans of the EU, and individual countries in the areas of energy savings and energy policy. The document also serves as a basis for subsequent tasks within the project. Based on this document, a final draft of the Smart EES model will be created.

The document includes an overview of selected technologies suitable for smart EES, identification of energy-saving opportunities, financial analysis and evaluation of services, monitoring and management of energy consumption, legislative and regulatory advisory services, training and consultancy, and implementation of energy projects. It proposes technical solutions and services offered within packages, economic evaluation of the offered packages, cost studies of technologies and services.

The document summarizes various financing options, including internal financing and financing of provided services, flexibility options, data use and management, communication of energy flexibility needs, the energy market, and the benefits of the aggregator for households and the energy market. It also addresses technical barriers, diverse owner needs and preferences, legislative restrictions, and national barriers specific to Slovakia, the Czech Republic, Portugal, Spain, and Germany.

This document serves as a foundation for understanding and implementing effective and innovative energy services that can contribute to sustainable development and the optimization of energy consumption.

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Definitions

Building Management System (BMS):

Energy efficiency (EE):

Using less energy for the same output or producing more with the same energy input, and minimizing energy waste.

Energy efficiency improvement (EEI):

An increase in energy efficiency as a result of technological, behavioral and/or economic changes.

Energy efficiency improvement action or measure:

An action/measure normally leading to a verifiable, measurable or estimable energy efficiency improvement.

Energy efficiency improvement investment:

An EEI measure that requires an upfront investment, usually through the involvement of a financial institution (FI), and regardless of whether these investments are related to installation of hardware or as a service.

Energy Efficiency Service (EES):

An agreed task or tasks designed to lead to an energy efficiency improvement and other agreed performance criteria. The EES will include energy audit as well as identification, selection and implementation of actions and Measurement & Verification (M&V). A documented description of the proposed or agreed framework for the action(s) and the follow-up procedure should be provided. The improvement of energy efficiency will be measured and verified over a contractually defined period through contractually agreed methods [EN 15900:2010[1]]. If the EES includes EEI investments, it may or may not include financing of these investments.

Energy Efficiency Service provider (EES provider):

A company that offers EES to its clients. Another term frequently used in this context is ESCO (Energy Service Company), but this term is mostly connected to the provision of energy performance contracting (EPC) or energy supply contracting (ESC), which are specific forms of EES.

Energy performance contracting (EPC):

A comprehensive energy service package aiming at the guaranteed improvement of energy and cost efficiency of buildings or production processes. An external ESCO carries out an individually selectable cluster of services (planning, building, operation & maintenance, (pre-) financing, user motivation, etc.) and assumes technical and economic performance risks and guarantees. Most projects include third-party financing. The services are predominantly paid out of future saved energy costs (Graz Energy Agency Ltd, 2008).

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[1] EN 15900:2010 Energy efficiency services. Definitions and requirements

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Smart Energy Efficiency Service (Smart EES):

Smart Energy Efficiency Service (Smart EES) is a comprehensive energy efficiency service that combines innovative modern technologies, data analytics and expert know-how to provide intelligent solutions for reducing energy consumption and increasing energy efficiency in various areas such as buildings, industrial processes, or infrastructure. This service includes data collection and analysis of energy consumption patterns, identification of areas with significant savings potential, design and implementation of energy efficiency measures, monitoring and M&V of results. Smart EES leverages innovative technologies such as smart sensors, automation, the Internet of Things (IoT), Artificial Intelligence (AI) and Machine Learning (ML) algorithms to provide users with a detailed understanding of their energy consumption patterns and provides recommendations for consumption optimization. In this way, it helps end-users to identify energy-saving opportunities and reduce costs associated with operation and maintenance.

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1. Introduction

The main objective of this report is to provide an essential perspective and description on the development of the smart energy efficiency service (Smart EES) model prototype. It is based on the energy efficiency service (EES) business model proved to be an effective and comprehensive approach to improve energy efficiency across the European Union (EU).

A smart energy efficiency service integrates different areas of the energy sector by encompassing energy efficiency, distributed generation, demand response, e-mobility and energy storage/hybrid energy systems, as well as innovative financing and rewarding cost-effective solutions.

A smart Energy Efficiency Service (Smart EES) is a comprehensive energy efficiency service that combines innovative modern technologies, data analytics and expert know-how to provide intelligent solutions for reducing energy consumption and increasing energy efficiency in various areas such as buildings, industrial processes, or infrastructure. This service includes data collection and analysis of energy consumption, identification of areas with the greatest potential for savings, design and implementation of energy efficiency measures and monitoring of results. Smart EES leverages innovative technologies such as smart sensors, automation, the Internet of Things (IoT), Artificial Intelligence (AI) and Machine Learning algorithms to provide users with a detailed view of their energy consumption and offer recommendations for consumption optimization. In this way, it helps users identify energy-saving opportunities and reduce costs associated with operation and maintenance.

Smart EES can be provided as a service by external service providers such as energy companies, consulting firms, or technology companies.

This report builds on the “Smart Energy Efficiency Concept Design” report developed earlier in the BungEES project, where the concept and the design of the Smart EES model was formulated. The outputs of this work are thematically divided between D2.1 and D2.2. D2.1 primarily deals with the initial design and data collection, following Sub-task 2.1.1: Engaging different actors from prosumers' platform established by WP4 and Sub-task 2.1.2: Blueprinting Smart Energy Efficiency Service concept. This deliverable D2.2 follows the work that was carried out within Sub-task: 2.1.3: Service model ideation using a service model canvas, Sub-task: 2.1.4: Design of a platform for retailers to integrate DR and EES, and Sub-task 2.1.5: Smart Energy Efficiency Service concept, as well as Sub-task 2.1.6: Service model prototype.

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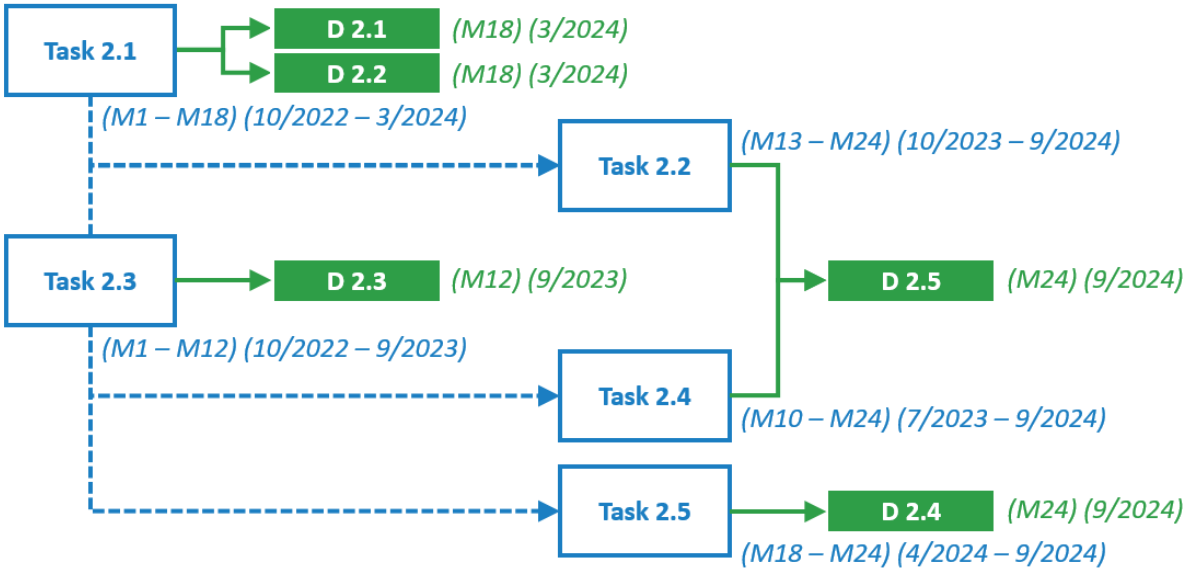

Figure 1: Diagram of the interconnection of deliverables and project tasks in WP2

This report delves into the intricate details of the Smart EES business model and examines its core components through the lens of the Business Model Canvas (BMC). Each element of the BMC contributes to the overarching strategy, facilitating a deeper understanding of how this model operates and its potential impact on the energy sector. As we navigate through the various aspects of the Smart EES business model, its key features are described, including its value proposition, customer segments, channels, revenue streams, and more. By dissecting these elements, we aim to provide insights into how the Smart EES model aligns with market needs, fosters innovation, and delivers tangible benefits to both businesses and consumers.

In addition, the report highlights the importance of addressing customer needs and developing a robust outline business model for the effective delivery of EES. It describes different service packages, including technology solutions, energy audits, financial analysis, energy monitoring and management, legislative advice, training, consultancy and energy project implementation. It also provides perspectives on service structure diagrams, flexibility options and key relationships with customers, suppliers and financial stakeholders.

Furthermore, the report addresses customer needs, taking into account the diverse requirements and preferences of consumers in the field of energy efficiency. By comprehensively addressing these needs, the services provided can be tailored to effectively meet market requirements.

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2. Examples of national EES models

This chapter focuses on comparison of existing successful EES models in selected countries. These models represent an inspiring source and starting point for designing the prototype of a new Smart EES.

The goal of this comparison is to identify key features, similarities, and differences among various approaches to providing EES across different EU countries. We analyze how individual countries approach supporting energy efficiency, what strategies and programs they implement, and what results they achieve.

Comparing these models will provide a comprehensive view of the diversity of approaches to energy efficiency and enable to identify best practices and potential areas for innovation. This analysis will serve as a foundation for designing- the new Smart EES, which will be capable of effectively addressing market needs and delivering real benefits in the field of energy efficiency and sustainability.

2.1. Slovakia

Although the EaaS market in Slovakia is underdeveloped, consumer interest is relatively high. This mainly concerns the industrial sector and the commercial sector (office buildings and commercial buildings). It is developers in the office building sector that have brought EaaS models to the residential sector, and specifically to the apartment building and mixed-use sectors. This is because they see the clear and undeniable benefits of smart energy services with flexibility management.

Flexibility oriented service packages for residential sector offer fully automated management of energy sources and technologies with the potential for regulation or accumulation, for example:

- Heat pumps;
- Furnaces;
- Reservoirs and tanks;
- HVAC systems Compressors;
- PV systems;
- Other technologies and energy sources.

The energy sources are combined with energy storage systems such as:

- Batteries;
- EV chargers with V2G.

The packages on the market offer fully automated battery management based on online data and predictions generated by artificial intelligence (AI):

- Customer’s electricity consumption;
- Electricity from local PV system;
- Electricity prices;
- Situation in the power grid;
- Electricity supplier’s load deviations;
- Available battery capacity;

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- AI predictions – weather, consumption, prices;
- Smart EV charging;
- Other data.

Although there is not enough evidence to draw conclusions on the success the integrated service packages in Slovakia, the business models used are the same as in other Member States, reflect current state-of-affairs in innovations and have been already validated in the western Member States of the EU

Servitisation of the energy sector also impacts Slovakia and the barriers to their market uptake can be divided into two areas:

- Regulatory barriers due to slow progress of approximation of the Slovak legislation to EU energy acquis, especially as the implementing regulations concerns that should detail rules for all players in the residential sector;
- Influence of incumbents that do not see the new opportunities in other sectors and revolt against more autonomy of residential sector to take care of its energy needs.

2.2. Czech Republic

In the Czech Republic, the market for energy services is evolving and legislation is gradually adapting to European directives and targets in the field of energy efficiency and decarbonisation. Approved amendments to the Energy Act, such as LEX RES III, show the government's efforts to support the development of renewable energy and energy services. In the Czech Republic, several key companies provide energy services (EES), which focus on different aspects of energy efficiency and renewable energy. These are primarily energy companies, energy suppliers or companies that focus on the EPC market.

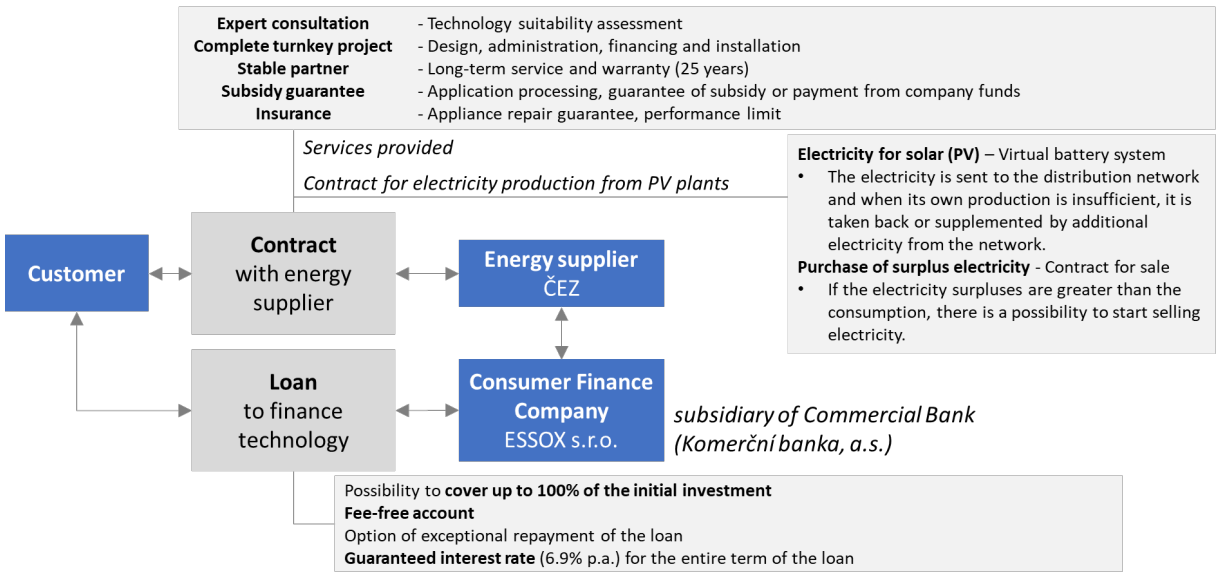

Figure 2: Diagram of EES service (Czech Republic)

The diagram in the figure shows a typical example of the delivery of a service to a customer and the financial linkages within the delivered service. This example is from CEZ, but most large EES providers have almost identical schemes.

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Practical examples

Photovoltaics with battery storage

Price proposal of configuration

- Price without subsidy from 22 687 €

State subsidies

The amount of the state subsidy is limited to a maximum of 50% of the eligible costs (8 717 €).

Total price with subsidy from 13 970 €

- *The total cost includes the actual equipment with delivery of components, installation, permit processing, administration of the subsidy application and 15% VAT.*

Technical Specifications

- **Installed power 5,46 kWp**
- Output voltage 400 V / 50 Hz / 3 phases
- Panels 12 x EXE SOLAR JUPITER A-HCM455/144
- Voltage converter integrated in CEZ Battery Box (10 kW)
- Usable **battery capacity 7,2 kWh**
- Total **panel area 26 m²**
- System lifetime up to 30 years
- 5 years warranty
  - Manufacturer's warranty for CEZ Battery Box 5 years
  - Battery warranty 10 years, > 6,000 charging cycles
  - Panel warranty 15 years
  - Panel warranty 25 years for 85% of performance

Savings on electricity costs 742 €/year

System payback period 11 years

Practical examples

Heat pump (air/water)

Price proposal of configuration

- Price without subsidy from 14 485 €

State subsidies

Maximum possible amount of subsidy New Green Savings 4 273 €

Total price with subsidy from 10 212 €

- *The total cost includes the actual equipment with delivery of components, installation, permit processing, administration of the subsidy application and 15% VAT.*

Technical Specifications

- Heat pump outdoor unit Mitsubishi ZUBADAN 80
- **Heat pump output 8 kW**
- Heating capacity at -15°C 8 kW
- Output voltage 400V/50Hz/3phase
- Heat pump indoor unit TENGEO HEAT
- **Bivalent power supply Electric boiler 6 kW**
- Heating capacity (CHP + EC) Up to 10.9 kW + 6 kW EC
- Controls Colour touch screen
- DHW storage tank OKC NTR/HP
- **Tank capacity 250 l**
- Heat pump lifetime up to 25 years

- Warranty for the entire system including labour 5 years

Savings on electricity costs 1 155 €/year

System payback period 8 years

Figure 3: Practical examples of energy efficiency measures (Czech Republic) (Source: ČEZ company)

EPC projects

The EPC market is growing significantly in the Czech Republic. Investments in projects implemented through energy services with guaranteed savings (EPC) have increased almost tenfold year-on-year. This is due to the price of energy, subsidy support for project preparation and pressure to decarbonize. Healthcare accounts for the largest number of projects. In addition to the latter, energy savings started to be counted last year in the buildings of the city of Breclav, the Pankrác prison and in two buildings of the Czech Statistical Office. In addition to reduced energy bills, the projects also have non-financial benefits in the form of improved indoor environmental quality or increased security thanks to better lighting.

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In 2023, a total of 16 EPC projects were implemented with a total investment of CZK 1.96 billion.

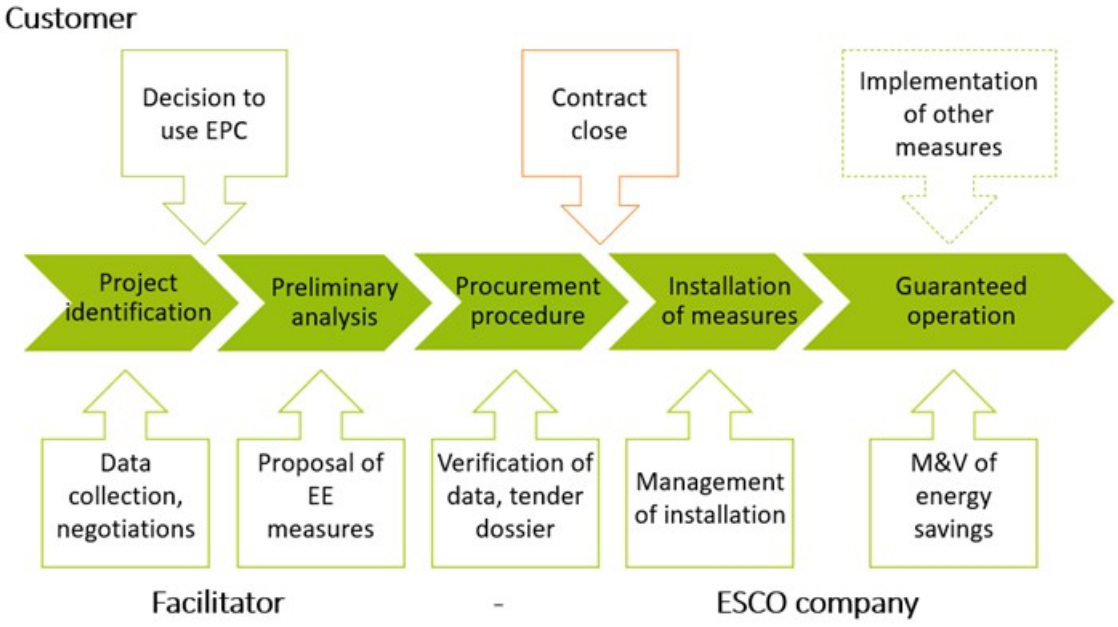

*Figure 4: EPC project diagram (Czech republic) (*Source: Transparense project)

2.3. Portugal

The EES model used in Portugal is aligned with the one used in other European countries (e.g. Czech Republic, Spain, France, etc.). This service model is mostly supported by EPC projects developed by private Small Medium Enterprises (SMEs). The combination/orchestration of different energy assets is still not a common practice in Portugal. Since the market is quite small, half of ESCOs usually implement projects both on public and private sectors. Currently some ESCOs are having an important role in the creation of energy communities mostly within the private sector (SMEs and electricity end-users).

The energy efficiency service model in Portugal typically involves several core components designed to optimize energy use and reduce waste. These components are integrated into different sectors, such as residential, commercial, and industrial, to achieve overall energy savings and sustainability goals. The main core components:

- **Energy Audit** – includes an initial assessment with a comprehensive analysis of energy consumption patterns, infrastructure, and operations to identify inefficiencies and areas for improvement. Additionally, this audit provides detailed insights and actionable recommendations for installing energy-saving measures;
- **Energy Management Systems** – After setting up the energy-saving measures it is necessary to implement M&V systems to monitor the energy savings. Moreover, the M&V systems will be collecting data that needs to be analyzed to assess the energy-saving measures success;
- **Training and awareness** – Conducting educational training sessions with stakeholders (building managers, technicians, etc.) to enhance their understanding and skills on energy managements is crucial. Additionally, awareness raising campaigns for building

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users on energy conservation and good practices is essential for the success of the EES model;

- **Monitoring and reporting** – The continuous monitoring (using sensors and IOT technologies, as well as a regular reporting of energy efficiency performance is essential for the EES to obtain good results and to ensure transparency and accountability;
- **Integration of renewables** – The integration of renewable energy solutions is usually considered (if technical conditions are available) as a form of reducing the building or facility carbon footprint. The inclusion of solar photovoltaic or solar thermal panels, geothermal or biomass systems (depending on the location and feasibility) to reduce demand from the grid and increase the building efficiency;
- **Building retrofit** – several strategies can be used in this case, the most common are: upgrading building insulation to reduce heating and cooling demand; Replacing or upgrading heating, ventilation, and air conditioning systems to more efficient models; and retrofitting the existing lighting systems to more energy-efficient lighting options, such as LED technology;
- **Incentives and Financing** – These tools are able to reduce the financial barriers for both businesses and consumers, making sustainable options more accessible. By providing tax rebates, subsidies, energy performance contracting (EPC), or low-interest loans, governments and financial institutions can encourage the adoption of energy-efficient technologies. These financial mechanisms not only spur initial investments but also support the development and scaling of innovative energy solutions. As a result, they accelerate the transition towards a greener economy, reduce energy consumption, and contribute to the mitigation of climate change. Effective incentives and financing options are thus essential for support ESCO business model in order to achieve the energy conservation goals and sustainability targets.

Not all the above components are covered in the same project, depending on the purpose of the project or on the building owner and/or ESCO financial capacity, the most relevant components are selected. However, the first four components are mandatory for the success of the EES, as well as for any energy efficiency project implementation.

Currently, there are around 20 ESCOs registered in Portugal, however most of them are not developing EPCs. More than 60% of these companies do very little or no work as ESCOs. Their core business is often related to renewable energy systems and/or work for the Portuguese DSO in power grid expansion and maintenance. The ESCO market in Portugal represents a slowly evolving sector within the broader energy landscape. ESCOs can play an important role in achieving the country objective in terms of emissions reduction, as well as in facilitating energy efficiency improvements, sustainability initiatives, and in the transition towards cleaner and more sustainable energy practices. The next figure presents a disaggregation of the implemented ESCO projects per economic sector/activity and per technologies.

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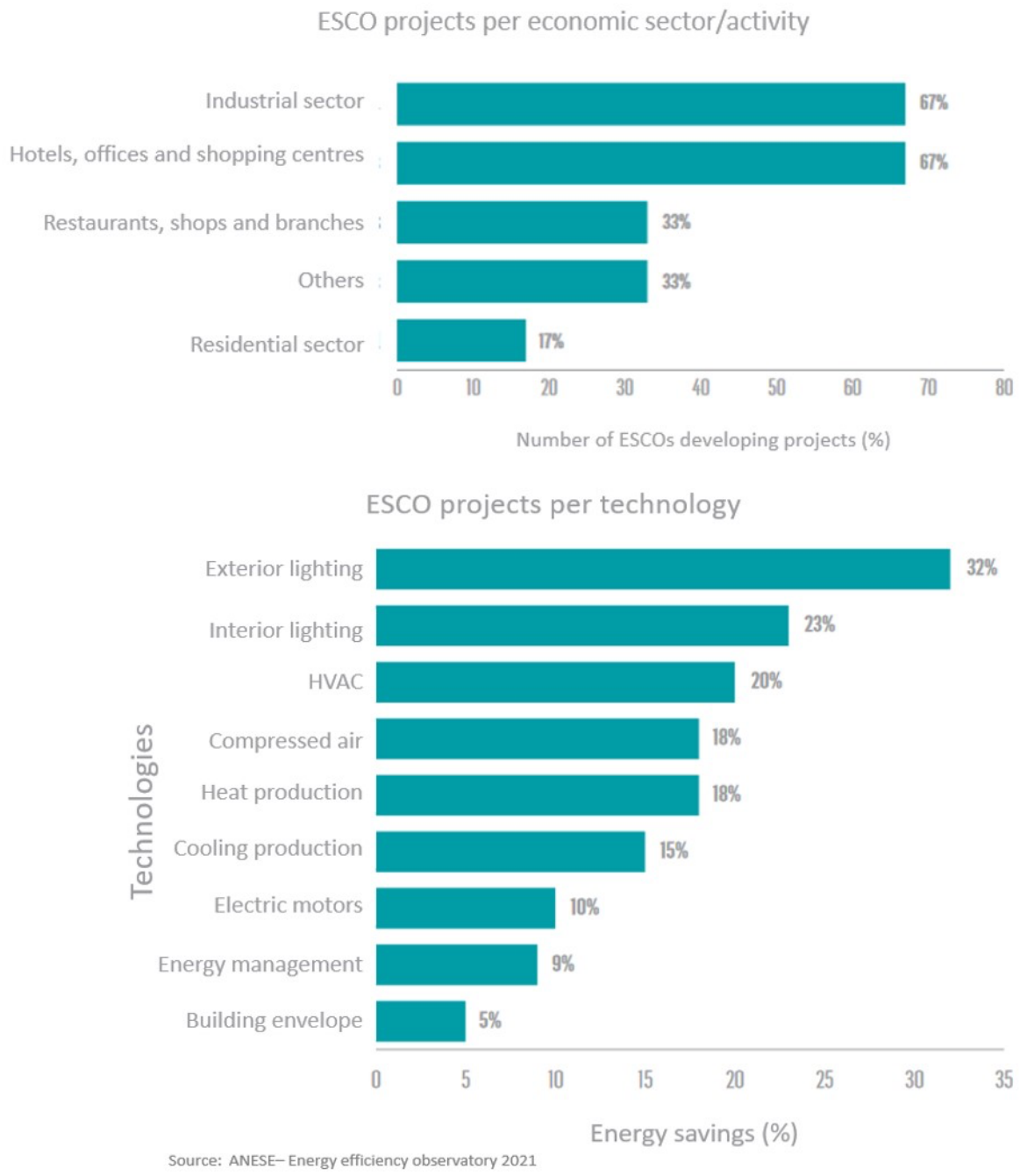

Figure 5: ESCO projects and technologies (Portugal)

The industrial and non-residential building sector are sectors that can be considered as drivers to the ESCO market. Regarding technologies, lighting is the most commonly used technology for ESCO projects (street lighting included).

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2.4. France and Spain

The following paragraphs summarise three existing examples that characterise energy efficiency services in France.

Case #F1

Providing EES to most households even when electric appliances are not genuinely controllable.

The business model targets electricity consumption from domestic volume heating on appliances which are not natively connected and not available for smart and/or automated control command. The company provides households with equipment and services to unable electricity savings (15% savings) through consumption monitoring and consumption management thanks to the provision of visualization and scheduling tools.

The technology is also used at a collective level providing aggregation of spread household flexibility with automated remote consumption adjustments (cuts). Aggregation of millions of appliances allows providing Demand Side Response flexibility to the network. Aggregated revenues generated at the grid level allows providing smart thermostat service to all end-users free of charge.

1. DR services:
   - Aggregation platform with connections to the electrical Grid and to market places.
   - Build automated bidirectional connection between platform and appliances.
   - Build automation between Grid needs (market prices, Balancing calls…) and spread appliances (forecast availability, rollout scheduling…)
2. Main challenges:
   - Get access and control of appliances which are not genuinely designed for remote control.
   - Control millions of spread appliances: remote monitoring and command, automated decisions, algorithms for combining appliances calls.
3. Benefits:
   - Provide flexibility to the electric system (generic: avoid pick, reduce cost per MWh, reduce C02, reduce grid needs: black out or further investments)
   - Flexibility to the grid is monetized on market: to operator (includes risk on price forecast)
   - Unable smart control scheduling of appliances EES:
     - Energy savings: money, CO2
     - Comfort
4. Capex
   All Capital Expenditures are supported by Flexibility operator:
   - Aggregation platform with automation (millions of appliances)
   - Installation of hardware
   - Communication to appliances (hardware, firmware, software…)
5. Maintenance and operating
   All maintenance, support and operating of the services are supported by the DR operator

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6. Run Demand Response orders (switch appliances)
   DR operator is directly controlling appliances remotely enable controlling at any time of day-night without disturbance for end-user.
7. Risks
   All risks are supported by the DR operator. These include:
   - Capital risks, initial investments
   - Operational risks
   - Regulation and market prices
8. Case examples:
   Among others the following companies have develop and operate this business case in France:
   - Tiko (see website https://www.tiko.fr)
   - Voltalis (see website https://www.voltalis.com/particuliers/notre-solution)

Case #F2

Providing Flexibility to households using electric radiators with cloud-to-cloud connection.

The business model targets electricity consumption from domestic volume heating on electric radiators which are connected to manufacturer to the cloud for remote control command. The DR company uses the remote cloud access to connect its aggregation platform to the appliances. If not provided by the manufacturer, the DR company provides households with equipment and services to unable electricity savings (15% savings) through consumption monitoring and consumption management thanks to the provision of visualization and scheduling tools.

The technology is also used at a collective level providing aggregation of spread household flexibility with automated remote consumption adjustments (cuts). Aggregation of millions of appliances allows providing Demand Side Response flexibility to the network. Aggregated revenues generated at the grid level are shared between the DR company and the end-users.

1. DR services:
   - Aggregation platform with connections to the electrical grid and to market places.
   - Build automated by-directional connection between platform and appliances.
   - Build automation between Grid needs (market prices, Balancing calls…) and spread appliances (forecast availability, rollout scheduling…)
2. Main challenges:
   - Develop manufacturer specific cloud-to-cloud connections to monitor and control appliances.
   - Control millions of spread appliances : remote monitoring and command, automated decisions, algorithms for combining appliances calls.
3. Benefits:
   - Provide flexibility to the electric system (generic: avoid pick, reduce cost per MWh, reduce C02, reduce grid needs: black out or further investments)
   - Flexibility to the grid is monetized on market, and benefits are shared between operator and end-user. End-users is remunerated with fixed revenues (lumpsum), and the operator holds the risks on price fluctuations

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- Unable automated energy consumption cuts (Demand Response) that generates additional energy savings: money, CO2

4. Initial investment costs
   Initial investment costs are supported by Flexibility operator:
   - Aggregation platform with automation (millions of appliances)
   - Communication to appliances: software development
5. Maintenance and operations
   System maintenance and service operations are held by the Flexibility operator.
6. Running DR orders
   DR operator is directly controlling appliances remotely enable controlling at any time of day-night without disturbance for end-user.
7. Risks
   All risks are taken by the Flexibility operator:
   - Investment (manly software developments)
   - operation
   - regulation and market prices
8. Case Examples:
   - Intuis radiators with Voltalis as DR aggregator (https://offre-effacement-intuis.voltalis.com/)
   - Netatmo radiators with Survoltage as DR aggregator (https://operations.muller-intuitiv.fr/experimentation-ma-flex/)

Case #F3

Providing Flexibility to households by sending messages to end-consumers who manually controls appliances in the household.

DR aggregator is making the link between the market place and electrical grid on one hand and households on the other hand for explicit DSR. Each household end-user is in charge of controlling its own appliances.

The business model targets electricity consumption from any appliances that the end-user is available to control on demand. The DR company builds media between the grid needs and end-consumers. Messages are sent to the end-user when flexibility is needed. It is to the end-user to manually activate Flexibility from its appliances.

The technology is also used at a collective level providing aggregation of spread household flexibility with manual consumption adjustments (cuts). Aggregation of thousands of appliances allows providing Demand Side Response flexibility to the network. Aggregated revenues generated at the grid level are shared between the DR company and the end-users. These revenues are expected to be less compared to automated solutions.

1. DR services:
   - Aggregation platform with connections to the electrical grid and to market places.
   - Build communication channels to end-users (not directly to appliances) for operating flexibility on appliances.
2. Main challenges:

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+421 911 421 844 doktor@viaeuropa.sk

- Develop communication, awareness and incentive for the end-user to participate, as much as possible to Flexibility.
- Develop forecast of technical (appliances) and human (action needed to control appliances) availability.

3. Benefits:
   - Provide flexibility to the electric system (generic: avoid pick, reduce cost per MWh, reduce C02, reduce grid needs: black out or further investments)
   - Flexibility to the grid is monetized on market, and benefits are shared between operator and end-user. At the time of this report, DR operators are not communicating clearly on expected revenues for the end-user.
4. Initial investment costs
   Initial investment costs are limited for Flexibility operator:
   - Aggregation platform
   - Communication to end-users
5. Maintenance and operations
   System maintenance and service operations hold by the Flexibility are mainly related to the communication between the platform and markets and grid.
   On the household side operator is not addressing any maintenance on the appliances nor communication/control of them. The platform sends explicit DR order (message) to end-users. In the other direction it aggregates electricity consumption measurements from smart meters in the households.
6. Running DR orders
   DR operator is running DR platform and communication to market places and electrical grid, there is no automated communication to appliances. DR operator send to each end-user notification on when Flexibility is needed. Communication can be made via a dedicated App, via text message or any alert media. Availability of Flexibility is there dependent on end-user availability and needs manual action from the end-user (can not run any time of day-night). The availability of the developed flexibility is less than with automated systems.
7. Risks
   Risks taken by the Flexibility operator are on market and grid side, not on appliances.
8. Case Examples:
   - Survoltage offers both manual and automated Flexibility services (see www.survoltage.fr/lapp-survoltage)

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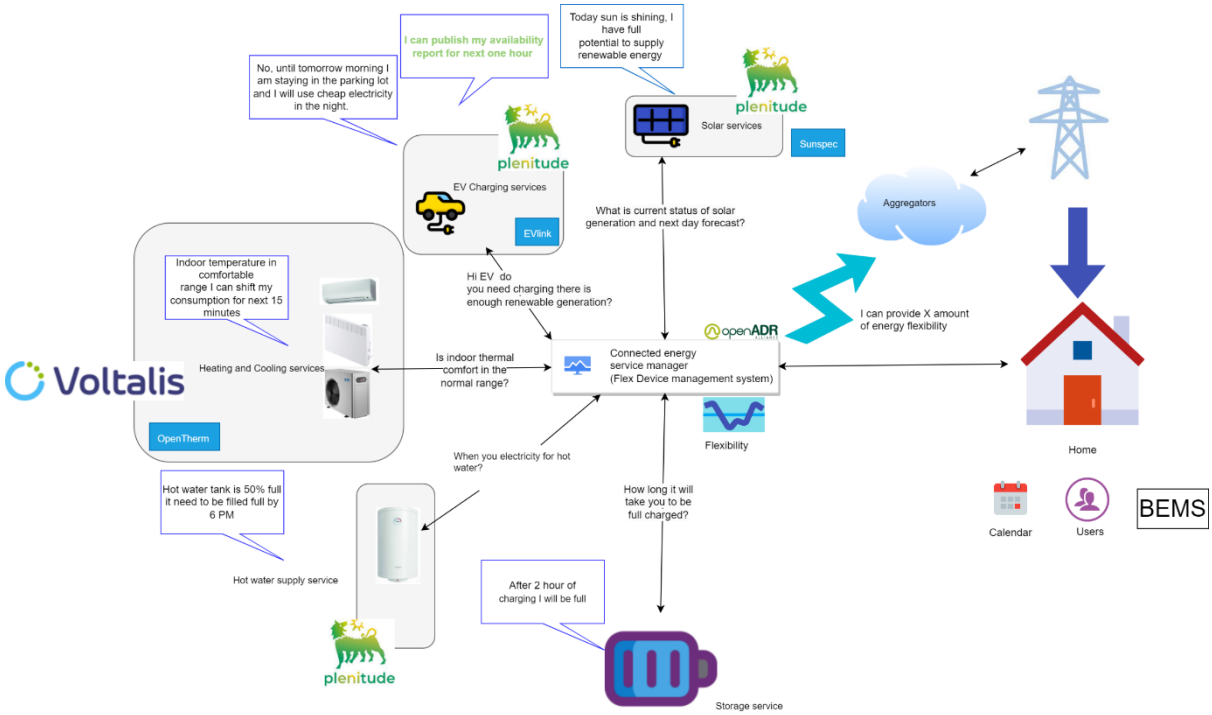

Figure 6: Diagram of business model design based on experience from France and Spain (Voltalis, Plenitude)

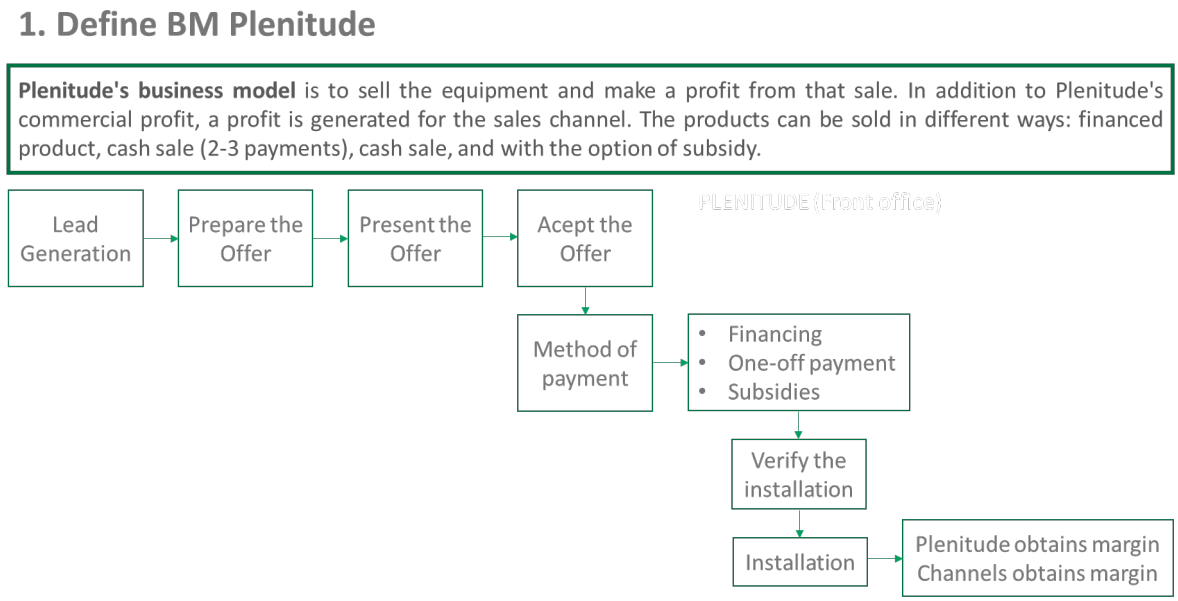

Figure 7: Definition of business model diagram (Plenitude)

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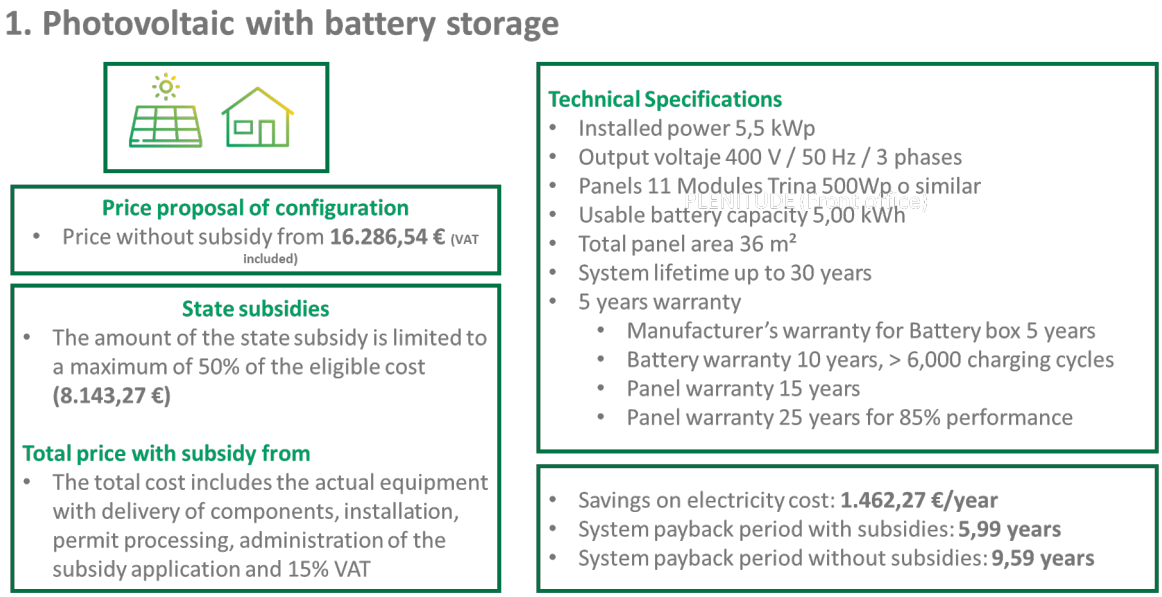

Figure 8: Example of services (Spain)

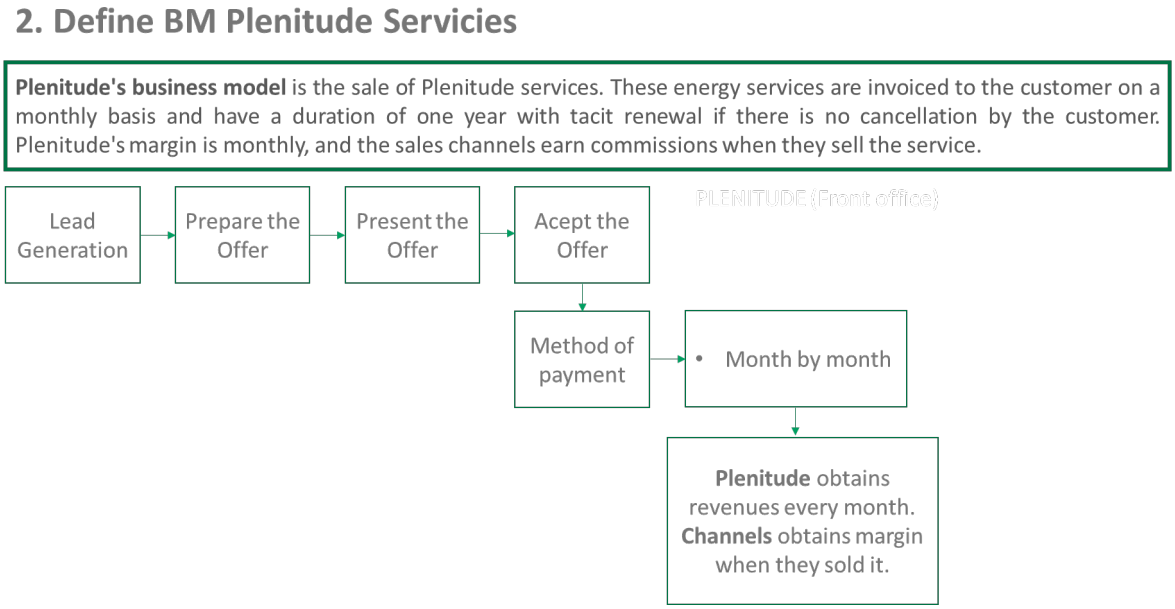

Figure 9: Business model diagram – Services (Plenitude)

In Spain, advice is offered to the client to prepare the offer. Currently in Plenitude we have two types of energy efficiency service offers, one of them is the self-consumption photovoltaic installation for residential customers and the other product is the recharging points to promote electric mobility.

In order to address these two processes, we have a solar simulator to facilitate the customer and the customer can make a personalised study for solar. [2]

2 https://eniplenitude.es/hogar/energia-solar/calcular-ahorro-placas-solares/

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From this simulation, an offer is generated and sent by mail to the end customer with the cost of the installation, the financing that would be available, as well as the option of obtaining the installation in cash.

In this personalised study, the client can choose between single-family house / flat / business. On the other hand, the client is also asked if he/she is an owner or a tenant. Within this personalised study, the client is asked about their monthly electricity costs and finally a consultation is carried out to find out what the client needs: “Estoy interesado y quiero entender las ventajas de instalar placas solares”; “Ya me he informado y quiero un presupuesto definitivo”; “Estoy convencido de instalar y quiero comparar con otros presupuestos”. Finally, the customer data is filled in and the final offer is sent to the customer.

With regard to the offer of recharge points, there is a lead generation on the Plenitude website. Based on this data generation, the offer of recharge points that will be sent to the customer is generated.

To generate the offer, the end customer is asked for a series of data such as: Name and surname, email, telephone, postcode and type of garage, which can be an individual garage or a collective garage.[3]

The type of offer we have from Plenitude for the charging points is with cash payment at two points in the process. The first payment would be at the time of signing the contract, this would be a payment of 50% and the second payment is at the time of installation also 50%.

Actors

Within the participants that appear in the photovoltaic business, it is distributed between an equipment supplier (inverter, solar panels, structure) and the installer's part. In this business we have the structure divided by zones in Spain and we carry out the installations with the installer assigned to each zone.

As for the recharging points, we have a partnership with a brand of recognized prestige in the sector and we carry out the installations with a national installer who has the capacity to carry out the installations throughout Spain.

In both cases, the supplier of the materials is a third party, and the installer is another third party. To develop this model, a tripartite contract is signed between the end customer, Plenitude and the installer to delegate responsibilities in each situation.

As for the financial product, we have partnerships with Spanish banks to be able to finance the photovoltaic product, in the case of the recharge point it would be in cash.

The composition scheme for both products would be as follows:

[3] https://eniplenitude.es/hogar/cargador-coche-electrico/

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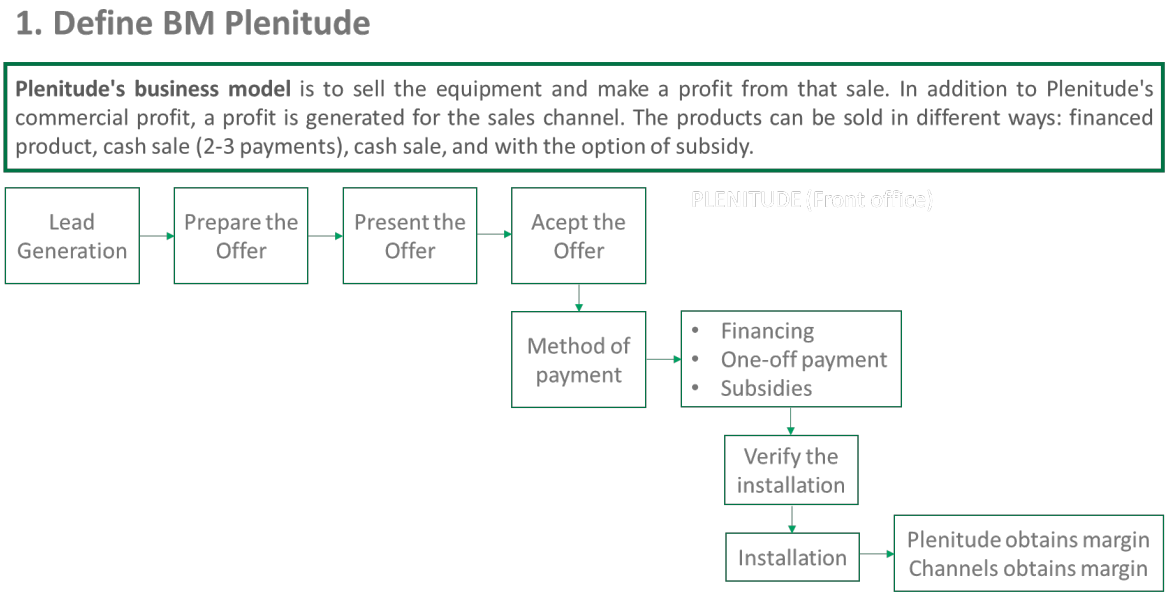

Figure 10: Business model diagram (Plenitude)

Cost structure and payments

With regard to the costs of the equipment and the installation, it is as follows. The cost of the equipment represents 32% of the total cost of the installation, while the cost of the installation together with the small material required represents 47%. The remaining 21% represent different margins between Plenitude's margin and the commercial agent's margin for selling the energy efficiency product.

The payment scheme is as follows:

The equipment (charging points, photovoltaic panels, inverters) is paid for when the contract is signed, and the order is placed to begin installation. This payment is made directly by Plenitude to the supplier of the corresponding equipment. The different prices are supported by a signed contract with each of the partners who are collaborating.

As for the installation of the equipment, the following process is followed: 50% of the installation is paid when the customer signs the contract and when the first milestone payment is received from the customer in the case of a cash payment, and the next 50% payment is made when the installation is completed.

Market size

We are currently positioning ourselves in the recharging points and photovoltaic markets. In the Spanish market within these sectors we have a position of less than 1% of Spain.

2.5. Germany

In Germany, both startups and established market players have developed innovative smart energy-efficiency service business models. Additionally, several successful pilot and research projects have demonstrated new energy efficiency service models. In addition to the traditional energy ESCOs model, these services provide tools for energy management, monitoring and control platforms, energy flexibility, and demand response. While the

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adoption of these use cases is still limited on a national scale, the financial models of such services have been successfully tested and validated. Therefore, the current draft provides a succinct overview of innovative energy service models in Germany.

At the building level, the major categories of Energy Efficiency Services (EES) observed in Germany include:

- Smart home energy management system
- Energy and environmental management systems
- Smart EV charging (mainly unidirectional charging and V2H, although many piloting activities for V2G are ongoing)
- Battery storage with PV (Connected energy service business model)
- Aggregation and demand response

EES Category	Value proposition	Services	Use cases
Smart home energy management system	Residential customers get a comprehensive energy ecosystem, integrating solar energy generation, energy storage, and smart energy management. Customers can reduce reliance on the grid, lower energy bills, and increase energy independence by generating and storing their electricity.	• Energy optimization, and control • Real time monitoring • Cost optimization •	Sonnen (smart home), Kiwigrid (The Independent home) 1KOMMA5° (energy manager Heartbeat)
Smart EV charging (V2G and V2H)	Unidirectional smart charging: Makes it possible to optimize self-consumption from roof-top PV by automated load shifting. Usually based on pre-set parameters on the desired state of charge and integrated into a smart home system. Alternatively, time-of-use-tariffs optimize on price. V2H: Allows EV owners to use their vehicle's battery to power their homes during outages or peak demand, increasing energy resilience and reducing electricity costs. V2G (pilots): Enables EV owners to sell excess energy stored in their vehicle's battery back to the grid during peak demand periods, earning revenue and supporting grid stability.	• Demand response • Real time monitoring • Battery charging management • Self-consumption optimization for prosumers • Variable / time-of-use charging	EnBW, E.ON, Beegy/MVV (self-consumption) , Rabot Charge (variable tariff)
Energy and environmental management systems	CO2 footprint monitoring along with energy management, currently mainly for B2B segment rather than private households	• CO2 Consulting • Advice on Sustainably goal • CO2 monitoring software • Environmental and energy manahement	optenda, cozero
Battery storage with PV	Offer customers the ability to generate, store, and consume their electricity, reducing reliance on the grid and utility providers. Enable customers to lower their electricity bills by storing excess solar energy during the day and using it during peak demand periods or at night when solar generation is not available.	• Self-consumption • Energy flexibility • Storage services • Energy flexibility	Sonnen (solar battery), Enpal (battery in package with PV)
Aggregation and demand response	Enable energy consumers to reduce electricity expenses by participating in demand response programs and earning incentives or payments for adjusting energy consumption during peak periods Support the integration of renewable energy sources by optimizing the use of clean energy.	• Peer-2-Peer trading • Energy flexibility • Flexibility sharing platform	Equigy (The crowd balancing platform) , Next Kraftwerke (virtual power plant)

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Technical solutions

Ranges of innovative technical solutions have been developed to facilitate smart energy services. The majority of these solutions include energy management software (e.g., energy manager Heartbeat[4] by 1komma5), platforms, smart thermostats, network and communication protocols (e.g., Energy Manager VoyagerX[5] by Kiwigrid), and more. Data-driven technologies such as Artificial Intelligence, blockchain, and machine learning models serve as the underlying technologies behind such developments.[6] Smart meter data also plays a crucial role in the implementation of EES, which remains a barrier in Germany due to the delays in the smart meter rollout

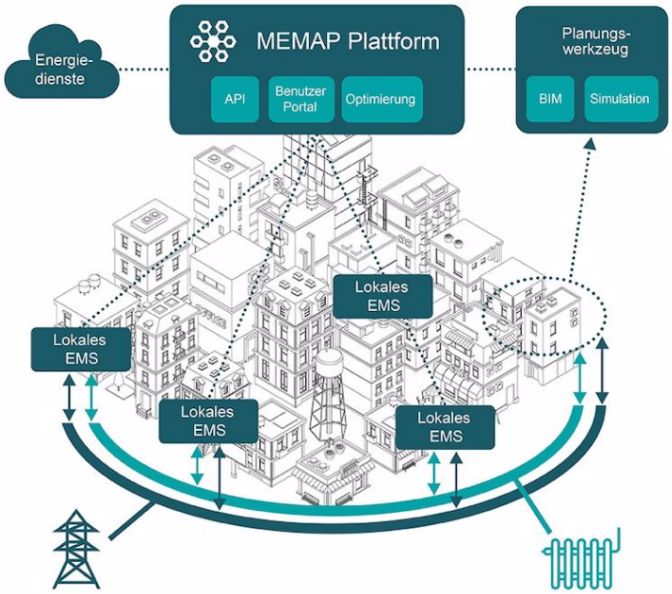

Figure 11: Multi-Energy Management and Aggregations-Platform (Source: project MEMAP)[7]

In addition to software development, there are also several innovative solutions that combine software with hardware. For instance, the use of smart charging and especially or Vehicle-to-Home (V2H) technology enables smart EV chargers to integrate software intelligence with hardware (e.g., Strom-Tracker Pulse[8] from Tibber), allowing for monitoring and control of EV charging. Further V2G use cases are being explored and are expected to strengthen this development. Platforms are another notable development in the field of ESS. These platforms consist of a combination of software and hardware components that serve as a foundation

[4] https://1komma5grad.com/de/angebot/heartbeat?utm_source=paid-online&utm_medium=google-ads&utm_campaign=search-brand&utm_content=brand-broad

[5] https://kiwigrid.com/de/produkte/energy-manager-voyagerx

[6] Mahendra Singh, Jiao Jiao, Marian Klobasa, Rainer Frietsch, Making Energy-transition headway: A Data driven assessment of German energy startups, Sustainable Energy Technologies and Assessments, Volume 47, 2021, 101322, ISSN 2213-1388.

[7] https://memap-projekt.de/

[8] https://tibber.com/de/smarte-steuerung

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for developing and deploying various applications and services. In the context of smart energy services, platform technology plays a vital role in facilitating the integration, management, and optimization of diverse energy resources, data streams, and control systems. The Equigy aggregation platform stands as a prominent example in this context. Additionally, a multi-energy management and aggregation system has been developed and tested within the MEMAP project.

Actors

Startups and energy companies are primarily engaged in the development of EES services. Specifically, companies with expertise in software development and data analytics are leading the way.

However, the implementation of ESS services is heavily reliant on other actors, such as equipment suppliers, installation providers (often third-party companies), and building construction companies. Actors like banks and public funding also support the financing of EES services, for example through Green loans and energy-efficient renovation initiatives. Recently, there has been uncertainty regarding the funding for several of these schemes due to the federal budget crisis, which affected the funding given by the main institution in this segment, the KFW (Kreditanstalt für Wiederaufbau / Credit Institute for Reconstruction).[9]

Cost structure and payments

The cost of EES services varies depending on the offered services. Usually, these services are provided through contracts between end-consumers and service providers, and the cost structure is not publicly disclosed. In many cases, service providers arrange the equipment installation and maintenance. In addition, several companies have developed their own hardware and software solutions specifically tailored to deliver the offered services. Payment models for EES include short and long-term contracts, as well as pay-for-outcome or service models. Additionally, these contracts often involve leasing, renting[10], and fixed-term or long-term service contracting arrangements.

[9] https://www.tagesschau.de/wirtschaft/verbraucher/foederung-kredite-zuschuesse-haus-wohnen-100.html

[10] https://www.viessmann.de/de/mehrwertdienstleistungen/viessmann-waerme-strom.html

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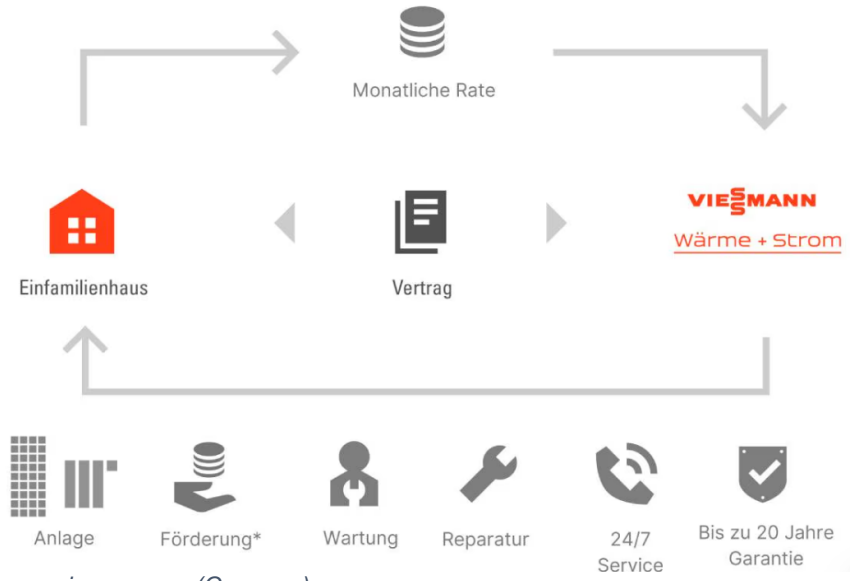

Figure 12: Diagram service process (Germany)

In Germany, several funding schemes indirectly support energy efficiency services. These funds are designed to promote energy-efficient renovations, sustainable living, and circularity in the residential sector. In many cases, EES is included as part of these schemes, covering activities such as installing PV panels or efficient heating systems. One well-known scheme in Germany is the KFW[11] promotional loan, which promotes the purchase of new buildings, the use of renewable energies, and energy-efficient renovation of existing buildings. The offer form KFW also covers various technologies such as, building envelope technologies, lighting technologies, Smart appliances, Heat pumps, Thermostats etc. The federal funding for efficient buildings - BEG promote energy efficiency and renewable energies in the building sector and supports, among other things, the use of new heating systems, the optimization of existing heating systems, measures on the building envelope and the use of optimized system technology building certifications and other sustainability factors. The BEG consists of three sub-programs:

- Federal funding for efficient buildings – residential buildings (BEG WG)
- Federal funding for efficient buildings – non-residential buildings (BEG NWG)
- Federal funding for efficient buildings – individual measures (BEG EM)

Furthermore, pbb Deutsche Pfandbriefbank[12] also has developed the concept of Green loan to finance financed real estate properties. Pbb's scoring model takes three combined dimensions into account: the energy efficiency of a building, the building certifications and sustainability factors.

Market size

In Germany, energy efficiency services are services generally provided by third-party energy service providers with the goal of implementing or incorporating energy efficiency measures.

[11] https://www.kfw.de/inlandsfoerderung/Privatpersonen/Neubau/F%C3%B6rderprodukte/F%C3%B6rderprodukte-PB-Neubau.html

[12] https://www.pfandbriefbank.com/en/customers/green-loan.html

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These service providers offer expertise, techniques, or comprehensive solutions to enhance energy efficiency. Investments in energy efficiency not only result in increased comfort, health, and productivity but also bring non-energy benefits.

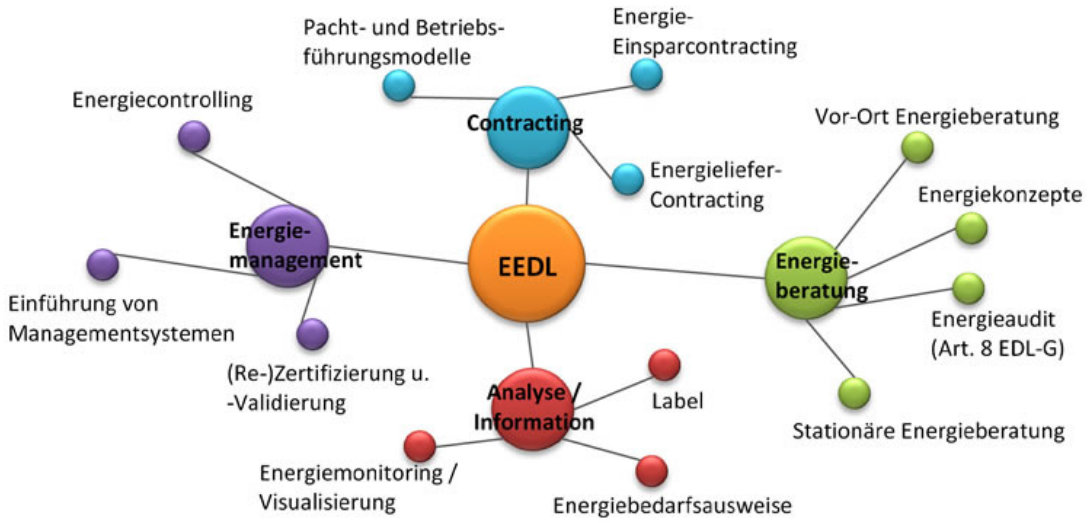

Figure 13: Overview of energy efficiency services in Germany (Source: BfEE)[13]

The range of energy efficiency services varies from simple online assessments or heating system modernization to comprehensive smart energy service packages, such as energy-saving contracts and onsite energy management. A dynamic market for energy efficiency services, supported by highly qualified providers, is a crucial requirement for achieving national and European energy efficiency objectives while promoting future-proof investments.

In Germany, the Bundesstelle für Energieeffizienz (BfEE) is responsible for reviewing and conducting market research on energy efficiency services. The primary focus of their market research includes energy service contracting, energy management services, and energy consulting.

Table 1: Market volume (Source: BfEE 20/04[14]*)*

[13] Bundesstelle für Energieeffizienz: https://www.bfee-online.de/BfEE/DE/Home/home_node.html

[14] Empirical Analysis of the Market for Energy Services, Energy Audits and other Energy Efficiency Measures Summary of the 2022 Final Report – BfEE 20/04, BfEE - Energiedienstleistungen - 2023 – Empirical Analysis of the Market for Energy Services, Energy Audits and other Energy Efficiency Measures Summary of the 2022 Final Report (bfee-online.de)

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	2015	2016	2017	2018	2019	2020	2021
Energy consulting (in € m)	Approx. 470–520	Approx. 790–850	Approx. 370–402	Approx. 360–403	Approx. 416	Approx. 654	Approx. 893
Energy contracting (in € bn)	Approx. 7.2–8.4	Approx. 7.7	Approx. 7.2–8.6	Approx. 6.7–9.7	Approx. 7.4–9.0	Approx. 8.8–10.9	Approx. 9.5–10.6
Energy management (in € m)	–	Approx. 107	Approx. 110	Approx. 99	Approx. 88	Approx. 96	Approx. 76
Total energy services market (in € bn)	**7.9–9.1**	**8.9–9.0**	**8.0–9.5**	**7.2–10.2**	**7.9–9.5**	**Approx. 9.6–11.7**	**Approx. 11.4–12.5**

The analysis for 2023 indicates that the energy service contracting market is stable, with a slight growth observed in 2022. On the other hand, the energy consulting market is experiencing significant growth. In contrast, the energy management market is declining compared to the previous year, 2022. However, the report does not separate out which part of the market is energy services for private households.

The overall annual sales of the German Energy Efficiency market in 2022 were estimated to be between approximately 10.7 and 11.4 billion euros (see table 1). The energy consulting segment accounted for around 1,038 million euros, while services related to energy management accounted for approximately 82 million euros. The market volume for the energy contracting segment is estimated to be between 9.6 and 10.3 billion euros. The survey conducted by BfEE also highlights that energy service suppliers are also expecting positive growth in energy contracting business. However, leasing or rental model are still expecting slow growth comparing to energy saving and energy supply contracting.

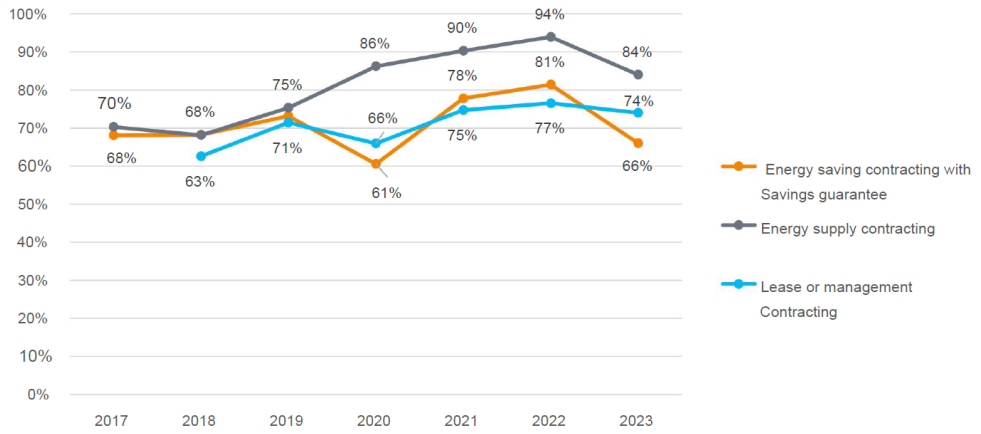

Figure 14: Proportion of suppliers who expect a growing market (Source: BfEE)

The survey conducted by BfEE also indicates a less positive market outlook compared to the year 2022 across all three categories (Figure 4).

2.6. Italy

In **Italy**, the definition of Energy Service Companies (ESCOs) and the detailed framework governing their operations, particularly in relation to energy efficiency, are primarily provided

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under the Legislative Decree 115/2008[15]. This legislation transposes the EU Directive on Energy End-use Efficiency and Energy Services (2006/32/EC) into national law.

Key Provisions of Legislative Decree 115/2008:

- Definition and role of ESCOs: The decree defines ESCOs as entities that deliver energy services or other energy efficiency improvement measures in a user's facility or premises, and accept some degree of financial risk in doing so. The payment for the services delivered is based either on the achievement of energy efficiency improvements or on the meeting of other agreed performance criteria.
- Definition energy performance contracts (EPCs) and the support mechanisms and incentives for energy efficiency initiatives, including fiscal incentives and white certificates, which ESCOs can utilize to finance energy-saving projects.

Italy has transposed the Energy Efficiency Directive (EED), Directive 2012/27/EU, into national law primarily through Legislative Decree no. 102 of July 4, 2014. The decree includes obligations for large companies to conduct regular energy audits, the promotion of energy management systems, and requirements for public bodies to purchase energy-efficient buildings, products, and services.

Legislative Decree 192/2005, decree 311/2006 and decree 28/2011 transposed the EPBD, this decree sets requirements for the energy performance of buildings, including the methodology to calculate the integrated energy performance and standards for new and existing buildings that undergo major renovations.

Demand Side Flexibility

The Legislative Decree 102/2014 implements the EU Energy Efficiency Directive (2012/27/EU) in Italy, providing a comprehensive approach to energy efficiency, including the promotion of demand response and other DSF measures.

- The Integrated National Plan for Energy and Climate (PNIEC) 2030 outlines strategies for incorporating demand-side resources into the energy market
- Italian National Regulatory Authority with the 300/2017/R/eel and 372/2017/R/eel Resolutions set out the criteria to enable the aggregation.
- The law n. 124/2017 has introduced the obligation on retail suppliers to provide at least one commercial offer linked to wholesale spot market prices in addition to flat rate offers[16].

2.7. Belgium

For **Belgium**, official sources use the definitions provided by the directive 2012/27/EU.

- **EPC framework in Flanders**

15 https://prod.iea.org/policies/426-legislative-decree-on-implementation-of-eu-energy-services-directive

16 italy_market_reform_plan_0.pdf (europa.eu)

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Energiedecreet (Energy Decree) of 8 May 2009[17] and Energiebesluit (Energy Decree) of 19 November 2010[18]: These decrees lay the foundation for energy policy in Flanders, including aspects related to energy performance contracting. They establish the legal framework for improving energy performance in buildings and support the implementation of EPCs by defining how energy savings and performance are measured and verified.

- **EPC framework in Brussels**

Order of 2 May 2013 on the Brussels Air, Climate, and Energy Code[19]: This ordinance regulates the energy performance of buildings and includes provisions for the implementation of energy performance contracting within the Brussels region. It sets out the requirements for energy audits, the use of renewable energy, and the enhancement of energy efficiency in buildings.

- **EPC framework in Wallonia**

Decree on the Energy Performance of Buildings of 28 November 2013[20]: This decree provides the regulatory basis for all matters related to the energy performance of buildings in Wallonia, including the use of EPCs. It outlines how energy savings must be calculated and the roles of various stakeholders involved in energy performance projects.

Demand side flexibility

For **Belgium**, specific characteristics of the Belgian energy market regulation regarding DR are[21]:

- The Electricity Act creates the role of an independent Flexibility Service Provider (FSP), which enables direct participation by consumers as well as independent aggregation, although an FSP still needs a BRP to gain market access. A consumer is free to choose a FSP
- The end-user is entitled to his metering data for demand response purposes, while the TSO is the responsible party for the administration of the data. For end-users connected to the distribution grid, the TSO will have to seek cooperation with the regional DSO
- An active role has been allocated to the federal regulator CREG in stimulating the evolution of demand side response within Belgium

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17 https://www.bing.com/search?pglt=675&q=Energiedecreet+(Energy+Decree)+of+8+May+2009&cvid=fb6ab00300c944c788e10aae9c36021c&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIGCAEQABhAMgYIAhAAGEAyBggDEAAYQDIICAQQ6QcY_FXSAQgxNTE5ajBqMagCALACAA&FORM=ANNAB1&PC=LCTS

18 Besluit van de Vlaamse Regering houdende algemene bepalingen over het energiebeleid [citeeropschrift "het Energiebesluit van 19 november 2010"] (vlaanderen.be)

19 Ordonnance du 02/05/2013 portant le code bruxellois de l'air, du climat et de la maitrise de l'energie (openjustice.be)

20 7 (wallonie.be)

21 Drive (2018) Demand Response Integration TEchnologies: Unlocking the demand response potential in the distribution grid: https://zenodo.org/records/3360549/files/DRIvE_D2.2.pdf

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- Not all Belgian imbalance products are open for the participation of DR, as secondary reserve isn't yet available and there are other specific products for production units larger than 25 MW that are not open to DR. Furthermore no DSO balancing services are available

2.8. Comparison of EES Models Across Countries

Country	CZ	ES	PT
Name of EES model	EPC projects		EPC (or CDE-Contrato Desempenho Energético in Portuguese) projects
Clients	Municipalities (schools etc.), regions (hospitals etc.) and private clients with high creditworthiness	Household and SME	Municipalities (including buildings and public street lighting), schools, hospitals (public and private), Shopping centers, large retail stores (e.g. large supermarkets), hotels, restaurants, large companies/industry and SMEs with relevant business volume and high creditworthiness.
Providers	Private companies	Private	Private companies namely ESCOs and the portuguese utility EDP
Financial institutions & funds	Banks	Banks	Coomercial private banks
Other actors involved	technology suppliers	technology suppliers, installers	Technology suppliers, designer, installers and auditors
Payment scheme	The client-fixed payments are based on the investment and capital costs and are paid each quarter or each half a year. Energy savings are guaranteed and shortfalls compansated.	Customers pay by financing instalments or in two payments (50% contract signature; 50% at the time of installation).	The ESCO makes the investment and is responsible for the project implementation. The ESCO is payed through the savings achieved. These savings are usually garanteed.

2.9. Common core components of the EES models

Effective provision of services in the field of energy efficiency requires thorough and systematic planning, as well as clear definition of basic parameters that determine the scope, process, and expected outcomes of the provided services. This phase is crucial for the success of the project and to ensure the maximization of benefits to the clients.

The first step involves meticulous planning, which includes identifying client needs, setting project goals, and designing a strategy to achieve these goals. This involves analyzing the

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current situation, identifying key areas for potential energy savings, and establishing realistic expectations.

A thoroughly defined scope of services is essential for clearly outlining what the project will entail. This includes specifying the specific activities to be performed, establishing a timeframe, and assigning responsibilities for each task.

Another important parameter is planning the project deployment process, which involves setting key milestones, scheduling, and coordinating activities among team members. This helps ensure that the project is executed efficiently and in line with previously defined timetable.

The final and most important parameter is defining the expected outcomes and deliverables of the project. This includes setting specific goals that the project aims to achieve and identifying success indicators to evaluate the achieved results.

By offering comprehensive services encompassing assessment, implementation, monitoring, measurement, verification and customer support, the EES aims to assist clients in achieving significant energy savings, reducing operational costs, contributing to environmental sustainability and climate change mitigation.

Common core components of EES models typically include:

Energy Audit:

This initial step involves assessing the energy consumption patterns and identifying potential areas for improvement. Energy audits help to understand the current energy usage, to determine energy efficiency opportunities, and to set up benchmarks for future improvements.

Consultation and Analysis:

EES offers consultation services to clients, providing detailed analysis and recommendations tailor made to their specific needs. This may include suggestions for energy-efficient technologies, behavioral changes, and cost-effective measures to reduce energy consumption.

Implementation of Energy Efficiency Measures:

Once energy-saving opportunities are identified, the EES assists clients in implementing energy-efficient measures. This could involve upgrading/retrofitting lighting systems, installing energy-efficient appliances, improving insulation, adopting renewable energy solutions like solar panels, etc.

Monitoring and Verification:

Continuous monitoring, measurement and verification are essential to ensure that the implemented energy efficiency measures will achieve the expected results. The EES provides tools and systems to monitor energy consumption, to track savings, and to assess the performance of installed technologies over time.

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Training and Education:

To maximize the effectiveness of energy efficiency measures, the EES offers training and education programs for clients and their staff. These programs aim to raise awareness about energy-saving practices, encourage behavioral changes, and empower individuals to contribute to energy conservation efforts.

Maintenance and Support:

Energy-efficient technologies require regular maintenance (usually less that the old inefficient technologies) to ensure optimal performance and longevity. The EES provides maintenance services and technical support to address any issues that may arise, ensuring smooth operation and maximization of energy savings.

Financial Analysis and Incentives:

The EES may also offer financial analysis services to help clients evaluate the financial viability of energy efficiency projects. This may include calculating potential energy savings, return on investment (ROI), and identification of available incentives or rebates schemes to reduce the upfront investment.

3. Customer needs

Understanding customer needs is crucial for a successful delivery of energy efficiency services. Each customer has their specific goals, preferences, and expectations that need to be taken into account when designing and delivering energy solutions. Understanding these needs is a key factor for a successful and profitable working relationship with clients by providing them valuable and relevant solutions that meet their individual requirements and goals.

Energy Efficiency Analysis and Assessment:

Energy efficiency analysis and assessment are fundamental steps in planning energy-saving measures. This service begins with a detailed survey of the existent energy systems and energy consumption patterns in a given environment/location. This may include analysis of the energy efficiency of buildings, industrial facilities, or even entire energy networks. Energy efficiency experts conduct thorough measurements and data collection to identify areas where the most significant energy savings can be achieved.

Design and Implementation of Energy-Saving Measures:

Based on the results of the analysis, a plan that includes recommendations for implementing energy-saving measures is designed. This may include insulation measures, replacing or retrofitting outdated equipment with more modern and energy-efficient alternatives, automated energy systems, etc. A detailed implementation plan is the key for success, ensuring that customers fully understand the plan and how it allows to achieve the maximum energy savings.

Monitoring and Energy Consumption Management:

After implementing energy-saving measures, customers need a system for regular monitoring, measurement, and management of energy consumption. This system allows

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them to monitor and analyze their energy consumption in real-time and identify potential areas for further optimization. Monitoring and measurement can be done using specialized software tools, sensors, and other technologies.

Financial Analysis and Support:

Investing in energy efficiency can be financially demanding for customers. Therefore, they need services that provide detailed financial analysis of the return on investment in energy-saving measures. This may include advice on possible subsidies, loans, or other financial support schemes available for financing energy efficiency projects.

Training and Consultation:

The proper use of the energy systems requires not only technical knowledge but also appropriate training and consultation. Customers need to be informed about the optimal use of their equipment and systems to achieve maximum energy savings. Training may include instructional courses for employees, advice on operational procedures and behavioral changes, and other forms of support in order to create energy savings.

Regular Maintenance and Servicing:

To maintain the long-term efficiency of energy systems, regular maintenance and servicing are essential. Customers need services that provide regular inspections, maintenance, and servicing of their equipment. This includes routine inspections, preventive maintenance, and rapid response to any faults or issues.

Flexible Energy Consumption Management:

Some customers may require the flexibly to manage their energy consumption based on prices, availability of renewable sources, or grid requirements.

Integration of Renewable Energy Sources:

Customers investing in solar panels, wind turbines, or other renewable energy sources may need services to integrate these sources into their energy systems.

Optimization of Battery and Energy Storage Utilization:

For customers with batteries or other energy storage systems, relevant services may include optimizing the charging and discharging of these storage systems to maximize their performance and lifespan.

Virtual Power Plant Services:

Some customers may be involved in virtual power plant programs that allow them to share their variable energy consumption or production with grid networks to stabilize the power grid.

Energy Security and Reliability:

Customers may need to increase the security and reliability of their energy systems through backup energy sources, battery storage, thermal storage, diesel generators, or other measures.

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Energy Analysis and Forecasting:

For customers operating large energy systems, it may be important to conduct energy analysis and forecast future energy consumption and production for planning and optimization.

Integration of Renewable Energy Sources (RES):

Customers may need assistance in integrating renewable energy sources into their energy systems. This includes solar photovoltaic panels, wind turbines, small hydroelectric plants, etc. The EES service can help to optimize the use of RES and integrate them into existing energy infrastructures in order to maximize its use and reduce the demand from the power grid.

Demand Response (DR) Management:

Customers may seek services for managing their energy demand, which includes the ability to respond to changes in supply and demand in the energy market. This may include programs that encourage shifting consumption to times of lower demand or switching to alternative energy sources when needed.

Energy Storage (Batteries) Services:

Offering services related to energy storage, such as batteries, can be crucial for customers looking for ways to optimize their energy use. Energy storage allows storing energy from RES for later use and charging batteries during periods when the electricity tariff is lower and discharge them when peak periods where the electricity price is high, as well as for power grid stabilization.

Building Management System (BMS):

EES services may also include building management systems, which involve systems for monitoring and controlling energy systems in buildings. This service can help optimize energy use and improve the comfort and efficiency of building systems.

Adaptation to Regulations and Standards:

With an increasing emphasis on energy efficiency and sustainability, customers may need help adapting to new regulations and standards related to energy efficiency. The EES service can provide advice and support for compliance with regulation and for the implementation of new technologies and procedures.

Market Trend Analysis and Prediction:

Customers may be interested in the analysis and prediction of market trends in energy efficiency and flexibility. EES services can provide regular updates and forecasts regarding changes in the energy sector, allowing customers to better plan their investments and strategies.

4. Business Model Canvas

The BungEES consortium initiated a broad discussion within the consortium and during the project workshops the optimal business model for the newly developed energy efficiency-focused service was carefully discussed and established.

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Workshop on Identification of Existing Services & Developing of New Energy Efficiency Services at Kick-off Workshop (17-18 November 2022, Paris, France)

Within the frame of the BungEES project meeting, workshops were successfully held in Paris focusing on Identification of Existing Services & Developing of New Energy Efficiency Services. The data collected and the knowledge shared was subsequently used to develop Task 2.1: Service concept and the concept design of the innovated service model. The discussion covered existing services that provide energy efficiency improvement of buildings, installation of new technical equipment and energy management. Lists of technologies, energy carriers, key customers and EES partners were discussed and developed.

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Figure 15 - Workshops on Identification of Existing Services & Developing of New Energy Efficiency Services

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Workshop on Smart Energy Efficiency Services and EU experience (December 4, 2023, Prague, Czechia)

The BungEES project successfully hosted a workshop on December 4th, 2023, in Prague as part of the project consortium's 3rd meeting. The forum brought together industry professionals and project stakeholders to explore the current state and future prospects of Smart EES.

Commencing with an insightful overview of the Smart EES concept, the workshop featured a presentation on the state of affairs in its development. The session set the stage for a day of engaging discussions, including the presentation of study outcomes on market-proven services and the X-as-a-Service business model in the construction sector. Challenges posed by regulatory risk, red tape, and bureaucracy were identified as key issues hindering the current status quo. The workshop further explored the project's strategies and solutions for validating the business model and addressing challenges in quantifying the non-energy benefits (NEBs) incorporated in the comprehensive BungEES one-stop shop.

The workshop culminated with a panel discussion on Opportunities and Barriers to Smart EES.

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Figure 16 - Workshop on Smart Energy Efficiency Services and EU Experience

After many discussions, analyses, and consultations, it was decided to create a business model canvas to map out the key aspects of our business model. This will help to better understand how the consortium will create, deliver, and capture value for our customers. This chapter presents a detailed look at the individual components of the business model canvas and explore how it can effectively utilize this framework to achieve our business objectives.

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<table>
<tr><td rowspan="2">Key Partners</td><td>Key Activities</td><td rowspan="2">Value Proposition (Benefits)</td><td>Customer Relationships</td><td rowspan="2">Customer Segments</td></tr>
<tr><td>Key Resources</td><td>Channels</td></tr>
<tr><td colspan="3">Cost Structure</td><td colspan="2">Revenue Streams</td></tr>
</table>

Figure 17 – Business Model Canvas Scheme

The following sections show the specified parts of the Business Model Canvas that have been determined in accordance with the model being developed.

4.1. Key Partners

Partnering with key stakeholders is critical for Smart EES providers to effectively deliver solutions, access resources, and navigate regulatory landscapes in the dynamic energy efficiency market. The Business Canvas Model focuses on identifying these key partners and their contributions to the business, whether they are suppliers of key resources, collaborating firms, distribution channels, or strategic alliances.

Competent authorities (regulator, legal conditions)

Competent authorities, including regulatory bodies, play a key role in defining the legal conditions and regulations that affect the operation and implementation of services in the field of energy efficiency and flexibility. Collaboration with these authorities is crucial for compliance with regulations and ensuring compliance with legislative requirements, which builds trust with customers and provides a stable and legally secure environment for the development of the EES market.

Energy professionals (designers, engineers,, consultants, installers)

Energy professionals, such as designers, engineers, consultants, and installers, play a crucial role in the implementation and operation of services in the field of energy efficiency and flexibility. Their expertise and skills enable high-quality design, installation and maintenance of energy systems and equipment, which is crucial for achieving optimal results for customers. Collaboration with these professionals allows offering comprehensive and professional services that meet the needs of customers in the EES field.

Financial institutions banks to the customer or energy supplier

Financial institutions, such as banks, play an important role in financing projects related to energy efficiency and flexibility. Providing financial resources for investments in energy-saving measures and technologies enables customers and energy suppliers to implement projects that might otherwise be financially inaccessible. Collaboration with financial institutions can increase the availability of financing for customers while also supporting the development of the EES market.

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Funding institutions (private funds, public banks, public bodies)

Private funds, public banks, and governmental institutions can provide financial support and grants for projects in the field of energy efficiency and flexibility. This financial assistance can be crucial for supporting innovative projects and technologies that contribute to sustainable development and greenhouse gas emissions reduction. Collaboration with these institutions enables access to financial support for EES projects while also reinforces customer confidence in their implementation, as well as in the EES market.

Researchers

Research institutions and organizations play a key role in the development of new technologies and methods in the field of energy efficiency and flexibility. Collaboration with researchers enables access to the latest knowledge and innovations in the field, which can lead to the improvement of existing services and technologies and in the discovery of new market/business opportunities. Furthermore, collaboration with research institutions can provide credible and objective information about the effectiveness and feasibility of individual technologies in the EES field.

Startups

Startups represent a source of innovation and new technological solutions in the field of energy efficiency and flexibility. Their agile and experimental approach can lead to the discovery of new possibilities and the improvement of existing practices. Collaboration with startups enables access to new ideas and technologies that can enhance competitiveness in the market.

Marketplace

Marketplaces provide a platform for showcasing and distributing products and services in the field of energy efficiency and flexibility. They serve as a meeting point for supply and demand, enabling the efficient connection of service providers with potential customers. Collaboration with marketplaces allows reaching a broader audience and gaining new business opportunities.

Platforms (apps, SW for managing energy aggregator's platform)

Platforms for managing energy aggregators provide technological solutions for optimizing and controlling energy systems and devices. They are key tools for providing services in the field of energy flexibility and demand management. Collaboration with these platforms enables the utilization of advanced technologies for efficient energy management and operation.

Manufacturers (devices and technologies)

Manufacturers of devices and technologies play a crucial role in providing technological solutions for energy efficiency and flexibility. Their products, such as energy-efficient appliances, solar panels, or smart controllers, allows customers to reduce energy consumption and optimize the operation of their homes.

Small and medium-sized enterprises (SMEs)

Small and medium-sized enterprises play a key role in every country economy and are crucial drivers of innovation in the energy sector. They are capable of quickly responding to market

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changes and are able to provide flexible and adaptable solutions for customers. Collaboration with SMEs enables the utilization of their specialized know-how and expertise in offering energy-efficient products and services.

Energy suppliers (providing the one stop shop service)

Energy suppliers can play a key role in providing comprehensive services for energy efficiency and flexibility. Their services may include energy audits, consultancy, installation and maintenance of energy equipment and technologies, as well as energy contract management. This capability enables customers to have easy access to solutions for improving the energy efficiency and flexibility of their homes.

Government authorities

Government authorities influence the creation and implementation of policies and programs in the energy sector. Collaboration with them allows support for energy projects and access to public financing for the implementation of energy measures.

Service Providers (providers of concepts, technologies)

Service providers are key partners in providing concepts and technologies in the energy sector. Collaboration with them enables the utilization of their expertise and experience to create and implement effective energy solutions.

Energy Consumers/Prosumers

Consumers/Prosumers are end-users of energy services and have a significant impact on the demand for energy products and services. Collaboration with them allows for a better understanding of their needs and preferences and the adaptation of offered services to best meet their requirements.

Utilities

Energy companies and distributors play a crucial role in providing infrastructure and services for energy supply and management. Their involvement in the energy market can support investments in energy efficiency and flexibility and enable the integration of innovative technologies and services into existing infrastructure and processes.

Key Activities	Installation of RES
	Funding equipment
	Funding EE measures
	Recruitment of the costumers
	Evaluation
	Monitoring and communication of the systems
	Verification and controlling the installations

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	Initial data collection
	Scoring of costumers
	Flexibility
	Implementation of EE measures
Value Proposition (Benefits)	Customers
	Customers benefitting from new and smart service offers and up-take of services that facilitate the integration of sectors and energy carriers
	Reduced energy costs for end-users
	Reduced payback times of investments into sustainable energy
	Increased viability of services
	Up-take of contractual schemes that ensure legal and regulatory certainty, an attribution of fair shares of value across parties and a minimum of transaction costs
	Integrated benefits for the customers
	Faster involvement in green transition
Service providers	Faster involvement in green transition
	Economic benefits (new revenues)
	Increase loyalty to the service
	Increased flexibility
	New data available (from the customers)
	New market (business model)

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Customer Relationships	Customer
	Delivery of services
	Delivery of service and equipment management
	Partner
	Conclusion of an agreement for the exchange of information, experience and new trends.
Customer Segments	Research
	Energy professionals and researchers
	Commercial & Investments
	Experts from ESPCs, aggregators, DSOs, energy cooperatives, building owners and tenants, building managers
	EE Investors, financial institutions, EBRD and EIB, buildings owners
	Setting standards & Policy
	Competent authorities and agencies responsible for setting and enforcing (where applicable) standards
	Decision makers and opinion formers
	Social
	Occupants/tenants' representatives
Channels	Workshops, Seminars
	The prosumer platform (set up by the project and other existing platforms)
	Information days
	Partners' and project's websites
	Scientific publications
	Specific F2F meetings with the competent authorities

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5. Suitable EES and their potential

This chapter focuses on identifying and describing various services that can be offered to customers and explores their potential and benefits for achieving the energy efficiency and energy flexibility objectives. The chapter includes a list of selected services that have been evaluated as the most suitable for the proposed Smart EES model.

The aim of the chapter is to provide a comprehensive overview of the opportunities offered by energy efficiency and flexibility services. It describes how these services will be utilized to achieve optimal results for customers, energy operators, and companies as a whole.

5.1. Selected technologies suitable for Smart EES

The selected technologies represent key components of comprehensive Smart EES packages, offering a diversity of functionalities to address various energy management challenges and enhance overall efficiency and sustainability.

CO2/Gas sensor	Monitoring indoor air quality and detecting gas leaks to ensure a safe and healthy environment.
	Optimizing ventilation systems based on real-time data to improve energy efficiency and occupant comfort.
Motion sensor	Automatically controlling lighting and HVAC systems based on occupancy, reducing energy waste in unoccupied areas.
	Integrating with security systems to enhance building safety while minimizing unnecessary energy consumption.
Heat Pumps	Utilizing renewable energy sources such as air, ground, or water to provide heating and cooling, thereby reducing reliance on fossil fuels.
	Employing advanced control algorithms to optimize the performance of heat pumps and maximize energy savings.
Batteries	Storing surplus electricity generated from renewable sources like solar panels for later use, increasing self-consumption and energy independence.
	Offering backup power during grid outages, enhancing resilience and reliability of energy supply.
PV´s	Generating clean electricity from sunlight to offset grid power consumption and reduce carbon emissions.
	Implementing smart grid integration features to support bidirectional energy flow and facilitate energy trading.
Smart thermostats	Learning occupant preferences and adjusting heating and cooling settings accordingly to optimize comfort and energy efficiency.
	Providing remote access and control via mobile applications for convenient management of HVAC systems.

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e-mobility	Charging electric vehicles (EVs) intelligently to minimize grid stress and take advantage of off-peak electricity rates.
	Integrating EV charging infrastructure with renewable energy sources to promote sustainable transportation solutions.

CO_2/Gas sensor

Thanks to suitable sensors, air quality can be monitored, and gas leaks can be detected, increasing safety and comfort for residents. The benefits of using sensors include identifying safety risks and opportunities for improving environmental quality. In terms of energy flexibility, sensors can help to optimize system operation based on air quality and user needs.

Motion sensors

Motion sensors enable the detection of human presence and can activate or deactivate lighting and other appliances, reducing unnecessary energy consumption and contributing to cost savings. In terms of energy flexibility, they can be used for automatically manage energy consumption based on occupancy and environmental dynamics.

Heat Pumps

Heat pumps allow to use energy in a more efficient way using outside environment for heating and cooling of buildings. Heat pump benefits include reducing energy costs and CO_2 emissions. In terms of energy flexibility, they can be used for heat storage using the thermal mass of the building during low demand periods and subsequent release during peak load times.

Batteries

Batteries enable the storage of surplus energy from renewable sources or at low-tariff periods and its subsequent use during peak demand periods. The benefits include optimizing energy consumption, reducing costs, and increasing independence and resilience from the grid. In terms of energy flexibility, batteries can be used for energy storage and load balancing in the distribution network.

PV´s

Photovoltaic panels allow for the generation of electricity from renewable sources, reducing dependence on conventional sources and decreasing CO_2 emissions. The benefits include long-term energy cost savings. In terms of energy flexibility, they can be used for charging batteries, direct supply to buildings/facilities and for energy consumption optimization.

Smart thermostats

Smart thermostats enable efficient control of home heating and cooling according to user needs and external conditions, as well as to reduce unnecessary energy consumption and costs. In terms of energy flexibility, they can be used to automatically adjust temperature based on energy prices, weather forecast or renewable energy availability.

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e-mobility

Electric mobility represents a more environmentally friendly alternative to traditional combustion engines, reducing CO_2 emissions and air pollution. The benefits include fuel cost savings and increased energy self-sufficiency. In terms of energy flexibility, electric vehicles can be used for energy storage (V2G – Vehicle to Grid) and for load balancing in the distribution network.

5.2. Identification of energy-saving opportunities

Energy improvement proposals provide customers with specific recommendations and plans for enhancing the energy efficiency of their homes. The benefits include identifying specific measures and technologies that can lead to energy and cost savings. To address energy flexibility, proposals may focus on optimizing energy consumption according to users' individual needs and preferences.

An energy audit is a key step in the design of an energy efficiency service for buildings, it allows to identify areas where energy savings and overall energy efficiency can be achieved. This process involves a thorough analysis of all energy systems, insulation, appliances, and other factors affecting energy consumption. The following steps describe how an energy audit should be performed:

Preliminary Analysis and Planning

The first step in conducting an energy audit is to perform a preliminary analysis and planning. An energy expert will visit the building and interview the users to understand their needs, priorities, energy related habits/behaviors and areas with the highest potential for achieving energy savings.

Data Collection and Energy Consumption

Once the audit goals are defined, the energy expert will collect data related to energy consumption patterns. This may include analyzing energy bills, measuring electricity, gas, and heat consumption, and examining the appliances and technologies used in the house.

Visual Inspection of the House

The next step is a visual inspection of the house, during which the expert will look at the condition of the insulation, windows and doors, heating and cooling systems, lighting, and other elements affecting the energy efficiency of the house. Potential problems and areas where energy savings can be achieved are identified during this inspection.

Data Analysis and Identification of Energy-Saving Measures

Based on the data collection and visual inspection, the energy expert will conduct a detailed analysis to identify areas where the significant energy savings can be achieved. This may include insulation of walls, roofs, and floors, replacing inefficient windows and doors, updating heating and cooling systems, installing high-efficiency appliances and lighting retrofit or replacement, as well as other energy saving measures.

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Processing and Presentation of Results

After completing the energy audit analysis, the energy efficiency expert will prepare a report containing the audit results and the proposed energy-saving measures. Homeowners will be briefed on the audit results and proposed measures, as well as further discussions will be held about next steps.

Implementation and Monitoring

Upon approval of the proposed measures, necessary adjustments and improvements can be made by homeowners. After implementation is completed, regular monitoring of the energy consumption in the house is recommended to track savings and make any necessary adjustments or optimizations.

5.3. Financial analysis and evaluation service

Financial analysis and evaluation are key components in the process of planning, investing, and managing finances for both individuals and businesses. Financial analysis and evaluation are essential for assessing financial health and performance and for establishing strategies to achieve financial goals. Here is a detailed description of how the financial analysis and evaluation service would proceed:

1. Initial Consultation and Planning

The first step in providing financial analysis and evaluation is to consult with the client to understand their financial goals, needs, and expectations. Based on this consultation, a plan is created for conducting the financial analysis and evaluation.

2. Collection of Financial Data and Information

Once the objectives and scope of the analysis are defined, all necessary financial data and information are gathered. This may include financial statements, bank statements, tax returns, investment portfolios, and other relevant documents.

3. Analysis of Financial Position and Performance

Based on the collected data and information, a thorough analysis of the client's financial position and performance is conducted. This may involve analyzing profitability, liquidity, leverage, and asset management efficiency.

4. Development of Recommendations and Strategies

Based on the analysis of the results, recommendations and strategies are developed to achieve the client's financial goals. This may include optimizing cash flow, diversifying investment portfolios, reducing debt, or retirement planning.

5. Presentation of Results and Consultation

Upon completion of the analysis, the results are presented to the client and discussed with them. During this consultation, the client is given the opportunity to ask questions and clarify any uncertainties regarding recommendations and strategies.

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6. Implementation and Monitoring

After the client approves the recommendations, the proposed strategies and measures are implemented. The client is advised to regularly monitor their financial results and make any adjustments or optimizations in line with changing conditions and goals.

5.4. Monitoring and management of energy consumption service

Data Collection and Energy Consumption Analysis:

This service involves regular data collection on energy consumption from various sources, such as electricity meters, heat meters, cooling systems, water meters, etc. This data is then analyzed to identify trends, seasonal variations, and potential energy-saving measures.

Real-time Monitoring:

Real-time monitoring provides instant information on energy consumption and the performance of energy systems in real-time. This allows for immediate response to consumption fluctuations and the identification of potential issues in energy systems.

Energy Dashboards and Reports:

Creating energy dashboards and reports allows customers to visualize their energy consumption and the performance of their energy systems. These tools enable easy data interpretation and tracking progress towards energy goals.

Remote Control and Automation:

This service enables remote control and automation of energy systems, such as heating, air conditioning, lighting, etc. Customers can set schedules, temperature limits, and other parameters to optimize the operation of their systems.

Performance Analysis and Consultancy:

Expert performance analysis of energy systems and consultancy regarding optimization and energy savings are key services in this area. This includes identifying effective measures, recommendations for adjusting settings, and technical support.

Alarm Management:

Alarm management systems monitor the energy systems and generate alerts for system administrators in case of faults, anomalies or problems. This allows a quick response to potential issues and minimization of downtime.

5.5. Legislative and regulatory advisory service

These services in the field of consultancy on legislative and regulatory issues are designed to help homeowners to comply with regulations and minimize risks associated with legal issues, while also keeping them informed about current requirements and changes in legislation.

Analysis and interpretation of relevant regulations:

Providing analysis and interpretation of legislative and regulatory documents related to energy efficiency, environmental protection, safety, and other aspects of home systems and equipment.

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Consultancy on implementing new regulations:

Assisting homeowners in implementing new legislative requirements, including recommendations for upgrades and changes to home systems and procedures to comply with new/updated regulations.

Regulatory compliance audit:

Conducting a regulatory compliance audit, which includes a thorough inspection of house equipment and systems to determine if they meet all applicable legal requirements.

Training and education:

Providing training and education for homeowners or building users regarding current legislative requirements, their obligations, and the impact on their behavior in the energy consumption.

Legal advice and support:

Offering legal advice and support in cases where homeowners have questions regarding legislation and regulation and assisting them in resolving any legal issues that may arise.

Monitoring legislative changes:

Regularly monitoring and informing homeowners about changes in legislation and regulatory requirements that could affect their homes and providing recommendations for taking appropriate actions.

5.6. Training and consultancy service

Energy Efficiency Training such as:

Workshop courses and seminars focusing on energy efficiency principles, including technologies and strategies for optimizing energy consumption.

Interactive training for employees and managers emphasizing the importance of efficient energy use and providing practical tools for implementing savings measures.

Energy Management Consulting services such as:

Individual consultations with energy efficiency experts who provide recommendations and strategies for optimizing energy in specific environments.

Building energy profile analysis and identification of energy-saving opportunities through technical audits and consumption assessments.

Energy Consumption Monitoring and Evaluation services such as:

Implementation of monitoring systems for data collection and analysis of energy consumption to identify potential savings and optimize operational costs.

Periodic assessment of the performance and effectiveness of the implemented energy saving measures and their adjustment to the current needs or technological trends.

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Support for Energy Solutions Implementation services such as:

Assistance in planning and implementing energy efficiency projects, including selection of appropriate/adequate technologies and suppliers.

Accompaniment during the implementation of recommended energy saving measures and monitoring of their effects to ensure the achievement of set energy goals.

5.7. Implementation of energy projects service

The following steps are essential for a successful implementation of an energy efficiency project:

Identification of the client needs

The EES supplier needs to understand the client needs and expectations. According to the information provided by the client and the location technical conditions, the EES supplier should provide advice on the most suited technologies to achieve significant energy savings.

Establishing a clear plan for improving energy efficiency in compliance with client needs

It is crucial to establish a clear plan, made in collaboration with the client, that is in compliance with the site technical conditions, the client willingness and financial capability to invest, that prioritizes the energy-efficiency measures that yield the most significant energy savings or the ones with the quickest paybacks. This plan needs to verify the compatibility of the selected technologies with the existing systems in order to allow its integration.

Selecting the adequate technology and implementation timetable

As mentioned above, the EES supplier needs to select the most suited technology systems according to the energy goals, onsite technical conditions and client investment capacity (if the client is investing). In this stage it is essential to establish a well-defined implementation timetable to manage the client expectations regarding the systems commissioning, which usually imply the systems to be running in a very short period of time.

Choosing equipment suppliers and/or installers

The choice of trustworthy suppliers and installers is crucial to assure a timely delivery of the project according to the previously defined schedule, as well as to avoid any disruption of the supply chain caused by the lack of expertise of the supplier/installer. In this stage it is ensured that the installation of new equipment or existing systems retrofitting is carried out by qualified professionals.

Commissioning, operation and maintenance

A well performed commissioning (systems testing and debugging of potential problems) of the project is crucial to ensure the client trust and maintain a healthy relation with the client. Customer support during the system operation and maintenance stages is also essential for the project success and will avoid misuse that might have impact in energy-saving results. To avoid this misuse, it is important to prepare in collaboration with the client, a staff training programme that provides knowledge and good practices to the staff in order to operate the new systems efficiently and safely. This training will raise staff awareness on the project purpose, energy-saving practices and will help to change the usual behavior into a more

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energy-efficient conduct that will help to achieve the project energy-saving goals. Regular maintenance is also very important to ensure that the equipment is operating at its optimal point and to reduce the downtime. Additionally, the data collected by the maintenance team can further be used to improve the building energy efficiency plan or even to generate new opportunities for energy savings.

Monitorization and verification

After implementation, continuously monitorization and verification of the performance of the installed technologies is essential to ensure the achievement of the energy savings goals. This can be done through regular energy audits or using energy management systems to track the evolution of the energy consumption, as well as to introduce adjustments to equipment set points or configuration that will allow to improve performance and achieve the establish goals in terms of energy savings.

By following these steps, different stakeholders (EES suppliers, clients, etc.) can ensure that their energy efficiency projects are not only successful in achieving immediate energy savings but also sustainable in the long term, contributing to overall operational cost reductions and environmental sustainability.

Selection of EES and technology

From Plenitude, we believe that the simplest solutions that are currently being developed within the energy market are those that have been studied during this project such as solar panels for obtaining renewable energy, we believe that this is the easiest source of renewable energy to implement in a home and in which there are more players in the market. The need to store this renewable energy highlights the interest and value of storage batteries as these devices can provide a certain independence from the grid. In line with the European energy model and the search for electrification, the substitution of natural gas equipment or other fuels is being sought, which is why the control or installation of heat pumps is being promoted as an optimal solution for the air-conditioning of dwellings. This technology should be supported by intelligent thermostats to control energy demand and increase the comfort of the home.

Finally, as electric mobility is being supported by all European bodies, special mention should be made of the use of charging points to implement the solution and develop the charging of electric vehicles, as well as in the future it would be interesting to be able to implement the capacity of vehicles with Vehicle to grid (V2G).

Within these aspects, the most decisive aspect is the unification and compatibility of the different brands of suppliers, as each one has its own type of communication and it will be complex to develop a solution in which these types of solutions are compatible and controllable.

Project implementation

Numerous pilot projects have been set up to study the different possibilities and to see the composition in each of the countries. A project is currently being developed in Portugal to control heat pumps in student residences, the second project planned in Portugal is the

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control of a heat pump, a self-consumption installation, a storage battery, a recharging point and an electric water heater.

On the Spanish side, 3 climatically interesting areas have been identified in order to develop three pilots to control 15-20 heat pumps of Plenitude's residential customers, these pumps can be air-to-water and air-to-air. The installation process will start at the end of May in the Barcelona area, this will be the first step. As for the next step, installations will begin in June.

The aim of these installations is to study how heat pumps work in Spain and how customers would test the development of DR, as well as to test flexibility solutions in Spain under real conditions. The aim is to regulate customers' consumption by turning their devices on and off to generate savings for the customers involved without affecting their comfort.

Other projects will be developed in the following months in the Czech Republic and Slovakia.

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6. Smart EES packages

This chapter provides an overview of **key elements that should be included in an effective and user-friendly Smart EES** model. It focuses on innovative approaches to energy efficiency and energy consumption optimization through smart technologies and services. The main objective is to analyze and present various service packages designed to help users optimize their energy consumption, reduce costs, and improve sustainability and explore the strategies, technologies, and concepts used to create these service packages. Examining these packages not only offers insights into current trends in energy efficiency but also contributes to the discussion on the future direction and development of smart energy solutions.

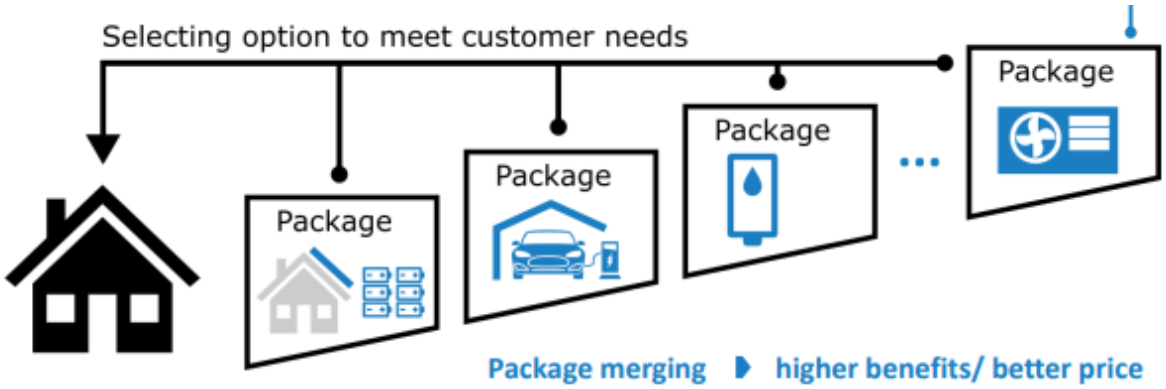

Figure 18 – Diagram of system for Smart EES model packages

6.1. Technical Solution Packages

From the commercial point of view, the BungEES packages need to be distributed using a model where the acquisition of more packages represents more benefits (e.g. a higher discount, more energy savings, etc.). The use of this distribution model will attract client to acquire a bundle of services (packages) to obtain a higher discount (e.g. acquisition of one package represents a 10% discount and for each additional package an extra 5% discount). For each additional package acquired, the end-user gets a more energy efficient system that allow to obtain higher savings and is more cost-effective. This model might also be more interesting for energy services providers because it may allow to increase the sales volume and the combination of technologies gives them a diversification of their business model. Additionally, for financing institutions systems with higher upfront costs gives them the possibility of having higher profits. The combination of packages increases the possibility of creating flexibility services in each house/building. Due to this fact the BungEES model is also crucial for the establishment of flexibility services.

Package 1: There should be a complete package in which the customer can have all the solutions available. These solutions would include self-consumption solutions, charging point solutions, storage with storage batteries and heat pumps to produce the necessary heat energy to heat the rooms. This is a novel solution that does not comply with conventional brands, as there are solutions on the market that can communicate the recharge points with the photovoltaic panels, but there is no solution that encompasses all these services.

Package 2: In this package I would give the option of combining the photovoltaic installation with the electric vehicle, in order to use the surplus energy to charge the electric vehicles,

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giving priority to the electric vehicle over the house or whatever the customer decides. With this solution, 100% renewable energy would be used to recharge an electric vehicle.

Package 3: You would get an application to manage the photovoltaic self-consumption with the heat pump. This would be used to heat the house by using solar energy or with self-consumption energy stored in the customer's storage battery.

6.2. Packages of services offered

These packages present a comprehensive set of measures and services designed to optimize energy usage in households, commercial buildings, and industrial facilities. Each package is tailor made to meet the customer needs and aims to reduce energy consumption, increase energy efficiency, and support sustainable operations.

BungEES will explore various types of packages provided by energy companies and analyze their individual components and benefits for end-users. From energy efficiency audits to the installation of energy-saving devices/equipment and incentive programs for participants, these packages offer a wide range of options for reducing energy costs, improving comfort, and protecting the environment.

The following chapter provides an insight into the world of energy services and demonstrates how service packages can contribute to a more sustainable energy use and for .

Smart EES packages include components essential to any EES, such as energy audits and installation of energy-efficient equipment. In addition, smart EES packages include extensive employment of smart technologies and smart energy management, which are described below in more detail.

6.2.1. Analyses and Energy Audits

Providing energy auditing services to examine homes, businesses, or industrial facilities is essential to identify areas where energy efficiency can be improved. Energy efficiency auditing is an important first step in the effort to optimize energy use in a house, apartment building, or commercial facility. It is a systematic process in which appliances, building envelope, heating, cooling, lighting systems, and other factors affecting the energy efficiency of the building are analyzed.

During the audit, a comprehensive evaluation of the current state of energy efficiency of the building is conducted. This includes an analysis of the energy consumption, assessment of insulation, evaluation of heating and cooling systems, assessment of lighting, and identification of potential areas for improvement. The goal is to find ways to reduce energy consumption and increase energy efficiency without compromising the comfort of occupants.

During the audit, the following activities may be carried out:

1. **Energy consumption analysis**: Evaluation of historical energy consumption and identification of areas with high consumption.
2. **Building envelope and air tightness inspection**: Examination of the condition of insulation materials, thermal bridges, windows, and doors to determine the extent of heat loss.

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3. **Heating and cooling assessment**: Assessment of the existing heating and cooling systems, including evaluating the condition and efficiency of heating/cooling appliances, air conditioning, and ventilation.
4. **Lighting analysis**: Assessment of lighting systems in use and evaluation of options for replacement or retrofit into more energy-efficient lighting systems, such as LED lights.
5. **Identification of areas for implrovement**: Evaluation of all identified shortcomings and proposing measures that will lead to improved energy efficiency of the building.

After the audit, a detailed report is typically submitted containing an analysis of the current state, recommended measures to improve energy efficiency, as well as to estimate costs and savings associated with these measures. This report serves as a guideline for building owners for deciding which are the steps to optimize the energy use of their property.

The audit provides users with an overview of how energy is consumed in their house or facility. It helps to identify specific areas where significant energy savings can be achieved and proposes measures to increase energy efficiency. Through the audit, users can identify and implement measures that reduce their energy consumption. This can lead to significant energy savings and reduced operational costs. Some energy-saving measures, such as improved insulation, modernization of heating/cooling systems, or lighting improvements, can additionally enhance overall environmental comfort for users and achieve high energy savings. This may include improved indoor climate control temperatures, better indoor air quality, and more pleasant/adequate lighting.

Reducing energy consumption has a positive impact on the environment by reducing greenhouse gas emissions and pressure on energy resources. An energy audit can be the first step towards achieving long-term sustainable in building operation. Investments in energy-saving measures can also increase the property value. Modernization and improvement of energy efficiency can make a house/building more attractive for potential buyers or tenants and can also reduce operational costs for the future owners.

6.2.2. Installation of energy-efficient equipment

Offering installation services (e.g. free of charge or at a reduced cost) for modern and innovative equipment and technologies that reduces energy consumption, such as energy-efficient lighting systems, improved building insulation, high-efficient heating and cooling systems, etc. is a key factor to support clients in the decision-making process regarding the adjudication of an energy efficiency project. These installations are part of comprehensive energy efficiency programs provided by EES and help customers to reduce the energy costs, as well as to decrease their environmental footprint.

EES can provide a wide range of installations of energy-efficient equipment, which help to reduce energy consumption and improve the energy efficiency of homes, businesses, and other facilities. The possible equipment includes:

Solar Panels

Installing solar panels (photovoltaic or thermal) allows harnessing solar energy to generate electricity or hot water, reducing dependence on conventional energy sources and electricity expenditures.

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An Energy Efficiency Service can provide comprehensive services for installing solar panels that convert solar energy into electricity or hot water. These devices can be installed on the roofs of homes (or ground based in gardens or backwards if available), commercial buildings, or industrial facilities. Solar energy is clean and renewable, reducing reliance on fossil fuels and on the power grid, as well as reduces greenhouse gas emissions. EES can conduct a site analysis, propose suitable solar systems (for roofs or ground based), and ensure their proper installation and maintenance.

This point encompasses comprehensive services from the beginning to the completion of the solar panel project, including technical planning, installation, and regular maintenance. Solar panels have the potential to dramatically reduce electricity consumption from the grid (especially if combined with battery storage systems) and can even generate surplus energy that can be sold back to the grid, which can be financially advantageous for users depending on the country regulatory framework.

Heat Pumps

Heat pumps use energy from the surrounding environment (air, water, ground) for heating or cooling a house or building. They are very efficient and environmentally friendly.

In this case an Energy Efficiency Service can also provide installation services for heat pumps that use energy from the air, water, or ground for heating buildings or water heating. Heat pumps are a efficient way of heating and cooling with lower operational costs than the traditional heating systems (e.g. gas or diesel boilers). The EES can analyze the heat and water needs in the building, suggest the most suitable heat pumps for specific applications, and handle their installation and maintenance.

This point includes comprehensive services from assessing heat and hot water needs in the building in order to design and install an adequate heat pump. Heat pumps can be an effective alternative to traditional heating systems, especially in areas with moderate climates (new technologies are becoming available for cold weather operation), and can dramatically reduce energy consumption and heating/cooling costs.

Energy-Efficient Lighting

Replacing traditional bulbs and fluorescent lights with energy-efficient LED lights reduces electricity consumption and lowers energy costs.

An EES can provide services for installing modern energy-efficient lighting or retrofitting the existent lighting systems. LED lighting consumes less energy than traditional bulbs and fluorescent lamps and has a longer lifespan, reducing the need for frequent replacement and maintenance. The EES can analyze the existing lighting system in the building, recommend suitable types of LED lighting for different spaces, and perform its installation.

This point encompasses comprehensive services from assessing current lighting to designing and installing modern LED lighting. Energy-efficient lighting can significantly reduce electricity consumption in the building and operating costs. Additionally, LED lights provide higher-quality lighting and can contribute to better comfort and productivity for building users.

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6.2.3. Smart thermostats and automatic controls

Installation of smart thermostats and control systems enables efficient management of heating and cooling in a home, resulting in the reduction of the energy consumption. The EES can offer services for installing intelligent appliance control systems, allowing for more efficient energy utilization in households and commercial spaces. These devices may include smart thermostats for regulating heating and cooling, programmable thermostats for optimizing heating and cooling according to schedules, and smart plugs and switches for automating electronic control.

The EES can conduct an analysis of energy consumption and appliance usage in the building, design and implement suitable intelligent control systems, and provide training and support for users. Smart appliance control enables users to monitor and manage their energy consumption, which can lead to significant energy savings and reduced operational costs. These devices also provide a higher level of comfort and convenience for building users.

Smart appliance control uses modern technologies such as sensors, Wi-Fi, and cloud-based services to enable a more efficient and convenient control of appliances and devices in households and commercial spaces. Sensors are a key component of smart appliance control, measuring various parameters such as temperature, humidity, light, and motion, allowing the system to respond to environmental conditions and user preferences.

Appliances are often equipped with wireless technologies such as Wi-Fi and Bluetooth, enabling communication with other devices and internet connectivity, allowing for remote control and monitoring. Cloud-based services provide a platform for storing data and operating intelligent systems, allowing users to access data and control their appliances from any internet-connected device.

Implementing smart control requires appliances to be compatible with the system. Some new appliances have built-in support for Wi-Fi or Bluetooth, while older appliances may require additional adapters or modules. Stable internet connectivity is necessary for remote control and monitoring to communicate with devices and cloud-based services.

Smart appliance control enables more efficient energy use, such as programming heating and cooling as needed or automatically turning off unused devices. Users can control their appliances remotely using smartphones or other devices, providing greater flexibility and convenience. Intelligent systems allow for monitoring energy consumption and appliance behavior, enabling users to identify areas where energy savings can be achieved. Some smart systems can also serve to monitor home security, such as motion detection or alerting in case of unusual events.

Energy-efficient devices are appliances, equipment, or systems designed to minimize energy consumption while providing the same or better level of functionality as their conventional counterparts. These devices are engineered to use less energy without sacrificing performance, thereby reducing energy bills and environmental impact. Examples of energy-efficient devices include:

- **Energy Star Appliances**: Energy Star-rated appliances, such as refrigerators, washing machines, dishwashers, and air conditioners, meet strict energy efficiency guidelines

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set by the U.S. Environmental Protection Agency (EPA). These appliances consume less energy during operation, resulting in lower utility bills.

- **Programmable Thermostats**: Programmable thermostats allow users to schedule heating and cooling settings based on their daily routines. By automatically adjusting temperatures when occupants are asleep or away, these devices help conserve energy without compromising comfort.
- **Smart Power Strips**: Smart power strips automatically shut off power to electronic devices when they are not in use or in standby mode, preventing energy waste from vampire power (standby power consumption).

6.2.4. Smart energy management

The implementation of energy management systems allow to optimize the energy consumption in households, buildings or industrial facilities according to the current needs and energy prices. Energy management utilizes modern and innovative technologies for efficient monitoring, measurement, and optimization of energy consumption in households, commercial buildings, and industrial facilities.

Here are the main technologies, requirements, and benefits of smart energy management:

- **Sensors and measuring devices**: Sensors and measuring devices are used to monitor energy consumption patterns, temperature, humidity, and other parameters, allowing the system to obtain real-time data on energy consumption, comfort levels and self-production (if available).
- **Automation and regulation**: Intelligent systems can be equipped with automation functions that enable automatic control of energy consumption in accordance with defined parameters and conditions.
- **Internet of Things (IoT)**: Connecting devices and sensors via the Internet of Things allows communication and control of appliances and devices remotely using smart devices and computers.
- **Artificial intelligence and data analysis**: The use of artificial intelligence and data analysis allows intelligent systems to identify patterns and trends in data and adjust their operation to achieve optimal energy efficiency.

To implement smart energy management, it is necessary to have compatible devices and infrastructure that enable data collection, communication, and control of energy processes. Stable and high-quality data connection is crucial for the proper operation of the energy management system, especially in the case of remote monitoring and control.

The main benefit of a smart energy management system is the reduction of energy consumption and operational costs due to a more efficient energy use and optimization of energy processes. Energy management allows optimizing the operation of devices and appliances according to current needs and conditions, increasing the efficiency and reliability of the energy systems. By reducing the energy consumption, energy management systems contribute to the reduction of greenhouse gas emissions and helps to protect the environment. The optimization of the energy system operation can lead to better comfort and convenience for users, such as more stable indoor temperatures and better lighting control.

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6.2.5. Battery energy storage

Offering battery energy storage for households or businesses enables the storage of surplus energy from renewable sources or cheap off-peak energy for use during peak demand periods or when energy prices are higher. The following types of battery storage systems are some of the most used systems.

- **Lithium-ion batteries**: Lithium-ion batteries are by far the most common technology used in battery storage systems due to their high energy density, long lifespan, decreasing costs and fast charging and discharging.
- **Redox flow batteries**: These batteries utilize electrochemical reactions between electrolytes to store and release energy and are suitable for long-term energy storage.
- **Ultracapacitors**: Ultracapacitors offer high power and fast charging and discharging, making them ideal for applications requiring immediate response, such as short-term fluctuations in energy supply.

Proper infrastructure for installation: Battery storage systems require suitable spaces for their installation. These spaces should be spacious and secure enough to allow safe handling of batteries and other components. Furthermore, access to the electrical grid is needed to connect the battery storage system to the distribution network.

Safety requirements: Safety measures are crucial for preventing accidents associated with the operation of battery storage systems. This includes proper ventilation and cooling to minimize the risk of explosive gas buildup or battery overheating. Additionally, having a battery monitoring system systems to detect variations in temperature, pressure, and other parameters that may indicate potential issues is very important.

Thorough maintenance and monitoring: Battery storage systems require regular maintenance and monitoring to optimize performance and extend battery life. This includes regular battery status checks, testing cooling systems and control systems functionality, as well as monitoring of energy consumption and battery storage performance.

Theft and vandalism protection: Due to the high cost of battery storage systems, it's important to ensure protection against theft and vandalism, namely in outdoor installations. This may involve installing security cameras, fencing, and alarm systems to detect potential intruders.

Environmental protection measures: When operating battery storage systems, it's important to consider their potential environmental impact. This includes proper disposal and recycling of batteries at the end of their lifespan and minimizing the potential release of hazardous substances into the environment.

Battery storage allows to store the excess energy from renewable sources, such as solar photovoltaic panels and wind turbines, for use during periods of high demand, high tariff, or low energy production. Battery storage can be used to balance the load on the electrical grid by absorbing excess energy during periods of low demand and releasing it during periods of high demand. Battery storage can serve as a backup power source in the event of a power outage, increasing energy supply reliability. With battery storage, it is possible to improve the energy systems management and response to changes in the energy supply and demand, leading to a more efficient energy use and lower operational costs.

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6.2.6. Other possible package contents

Flexible tariffs and demand side management: providing services that allow households and businesses to adjust their energy consumption according to tariffs and offers so that they can use energy when it is cheaper or when more renewable energy is available.

Training and advice: providing training and advice to customers on how to use energy efficiently, manage consumption and how to optimize their systems.

Training and consultancy programme: offering training and advice to customers on ways to maximize energy efficiency of the buildings they operate.

Financial support and subsidies: Providing financial incentives, grants or loans to invest in energy saving measures.

Energy Contract Management: Offering energy contract management and monitoring services to enable customers to optimize their energy use and minimize costs.

6.3. Economic evaluation of the packages offered

The following section presents data related to economic indicators and data that were collected during the survey.

6.3.1. Costs Structure

Building envelope costs	Installation	Investment costs
		Transport cost
		Personal costs
		Other associated costs
	Maintenance	Material costs
		Personal costs
	Renewal/replacement	
Cost of technology and equipment installed	Installation	Investment costs
		Transport cost
		Personal costs
		Other associated costs
	Maintenance	Material costs
		Personal costs
	Renewal/replacement	
Maintenance costs	Material costs	
	Personal costs	
	Other associated costs	
	Personal Education	
	Control systems	
Other construction-related costs		
Energy costs		
CO2 costs		

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6.4. Cost study of technologies and service packages

The following section shows data collected as part of an international survey within the project countries by the project consortium, data was collected on the costs of energy efficiency measures and new technologies. The data will be used as a basis for the final model, and will be the basis for the economic evaluation of the model and its financial viability.

6.4.1. Building envelope costs

Table 1: Building envelope construction element - Window construction

Building envelope construction element Window construction		Heat transfer coefficient W/m²K.	Construction costs	Maintenance costs	
				period	costs
roof window - wooden frame (double glass)	CZ	1.4	900		
roof window - wooden frame (triple glass)	CZ	1.1	696		
roof window - wooden frame (triple glass)	CZ	0,98	857		
roof window - wooden frame (triple glass)	CZ	0.9	857		
roof window - plastic frame (double glass)	CZ	1.4	718		
roof window - plastic frame (triple glass)	CZ	1.1	672		
roof window - plastic frame (triple glass)	CZ	0.98	1,447		
roof window - plastic frame (triple glass)	CZ	0.9	1,447		
window - wooden frame (double glass)	CZ		388		
window - wooden frame (triple glass)	CZ		471		
Reference Building: Alumium window thermal break and 4/16/6 mm glazing	SP	2.42	80-200 € window	10	
New buildings: Construction 2000. Aluminium window frames with thermal break and BE4/16/6mm glazing.	SP	1.14		10	
J1a - Standard Euroframe 70 in PVC, low-emissivity double glazing	PT	1.5	441	10	57.6
J1b - Termomax Eurobox in PVC, low-emissivity double glazing	PT	1.1	459	10	59.8
J2 - Schuco type aluminium frame, normal double glazing	PT	2.2	407	10	53.1

Table 2: Building envelope construction element – Wall construction

Building envelope construction element Wall construction	Heat transfer coefficient W/m²K.	Construction costs	Maintenance costs	
			period	costs

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Reference Building: Cement plaster + 1/2' brick cladding + 2cm insulation	SP	0.86	200 €/m	10	
"New buildings: Construction 2000. Cement plaster + 1/2' brick cladding + 6cm insulation+ single sheet hollow brick walls + plaster."	SP	0.41		10	
pa0_No_Insulation	PT	1.3	90	10	5.5
pa1_eps3_with 3mm of EPS insulation	PT	0.67	95	10	5.5
pa0_eps4_with 4mm of EPS insulation	PT	0.58	97	10	5.5
pa1_eps6_with 6mm of EPS insulation	PT	0.45	100	10	5.5
pa2_eps8_with 8mm of EPS insulation	PT	0.37	103	10	5.5
pa3_eps_10_with 10mm of EPS insulation	PT	0.31	106	10	6.1
pa4_eps12_with 12mm of EPS insulation	PT	0.27	112	10	6.6
pa5_eps15_with 15mm of EPS insulation	PT	0.22	120	10	6.6
pa1_eps20_with 20mm of EPS insulation	PT	0.18	132	10	7.7

Table 3: Building envelope construction element – Roof construction

Building envelope construction element Roof construction	Heat transfer coefficient W/m^2K.	Construction costs	Maintenance costs	
			period	costs
Reference Building: Roof construction	0.61	120	10	
New buildings: Construction 2000. Roof construction	0.35		10	
C0_pitched roof with waterproofing underneath the insulation (4mm)	0.45	100	10	11.1
C0_pitched roof with waterproofing underneath the insulation (6mm)	0.64	100	10	11.1
C1_pitched roof with waterproofing underneath the insulation (10mm)	0.39	110	10	31
C0_pitched roof with waterproofing underneath the insulation (6mm)	0.36	110	10	31
C2_pitched roof with waterproofing underneath the insulation (12mm)	0.32	110	10	31
C2a_pitched roof with waterproofing underneath the insulation (15mm)	0.26	120	10	33.2
C3_horizontal mat slab roofing (6mm)	0.51	62	10	16.6
C4_horizontal mat slab roofing (10mm)	0.33	65	10	17.7
C4_horizontal mat slab roofing (4mm)	0.43	62	10	16.6
C5_horizontal mat slab roofing (12mm)	0.32	68	10	18.8

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C5_horizontal mat slab roofing (15mm)		0.26	72	10	19.9
C6_Tilted roof with sloping slab (10mm)		0.41	68	10	18.8
C7_Tilted roof with sloping slab (12mm)		0.34	74	10	21

6.4.2. Technology and equipment costs

Table 4: Technology and equipment costs – Heat source: Heat pump - air/water

Technology and equipment costs **Heat source: Heat pump - air/water**		Heating Capacity kW	Efficiency %	Construction costs	Maintenance costs period	 costs
Heat pump: Name: EcoPart 406 (SVT 1157)	CZ	5.9	457	6167		
Heat pump: Name: EcoPart 410 (SVT 1160)	CZ	9.97	459	6692		
Heat pump: Name: EcoPart 414 (SVT 1164)	CZ	14.47	454	7664		
Heat pump: Name: EcoPart 417 (SVT 1165)	CZ	16.76	452	8168		
Heat pump: Name: EcoPart 435	CZ	32.48	436	17152		
Heat pump: Name: EcoPart 408 (SVT 7136)	CZ	8.19	458	9728		
Heat pump: Name: EcoPart 412 (SVT 7139)	CZ	11.75	461	10504		
Heat pump: Name: EcoPart 406 (SVT 1157)	SP	4.68	COP 4.95	6 167.00 €		
Heat pump Ferroli OMNIA M 3.2 6	SP	6.5	COP 4.95	3 609.67 €		
Heat pump RUA-CP1701H8	SP	17	COP 4.10	11 800.00 €	5	
Generic Ait-to-water heat pump with domestic hot water production	PT	10	COP 3.4	6500	5	262.5
Daikin Altherma 3	PT	4	COP 3.0	10978	5	2742
Kaysun Ecotank	PT	4	COP 4.0	10978	5	695

Table 5: Technology and equipment costs – Heat source: Heat pump - air/air

Technology and equipment costs **Heat source: Heat pump - air/air**		Heating Capacity kW	Efficiency %	Construction costs	Maintenance costs period	 costs
Heat pump air/air Baxi 4MR	SP	4.2	COP 5.15	3800		

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Toshiba Heat pump	SP			4200	5	
Mitsubishi MSZ-HR60VF	PT	6.8	COP 4.5	1900	5	100 *estimation*
Generic equipment	PT	10	COP 3.4	4500	5	315
Daikin Multi split R-32	PT	7	COP 4.4	4060	5	1000

Table 6: Technology and equipment costs – Heat source: Gas Boiler

Technology and equipment costs Heat source: Gas Boiler	Heating Capacity	Efficiency	Construction costs	Maintenance costs	
	kW	%		period	costs
PROTHERM Gepard Condens 18/25 MKV-A kombi			1240		
ENBRA CD 24 Combined			2160		
PROTHERM Panther Condens FlameFit 20/26 KKV-CS/1			1640		
ARISTON CLAS ONE SYSTÉM 24			1240		
Gas Boiler (Manaut Condensation boiler)		95	1250	2	50
Generic Biomass boiler for heating	25	COP 0.89	4000	5	158
Generic Biomass boiler for sanitary hot water	23	COP 0.9	3800	5	100
Baxi Roca CBP Compact (K)	23	COP 0.9	8647	5	900
Melt CP	25	COP 0.9	3800	5	100
Solzaima SZM	24	COP 0.9	4204	5	250

Table 7: Technology and equipment costs – Cooling systems

Technology and equipment costs Cooling systems		Cooling load	Efficiency	Construction costs	Maintenance costs	
		kW	%		period	costs
HAIER Flexis UV WiFi	SP	3.5	SCOP 4.6	800		150
Generic Chiller (cooling only)	PT		COP 3.4	4500	5	262,5
Daikin mini chiller EWAQ008BAPV (+ AQS)	PT		COP 3.0	5197	5	1500

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Table 8: Technology and equipment costs – PV panels

Technology and equipment costs PV panels		Rated Power	Efficiency	Construction costs	Maintenance costs	
		kW	%		period	costs
PV panels (SunPower Maxeon 6AC 425W)	SP	440W	22.8	6200		
Jinko solar Tiger Neo	SP	480W	22.0	6200		
Solar thermal system Daikin Soar CESI	PT	2	COP 1.0	3000	30	1323

6.4.3. Costs associated with energy flexibility

Initial investments

To be able to have Automatic DSR as stated before, an Energy Box needs to be installed in every individual household.

This represents the following investments for DSR Operators: (i) acquisition of end-users (finding and convincing them), (ii) hardware and (iii) installation of this hardware (to be sure that it is well installed and operational, i.e. well connected to the DSR platform).

Operational costs

There are three operational costs for DSR Operators:

- Install base maintenance: unlike a classical domotic box, the goal of a DSR box is to be continuously connected to the DSR Plateform in order to have actions on the Grid. Therefore, DSR Operators must make sure that equipment is always operational and is repaired whenever there might be technical failures (over-the-air or locally). Therefore, an after-sales organization must be built (call center and maintenance team)
- Telecom costs: as the Energy boxes must be always connected to the platform (and in order not to rely on home wifi) a sim card is installed in every Energy boxes and is continuously communicating with the platform
- Market team: to monetize energy and capacity installed in every household, a dispatching center must exist with the responsibility of placing orders on all different electricity markets

Risks

As DSR Operators have direct access to individuals' equipment, there is a strong risk for them to uninstall the Energy Boxes whenever they fill like it's impacting their comfort. This can be mitigated by measuring in real-time the impact over them and never exceeding the limit.

The second risk concerns the fact that people stay indefinitely in the same households. Yet even if Energy Boxes have last more than decades, they can't be operated without the consent of the household occupier. There is therefore a strong risk of "loosing" end-user

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when these ones move from their household. This can be mitigated through a strong "customer link" that enable to follow this regularly to contact the new occupier from the household. Of course, it would be very much easier the day DSR Operators were known by the general public.

Practical examples in France:

Practical examples on existing appliances (electrical radiator) one can buy and install communication device that will provide Smart thermostat (via an app) and connection to a DR operator (Survoltage in this case)

1. **Netatmo devices (the DR operator is Survoltage)**

- https://shop.netatmo.com/fr-fr/energy/power-management/ripple-control-starter-pack-white
- the cost of equipment (no installation) is then:
- communication device and 1st radiator: 119.99€
- next 2 radiators: 119.99€
- nest 1 radiator: 63.99€

2. **Leroymerlin with product enki-home (DR operator(s) no disclosed yet)**

- https://enki-home.com/fr/chauffage-connecte/module-radiateur-connecte
- the cost of equipment (no installation) is then:
- communication device and 2 radiators: 99.9€
- nest 1 radiator: 39.90€
- cost of installation is between 200 and 400€ (depending on location and size of household).

Another approach could be the calculate the extra-cost to acquire native IoT instead of not IoT appliances. This would be more theoretical as the extra cost usually includes more services than only DR services.

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7. Methods of financing

Portugal significantly benefits from the European Union's Cohesion Fund and the European Structural and Investment Funds (ESIF), which are pivotal in financing large-scale energy efficiency projects. More recently the European recovery and resilience plan allows the country to invest in innovate high energy efficiency projects. These funds are designed to strengthen economic and social cohesion by correcting imbalances between EU regions. The specific focus on sustainable energy and efficiency projects allows Portugal to invest in upgrading infrastructure, enhancing residential and commercial buildings' energy performance, and promoting the adoption of renewable energy sources.

Additionally, the Portuguese government has also established several national programs and schemes that directly support energy efficiency projects:

- Portugal 2030 - This is an umbrella of various programs funded by European funds aimed at promoting integrated and sustainable development. Part of its focus is on enhancing energy efficiency in public and private sector buildings.
- Environmental Fund - This program focuses on the rehabilitation of existing buildings, improving their energy efficiency, through specific measures (e.g. building envelope, windows, solar PV, etc.). The fund provides incentives in the form of grants and subsidies to homeowners, local authorities, and businesses undertaking retrofitting projects.
- Tax Benefits and Incentives schemes - Tax incentives play a crucial role in promoting energy efficiency in Portugal. These include reductions in VAT (Value Added Tax) for energy-efficient materials and equipment (e.g. solar residential photovoltaic systems), building retrofitting, as well as tax credits for individuals and companies investing in energy efficiency improvements.

In terms of private funding the following sources can be used to fund energy efficiency projects:

- Bank financing – Some commercial banks operating in Portugal offer loans or other financial products (e.g. leasing) where energy efficiency projects can be funded. These loans often come with lower interest rates or favorable terms to encourage investments in energy-saving upgrades.
- Energy Performance Contracting (EPC) - Is an increasingly popular method, EPC involves a contract between a beneficiary (e.g., a building owner or a municipality) and a provider (usually an energy service company or an ESCO). The ESCO covers the project's upfront costs which is paid back through the cost savings generated by the energy efficiency improvements over time. This method is attractive because it minimizes the financial risk to the property owner and leverages private sector expertise in energy management.
- Venture capital and private equity funds – this funding source is also quite active in financing innovative energy efficiency technologies and projects in Portugal. These investors typically fund high-potential startups and companies developing new technologies that contribute to energy efficiency, expecting a return on their investment through the company's growth and eventual success.

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- European Local Energy Assistance (ELENA) – ELENA is funded by the European Investment Bank, provides grants for technical assistance focused on implementing energy efficiency, distributed renewable energy, and urban transport projects. By covering up to 90% of technical support costs, ELENA helps municipalities, public entities, and private companies in Portugal to prepare and implement substantial energy-related projects.

7.1. Internal financing

Within Plenitude, the model presented for financing would be an external financing model. What we develop in all projects is to find a way to finance the product through an agreement with a bank. The relationship is established by showing them the project we are talking about and giving an estimate of the amount that would be necessary to finance. Once this amount is fixed and based on the scales available in the financial entities, an interest rate for the product is granted.

7.1. In this project, the possibility of seeking financing in crownfunding projects can be studied. An agreement would be sought with a crownfunding financing entity that is present in Europe to be able to jointly develop the financial project.

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8. Service structure and aggregator's role

This chapter focuses on the structure of provided energy services and the role of the aggregator within these services. The aggregator plays a key role in ensuring the flexibility of the energy system by integrating and optimizing energy consumption among various users. This chapter will discuss flexibility options, data usage and management, communication of energy flexibility needs, and interaction with the energy market. Additionally, the benefits that the aggregator brings to households and the broader energy market will be analyzed. This analysis will provide insights into how an effective service structure and the role of the aggregator can contribute to better energy resource management and the achievement of sustainability goals.

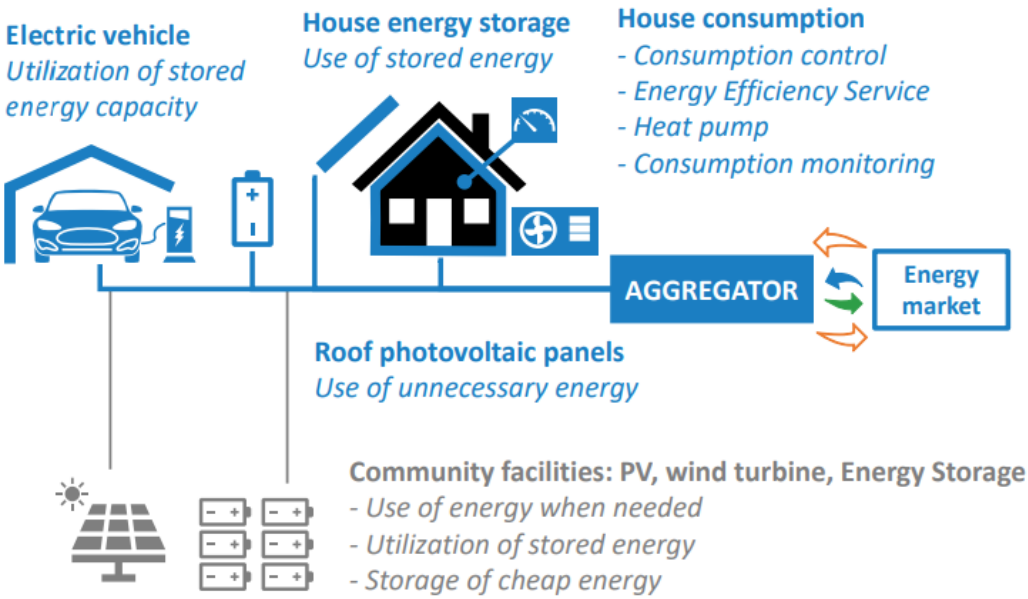

Figure 19 – Diagram of Smart EES Model Prototype designed by BungEES project

8.1. Flexibility options – Data use and management

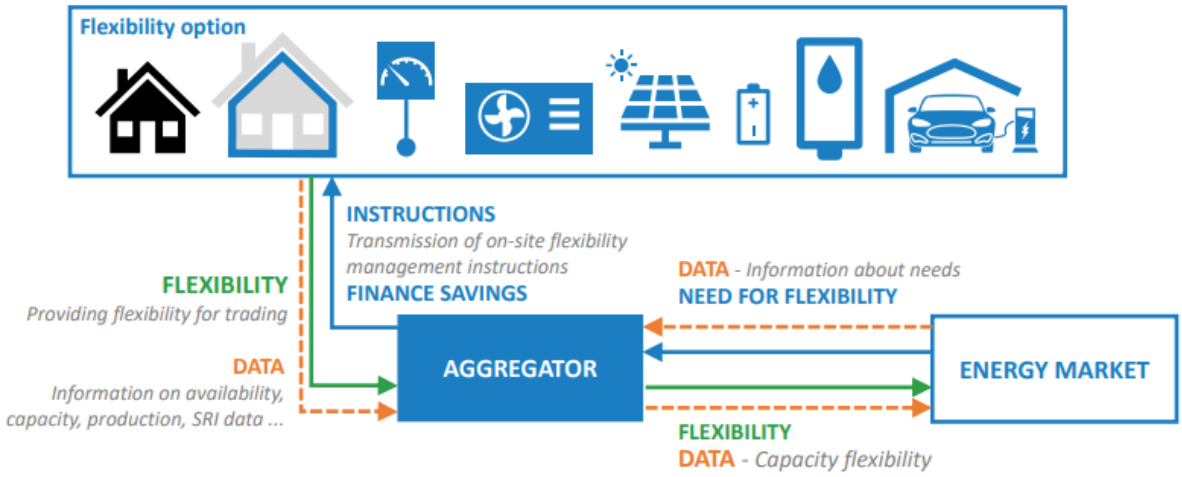

Figure 20 – Diagram of Communication in Smart EES Model Prototype designed by BungEES project

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The aggregator in the EES sector plays a crucial role in **connecting energy service providers with end-users**, such as households, businesses, or industrial entities. Its task is not only to gather and coordinate various resources and services related to energy efficiency and flexibility but also to provide a comprehensive solution for optimizing energy usage.

The aggregator clearly identifies available energy sources and services, such as solar panels, heat pumps, energy-efficient devices, and **consolidates them into one comprehensive service portfolio**. In this way, it creates a unified and easily accessible resource for users for their energy needs.

Another key element of the aggregator is its **ability to monitor and analyze users' energy consumption in real-time**. This analysis enables efficient management and optimization of energy consumption, which may include redirecting energy from renewable sources to households during peak demand times. In this way, the aggregator contributes to the efficient utilization of available energy sources and reduces the environmental impact of energy usage.

Finally, the aggregator **combines these diverse sources and services into packages or programs** that can be offered to end-users as part of EES. These packages may include a combination of solar energy, energy savings, energy consumption monitoring, and other services tailored to the users' needs. In this way, the aggregator provides a comprehensive and integrated solution for energy efficiency and flexibility that is easily accessible and effective for end-users.

8.1.1. Communicating the need for energy flexibility

Instructions sent from the energy market to the energy flexibility aggregator typically concern the need to adjust energy production or consumption in line with the current market situation and system requirements. These instructions may include:

- **Demand for flexibility**: The energy market may require the aggregator to provide a certain amount of energy flexibility at a specific time, such as reducing consumption or increasing energy production.
- **Updating delivery plans**: Based on current energy prices and market demand, the aggregator may receive instructions to change energy delivery plans to households and businesses.
- **Balancing the energy grid**: In case of imbalance between energy supply and demand, the aggregator may be tasked with balancing the grid using energy flexibility, such as providing reserve capacity or rapidly regulating consumption.
- **Real-time event response**: The energy market may send real-time instructions to the aggregator in the event of unexpected occurrences or changes in the environment to ensure stable and reliable energy supply.
- **Response to price changes**: If energy prices in the market fluctuate, instructions may be sent to the aggregator regarding the optimization of energy production or consumption to maximize profits or minimize costs.

The instructions provided by the aggregator to households are designed to enable households to actively contribute to the energy flexibility of the energy system while simultaneously taking advantage of potential economic benefits. The goal is to optimize consumption and contribute to balancing demand and supply in the energy market.

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- **Energy consumption management**: The aggregator may send households instructions regarding the appropriate timing to turn on or off specific appliances or devices to balance demand and supply in the market.
- **Balancing energy production**: If a household generates energy using solar panels or other renewable sources, the aggregator may instruct the household on when it is best to consume their own generated energy or feed it back into the grid depending on market needs.
- **Flexible consumption offerings**: Households may be encouraged to temporarily reduce or increase energy consumption at specific times to take advantage of potential price benefits or support the stability of the energy grid.
- **Estimated consumption**: The aggregator may provide households with estimates of expected energy consumption at certain times and recommendations for optimal energy utilization based on price and production factors.

8.1.2. Data communication

The aggregator needs data from households, energy providers, and may also use external sources of information such as weather services or energy market price indices. This data enables aggregators to perform real-time analysis, modelling and decision-making, allowing them to efficiently manage household energy systems and optimize their energy consumption in line with current needs and market conditions.

Households

Among the key data that the aggregator needs are:

- **Energy consumption**: Information about the current consumption of electricity, heat, or other forms of energy in households is essential for aggregators to monitor and analyze the energy behavior of households.
- **Energy production**: If a household generates its own energy using solar panels, wind turbines, or other renewable sources, the aggregator needs information about the energy production from these sources.
- **Appliance information**: Data about household appliances such as refrigerators, washing machines, air conditioning units, etc., can help the aggregator better understand energy consumption at different times and optimize the management of these devices.
- **Demographic information**: Information about household size, the number of occupants, their lifestyle, and preferences can be useful for personalizing and targeting energy services.

Energy suppliers

From energy suppliers, the aggregator requires a wide range of information crucial for its operations and for providing effective energy services to end users. Among the main types of data that the aggregator needs from energy suppliers are:

- **Energy prices**: Information about current energy prices on the market is essential for aggregators to efficiently plan and optimize energy delivery to households and businesses. Knowledge of energy prices allows them to decide when and how to purchase energy under the most favorable conditions.

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- **Tariffs and rates**: Detailed information about various tariffs and rates for energy consumption is important for accurate billing and accounting of energy consumption by end users. Aggregators need to know the terms of tariffs to offer optimal energy services to their customers.
- **Available energy sources**: Information about the availability of various energy sources, including renewable sources, is crucial for aggregators when planning energy deliveries and optimizing energy systems. Knowledge of available energy sources enables aggregators to use renewable sources more efficiently and minimize dependence on traditional energy sources.
- **Technical network data**: Information about the condition and performance of the energy network is important for aggregators when planning and optimizing energy deliveries. Understanding the technical parameters of the network allows them to better manage energy distribution and minimize losses in the network.
- **Regulatory and legislative information**: Information about applicable regulatory and legislative requirements is important to ensure compliance with energy regulations and standards. Aggregators need to know the current legal framework to properly plan and operate their energy services in accordance with regulations.

8.1.3. Energy market

The aggregator provides the energy market with data that enable proper evaluation and utilization of the offered flexibility to optimize operations and ensure the stability and reliability of the energy system.

- **Available flexibility**: Information about the amount of available flexible capacity that the aggregator can offer to the market. This data includes information about options for adjusting energy consumption, surplus energy production from renewable sources, or other ways in which the aggregator can contribute to balancing the energy system.
- **Planned actions**: The aggregator can inform the energy market about planned actions related to providing energy flexibility, such as changes in energy production, energy redirection, or changes in energy-consuming devices that are part of its portfolio.
- **Current system status**: Data on the current status of the energy system, including energy consumption and production, network status, and balancing needs, are important for assessing the required flexible capacity and decision-making regarding its deployment.
- **Flexibility demand**: The aggregator can also share with the energy market information about the current demand for flexibility from various actors, such as distribution and transmission networks, market operators, or end-users.
- **Price information**: Information about current energy prices in the market and prices offered for providing flexible services can be shared with the energy market for better strategic decision-making.

External sources

- **Weather forecast**: Weather information such as temperatures, sunlight, wind, etc., can help the aggregator predict energy consumption and production in households and better plan the optimization of the energy system.

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- **Price information**: Information about energy prices on the market, tariffs for energy consumption, or potential charges for consumed energy may be important for decision-making regarding the optimization of consumption when energy prices are lowest.

8.1.4. Benefits of the aggregator for households

The aggregator provides households with the opportunity for more efficient and sustainable management of their energy needs, which can result in financial savings and environmental protection.

- **Financial savings**: Efficient energy use and the utilization of renewable energy sources can lead to financial savings for households. Reducing energy consumption and energy costs may be associated with lower electricity and other energy bills.
- **Centralized access to energy resources**: The aggregator consolidates various energy sources, such as solar panels, heat pumps, or other energy-saving devices, into one portfolio of services. This allows households easy access to different options to meet their energy needs.
- **Optimization of energy consumption**: The aggregator monitors and analyzes households' energy consumption in real-time. Based on this data, it can help households manage their energy consumption more efficiently and minimize losses.
- **Diversification of energy sources**: Providing access to various energy sources allows households to diversify their energy sources and reduce dependence on a single energy source. This can bring greater stability and sustainability to energy supply to households.
- **Environmental protection**: Utilizing renewable energy sources and optimizing consumption contributes to environmental protection by reducing greenhouse gas emissions and pollution associated with traditional energy sources.

8.1.5. Benefits of the aggregator for energy market

The aggregator contributes to a more dynamic, resilient, and sustainable energy market by optimizing resource allocation, promoting renewable energy, enhancing grid stability, and fostering innovation and consumer empowerment.

- **Efficient Allocation of Resources**: By coordinating and optimizing the use of various energy resources, the aggregator helps ensure that energy is allocated efficiently across the market. This can lead to better utilization of renewable energy sources and reduced waste.
- **Enhanced Grid Stability**: Aggregators play a crucial role in balancing supply and demand on the grid. By actively managing energy consumption and production, they help stabilize the grid and reduce the risk of blackouts or brownouts, especially during peak demand periods.
- **Promotion of Renewable Energy**: Aggregators often prioritize the use of renewable energy sources, such as solar or wind power. By aggregating renewable energy generation from multiple sources, they increase the overall share of clean energy in the market and support the transition to a more sustainable energy system.
- **Facilitation of Demand Response Programs**: Aggregators enable participation in demand response programs, where consumers adjust their energy usage in response

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to signals from the grid operator. This helps reduce strain on the grid during times of high demand and can provide financial incentives for participants.

- **Market Innovation**: Aggregators drive innovation in the energy market by introducing new business models, technologies, and services. They often act as intermediaries between energy producers, consumers, and other market players, fostering collaboration and experimentation.
- **Customer Empowerment**: By providing consumers with access to a diverse range of energy services and options, aggregators empower them to make informed choices about their energy usage. This can lead to greater engagement with energy efficiency measures and renewable energy adoption.

9. Barriers to service deployment

9.1. Technical barriers

The implementation of EES reflects hopes for improving the sustainability and cost-effectiveness of energy systems, particularly in residential and commercial buildings. However, the successful deployment of these services is often hindered by technical barriers that require thorough planning and a strategic approach.

9.1.1. Technology diversity and technology compatibility

Integrating new technologies for energy efficiency and flexibility into existing energy systems can be challenging due to compatibility issues with existing devices and software systems. Many energy systems can be highly complex and diverse, which can complicate their optimization and the integration of new technologies for energy efficiency and flexibility.

The diversity of energy systems in residential and commercial buildings is one of the key factors that can present a technical barrier to the implementation of energy efficiency and flexibility services. Each building may have its own mix of energy sources and equipment, creating a challenge in finding universal/compatible solutions. For example, some buildings may be connected to municipal gas supply and use gas heating, while others may rely on electric heat pumps or traditional solid fuels.

This diversity of energy systems requires an individual approach to optimizing energy efficiency and flexibility. Each type of system has its own specific characteristics and potential for energy savings, meaning that thorough analysis and planning are required before proposing specific measures. Some technologies and strategies may be more suitable for certain types of energy systems than others, so it is important to consider this diversity in the development and implementation of energy efficiency and flexibility services. Adaptability and flexibility are a key factor for successfully overcoming this technical barrier and providing effective solutions for homeowners and building owners.

Some buildings and industrial facilities may have outdated infrastructure that is not ready for the implementation of modern technologies for energy efficiency and flexibility.

9.1.2. The need for additional data and its unavailability

Limited data availability is another challenge in implementing energy efficiency and flexibility services in residential and commercial buildings. While advanced monitoring and data

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collection systems are often installed in industrial environments, the infrastructure in households may be less developed or entirely absent. This can hinder the obtaining of the necessary information about energy consumption and the behavioral aspects related to the operation of the energy systems.

One of the main problems may be the lack of suitable metering devices for monitoring energy consumption. In some countries households still use traditional electricity meters (e.g. in Portugal more 90% of the meters are already smart meters), which provide only limited information about overall electricity consumption and do not allow for detailed analysis of consumption over time. Additionally, measuring the consumption of other forms of energy, such as heat or water, may be even more challenging, especially if these services are not centrally metered. The increasing number of smart meters being installed will help to overcome this technical barrier.

Another issue may be the lack of data interfaces or communication technologies for transmitting energy consumption data to a central monitoring system. Home devices may be equipped with outdated or incompatible data collection and transmission technologies, complicating the integration with modern monitoring and energy management systems.

To overcome this technical barrier, it is essential to find suitable technological solutions for collecting and transmitting energy consumption data in households. This may involve installing advanced metering devices, such as smart meters and sensors, which provide detailed real-time information about energy consumption. At the same time, it is also important to develop compatible communication infrastructure that enables data transmission to a central monitoring system. Integrating modern data collection technologies may be the key to successfully create effective energy efficiency and flexibility services for residential and commercial buildings.

- **Need for sensors and monitoring devices**: The proper operation of energy efficiency and flexibility services may require the installation of sensors and monitoring devices, which can be a time-consuming and costly task.
- **Security aspects**: The implementation of new technologies may raise concerns about cybersecurity and data protection, requiring careful planning and compliance with security regulation.
- **Limited financing resources**: The costs associated with deploying energy services can be high, making it difficult to obtain sufficient funding for their implementation, especially for small businesses and households.

9.2. Diverse owner needs and preferences

Diverse needs and preferences of homeowners pose a challenge when deploying energy efficiency and flexibility services in single family houses or multi-apartment buildings. Each homeowner may have different requirements for their home, requiring an individual approach and a wide range of options.

For example, some homeowners may emphasize economic aspects and seek solutions that allow them to reduce energy costs and home operation expenses. For them, energy-saving measures with a quick return on investment, such as insulation improvements, replacing inefficient appliances, or installing solar panels, may be a priority.

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On the other hand, other homeowners may place greater emphasis on comfort and convenience in their household and seek technologies that improve quality of life and comfort. For them, priority measures may include better temperature regulation in the home, home automation, or the use of intelligent control systems.

Additionally, homeowners' environmental priorities may also differ. Some homeowners may prefer eco-friendly technologies and measures that minimize their carbon footprint and contribute to environmental protection. For them, options such as renewable energy sources, waste reduction modifications, and support for eco-friendly practices in house daily operation may be important.

To overcome this technical barrier, it is crucial to provide homeowners with a wide range of options and tailor made services according to their individual needs and preferences. This may involve consultations with experts in energy efficiency and flexibility who can help homeowners to select the most suitable measures for their specific situation and goals. Furthermore, it is important to provide homeowners with clear and understandable information about available options and its benefits, which will allow them to take informed decisions in line with their needs and preferences.

9.3. Legislative restrictions

Energy efficiency and flexibility in single-family houses or multi-apartment buildings can be influenced by various legislative and regulatory requirements. One of the main technical barriers may be the ambiguity or complexity of these regulations, which can slow down or delay the process of planning and implementing energy-saving measures.

Different countries and regions may have different legislative frameworks and normative requirements regarding energy efficiency and building sustainability. This may include requirements for minimum energy efficiency standards for new buildings and large renovations, obligations to perform regular inspections and maintenance of energy equipment, or support for investments in energy-saving technologies.

For homeowners of single-family houses or multi-apartment buildings, these regulations may pose a challenge if they are not sufficiently informed about their obligations and options. Uncertainties in legislation can lead to uncertainty about the steps homeowners need to take and which technologies to implement.

Another technical barrier may be the need to gather and maintain up-to-date information about changes in legislation and the regulatory environment. Regulations are often updated or amended, requiring regular monitoring of developments and adaptation to new requirements.

To overcome this technical barrier, it is important to provide homeowners with access to updated information on legislation and regulatory requirements through specialized advisory services. These services may include analysis and interpretation of regulations, compliance advice, and recommendations for implementing suitable measures to ensure compliance with legislation. Furthermore, it may be crucial to provide homeowners with simple and accessible sources of information that allow them to stay informed during changes in the legislative environment and effectively plan their steps to achieve energy efficiency and flexibility.

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9.4. National barriers

This chapter focuses on the anticipated barriers to the development and dissemination of the new Energy Efficiency Service (EES) model. Each country faces unique challenges that may limit the effective implementation and adoption of these energy services. The chapter will analyze technical barriers, diverse owner needs and preferences, legislative restrictions, and specific national barriers in countries such as Slovakia, the Czech Republic, Portugal, Spain, and Germany. Understanding these barriers is crucial for identifying solutions that can facilitate the development and dissemination of EES and contribute to achieving energy efficiency and sustainability goals.

9.4.1. Slovakia

In Slovakia, the EU electricity market legislation (new market design) has been transposed by an amendment of the Energy Act No 251/2012 Coll. The amendment has enabled the establishment and operation of new electricity market participants, such as the active consumer, the energy community, the operator of an electricity storage facility and the aggregator. At the same time, the amendment to the Act defines the rights and obligations of these new market participants, including the conditions for their entry into the electricity market. Another important change is the further strengthening of the position of the consumer on the energy market and the promotion of the development of self-generation and self-consumption of energy. The amendment also introduces a modification around electricity storage, a modification of the legal framework for data flows related to the activities of new market entrants and support for the digitisation of the energy sector.

The approved energy package has modified the existing conditions for the deployment of smart metering systems, regulates the procurement of ancillary or flexibility services and introduces new rights and obligations for distribution system operators and transmission system operators. The new legislation should ensure increased transparency on the energy market by introducing public consultations on technical conditions, operating rules, and development plans of system operators as key documents for system users in terms of investment planning, access conditions and connection of consumers and electricity producers . The secondary legislation (implementing regulations) is still in the process of putting the new rules into daily practice on the ground.

An energy-performance based service is defined as guaranteed energy service within the meaning of Act 321/2014 Coll., on Energy Efficiency (§ 17 et seq.).

In EPCs, modernisation of buildings and equipment of the recipient of the service is carried out, which leads to a reduction in energy consumption and related operating costs. The cost of the upgrading, which shall be designed, planned, implemented, and financed by the provider according to the needs of the beneficiary, shall be reimbursed by future savings, which shall be guaranteed by the service provider. During the repayment period of the retrofit, the service provider shall provide energy management and evaluate the savings achieved. In the event of a shortfall in savings, the provider undertakes to reimburse the service recipient for the financial value of the shortfall in savings.

EPC in Slovakia is mainly, although not exclusively, used for retrofitting buildings and lighting systems. EPCs are used in both the private sector and the public sector. In the public sector,

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it is possible to have an arrangement whereby assets are upgraded which are only under the management (use) of the service recipient (e.g. the owner is the State) .

The EPC market in Slovakia is, however, blocked due to decision by the authorities to provide 100% grants for energy efficiency improvements in buildings.

Organiser of the short-term electricity market (OKTE) recently launched the energy data centre that should support operation of the market, as several of new activities of market actors cannot be implemented and operated without centralised data flow processing. The new activities are - sharing of electricity from RES, accumulation, creation of energy communities, aggregation and provision of flexibility, active consumers. The aim has been to create and implement a central platform for data exchange that would allow simplification and unification of data exchanges in the electricity market, reducing the administrative burden for existing market participants including customers as well as public institutions by removing duplication and multiple data provision, introducing new data flows that will allow new market participants to operate and making data available to end-users.

9.4.2. Czech Republic

In the Czech Republic, an amendment to the Energy Act has been approved. This is a groundbreaking law for Czech energy and society, as it allows citizens to directly participate in the energy transition by building and utilizing local renewable energy sources.

According to the law, a new entity called the Electro-Energetic Data Center (EDC) was established with the aim of enabling an efficient transformation of the domestic energy sector. The EDC will ensure the collection, standardization, and sharing of energy data. Its operation is crucial for the development of community energy. The center will consolidate all information on electricity production and consumption at the household and large company levels, electricity flows, and sharing.

Currently, an IT system necessary for receiving and evaluating large volumes of data is being developed, which is essential for the proper functioning of the center. Starting in July 2026, the so-called Final EDC Solution will be operational. At this stage, the EDC will expand its services according to the amendment of the Energy Act LEX OZE III to include data management for purposes of storage, flexibility, or aggregation.

Furthermore, the Czech government has approved another amendment to the Energy Act, LEX OZE III, aimed at adjusting the rules of the electricity market and better protecting customers in the energy market. The amendment will enshrine in law the concepts of energy storage, network flexibility, and aggregation.

The LEX OZE III amendment includes provisions that will allow the construction of large battery storage facilities with capacities in the order of megawatt-hours, specifically designed for grid balancing. Unlike most neighboring countries, the stability of the Czech grid currently relies almost exclusively on fossil fuels, which need to be gradually phased out in the interest of decarbonization and modernization of the energy sector.

9.4.3. Portugal

Energy efficiency is a critical component in Portugal strategy to reduce carbon emissions and promote sustainability. Despite the potential benefits, various barriers hinder the adoption

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and implementation of energy efficiency services. Energy efficiency faces multiple challenges in Portugal, including financial, regulatory, informational, and technological barriers. Understanding these obstacles is essential for stakeholders to develop effective strategies to overcome them and promote broader adoption of energy efficiency solutions. In Portugal the barriers to energy efficiency include the following aspects:

Financial Barriers

Upfront cost - One of the most significant barriers to energy efficiency in Portugal is the upfront cost associated with implementing energy-saving technologies. Many businesses and households find the initial investment prohibitive, even though these upgrades can lead to substantial savings over time. This issue is particularly acute in low income families and in older houses which require extensive renovations to improve energy efficiency.

Limited Access to Low Interest Financing - Although there are various funding and incentive programs available, access to these resources can be limited. Small and medium enterprises (SMEs) and low-income households often struggle to meet the strict criteria set by banks and other financial institutions for loans or grants. The complexity and length of the application processes further deter potential beneficiaries from pursuing these financial aids.

Inadequate Financial Incentives - While Portugal has implemented several incentives, such as tax reductions and subsidies for energy-efficient products and renovations, these measures are often insufficient to cover the gap between the costs of conventional and energy-efficient solutions. Additionally, the transient nature of government incentives, which can change with political climates, adds an element of uncertainty that can discourage long-term investments in energy efficiency.

Regulatory and Policy Barriers

Complex Legislation and Standards - The regulatory framework governing energy efficiency in Portugal can be complex and fragmented. Different standards and regulations apply to various sectors and types of projects, creating confusion and compliance difficulties for businesses and consumers alike. This complexity can delay the implementation of energy efficiency projects as stakeholders navigate the bureaucratic landscape.

Lack of Enforcement - There is a notable gap between the existence of energy efficiency regulations and their enforcement. Inadequate monitoring and enforcement mechanisms mean that many energy efficiency measures are not implemented to their full extent, undermining the effectiveness of policies intended to promote energy conservation.

Slow Policy Adaptation - The pace at which regulations and policies adapt to technological advances and market changes can also be a barrier. As new energy-saving technologies emerge, it can take time for the regulatory framework to catch up, delaying the adoption of innovative solutions.

Informational and Behavioral Barriers

Lack of Awareness - A significant challenge in promoting energy efficiency in Portugal is the general lack of awareness about the benefits and potential of energy-saving measures. Many consumers and businesses are not fully informed about how energy efficiency could benefit them financially and environmentally.

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Behavioral Resistance - Behavioral factors such as habits, preferences, and resistance to change can also hinder the adoption of energy efficiency measures. Even when the financial and environmental benefits are clear, the inclination to stick with familiar technologies and routines can prevail.

Technological Barriers

Technological Limitations - While advances in technology have increased the availability of energy-efficient solutions, there are still technological limitations that restrict their implementation. For instance, some older buildings and infrastructure in Portugal may not be easily adaptable to modern energy-efficient technologies without significant modifications.

Integration Challenges - Integrating new technologies with existing systems can be complex and costly. The technical expertise required to design and implement integrated solutions is not always available, and the risk of disruptions during the transition period can deter stakeholders from undertaking necessary upgrades.

The path to the widespread adoption of energy efficiency in Portugal is slowly being made, however there are still significant barriers to overcome. Financial constraints, complex regulations, lack of information, and technological limitations all play an important part in slowing the progress towards a more energy-efficient economy. Overcoming these challenges will require coordinated efforts from the government, industry, energy service providers and public society in order to simplify regulations, raise awareness, improve access to financing, and foster technological innovation. Addressing these barriers effectively is crucial for Portugal to meet the United Nations Sustainable Development Goals (SDGs) and pave the way for a sustainable future.

9.4.4. Spain

In Spain there are several barriers to implementing energy efficiency services apart from those mentioned above. The aim of these services is to reduce energy consumption in order to provide the same quality of service or comfort, reducing emissions and improving productivity and comfort, however, several barriers are emerging, among them are:

- Lack of awareness: This is currently improving, but when it comes to energy solutions, customer awareness of the need to adopt such solutions is paramount. Many people are not aware of the energy they use or the amount of energy they can save to improve their energy efficiency without affecting their daily activities. This lack of awareness can be overcome through energy education and knowledge of different energy saving solutions or energy habits.
- Lack of motivation/interest: This barrier would go hand in hand with the previous barrier of lack of interest in changing their behavior or investing in energy saving technologies. This barrier can be overcome by creating realistic and realistic targets for energy savings making it more interesting for customers
- Lack of resources: This is the most decisive barrier, as these efficiency solutions need to pay a certain amount for the purchase of the products or to finance the equipment in the expectation of a payback. But it is possible that end customers are not thinking about energy efficiency because they do not have the necessary funds to tackle this type of solution. It is therefore vital to support subsidies to promote energy efficiency solutions and increase public interest.

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- Energy prices: Currently, and given the situation of low prices of energy supplies, customers do not consider making savings efforts that would take more than 5 years to amortize and prefer to maintain their current habits without making investments and allocate that money to other situations.

9.4.5. Germany

In Germany, energy efficiency regulations are governed by the Energy Efficiency Act (EnEfG)[22], which was enacted by the federal government in 2023. This act establishes a clear legal framework for enhancing energy efficiency and defines specific energy efficiency targets. The EnEfG primarily focuses on companies with an annual energy consumption exceeding 2.5 gigawatt hours, as well as data centers and large public and private sector buildings.

To address energy efficiency in private household buildings, the Buildings Energy Act (GEG)[23] has been amended. The focus of this law is primarily on energy-efficient heating systems and sector coupling with renewable energy sources. Starting from January 2024, all newly installed heating systems in Germany must utilize at least 65 percent renewable energy. This includes the installation of heat pumps, biomass heating, solar thermal heating, and the use of sustainable bio-methane or biogenic liquefied gas. These regulatory changes undoubtedly make Germany an attractive market for energy efficiency. Despite the strong political will certain barriers and challenges still need to be addressed. Some of these challenges include:

- **Skill shortage**: Germany is currently facing a high skill shortage in the energy sector, which is impacting the pace of its energy transition[24]. Energy services, in practice, require complex technical solutions that need to be installed, monitored, and maintained. While there are already a large number of technical solutions available in the market (such as heat pumps, smart EV chargers, and energy management tools), the implementation of these technologies is taking an unexpectedly long time due to the lack of appropriate skills and training.

- **Complex bureaucracy**: Bureaucracy plays a significant hurdle in the German energy service and efficiency market. For instance, the process of contracting or de-contracting an energy service or supply involves navigating complex bureaucratic procedures. Utilities or energy suppliers often lack transparency in this process. Moreover, data sharing and ownership is still a debatable topic in German society.
- **Unstable subsidies and funding**: In many cases, subsidies and funding supporting energy efficiency measures are short-term and not clearly communicated to the public. This lack of transparency and clarity often leads to program failures and creates

22 Legal text: https://www.gesetze-im-internet.de/enefg/BJNR1350B0023.html

23 Legal text: https://www.gesetze-im-internet.de/geg/index.html

24 https://www.kfw.de/%C3%9Cber-die-KfW/Service/Download-Center/Konzernthemen/Research/Indikatoren/KfW-ifo-Fachkr%C3%A4ftebarometer/

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uncertainty in the market. As a result, a number of subsidies have been reversed due to the lack of adequate funding, further exacerbating the issue[25].

- **Investment in energy efficiency**: Transitioning towards energy efficiency and clean energy is a costly affair[26]. Companies offering innovative solutions often seek to make a profit by selling technologies at high prices. However, from the user's perspective, there is often a dilemma in deciding whether to invest in these technologies. As a result, only mandatory energy efficiency measures, such as energy audits and renovations, are typically implemented. Utilities and public authorities should be also part of the energy efficient pilots and funding programs.

9.4.6. Italy & Belgium

Significant barriers to financing energy efficiency projects, particularly affecting small and medium-sized enterprises (SMEs) in the energy sector exist in Belgium and Italy such like:

1. **Small Project Sizes**: Most EE projects require less than €500,000, a sum too small to attract large investors or developers. This necessitates the aggregation of projects to create bundles attractive enough for investment, which involves standardizing due diligence, risk analysis, and contracts.
2. **Lack of Standardization**: There is a notable lack of standardized processes and documentation, which complicates dealings with financial funds, especially for large companies, while SMEs often struggle with limited access to financial services.
3. **Access to Capital**: Small-scale developers often lack access to growth capital and project finance, which are crucial for scaling operations. They might also have to make debt arrangements with clients, impacting their capacity to accept new work or expand.
4. **Market Flexibility**: The financing market lacks flexibility, often constrained by prescriptive fund allocations across EU member states, hindering investment where viable.
5. **ESG Know-How**: There's a significant gap in knowledge and clarity regarding ESG (Environmental, Social, and Governance) compliance, complicating capital raising and slowing investment decisions.
6. **the high upfront costs associated with project evaluation and risk assessment**: This barrier arises primarily due to the lack of standardization in various aspects of project planning and execution, including due diligence processes and the contracting between EE developers and end clients.Therefore, Institutional and private investors, who typically look for scalable and low-risk opportunities, may find the EE sector less attractive due to these non-standardized, high-cost investment conditions

- **Specific barriers in Italy**:

25 https://www.bbc.com/news/uk-67709228

26 https://www.bdew.de/media/original_images/2024/04/24/fortschrittsmonitor_2024_zCu1QX7.pdf

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- **Bureaucratic Complexity**: Red tape and bureaucratic processes can deter investors and complicate the implementation of EE projects.
- **Economic Instability Difficulties to attract capital:** Italy has a credit rating on the edge of investment grade (with ratings like BBB and Baa3 from major agencies), this presents a real challenge. While not below investment grade, Italy's rating still reflects a relatively higher risk compared to AAA-rated countries, which could restrict access to certain EU funds and private investment unless there are specific EU-backed financial instruments like credit guarantee funds in place to enhance credit and stimulate investment.

- **Specific barriers in Belgium**:
  - **Regional Differences**: Belgium's federal structure can lead to variations in EE incentives and regulations between regions, complicating nationwide initiatives.
  - **High Labor Costs**: High costs associated with labor can increase the overall expense of initiating and completing EE projects, making them less financially viable.
  - **Other barriers specific to Wallonia region**:
    - Complexity and burden of conducting public tenders, absence of a reference specification, lack of administrative and legal framework.
    - Complexity and burden of administrative procedures for selecting suppliers
    - Large number of long-term maintenance contracts hindering the implementation of Energy Performance Contracts (EPC)
    - Legal and administrative complexity of EPCs
    - Lack of access to capital for small ESCOs (in the "shared savings" model or for beneficiary SMEs ("guarantee model"))
    - Lack of interest or maturity of banking institutions, especially regarding specific loan procedures (e.g., International Energy Efficiency Financing Protocol (IEEFP))
    - Interest rates too high for SMEs and consequently a lack of investment capacity for potential ESCOs
    - (potentially inability to secure successive loans)
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