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Active managed Buildings with
Energy performaNce Contracting

Deliverable Number (D1.1)

Analysis of directives, policies, measures and regulation relevant for the Active Building EPC concept and business models

The AmBIENCe Consortium

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EXECUTIVE SUMMARY

Deliverable D1.1 "Analysis of directives, policies, measures and regulation relevant for the Active Building EPC concept and business models" has the main goal to analyse the current directives, policies and measures already adopted, as well as those under consideration at the EU level and across the EU Member States, in support of the Active Building Energy Performance Contract (EPC) model proposed in the AmBIENCe project. The model extends the traditional EPC in the following three dimensions:

1. Extending energy performance guarantees related to energy efficiency to include the valorisation of flexibility through Demand Response (DR) services;
2. Tailor EPCs to a broad scope of building types (residential, hospitals, education offices, commerce, etc.);
3. Extending the scope to groups/clusters of buildings under the concept of Technical/Market Aggregators or (local) energy communities.

First, the main concepts related to EPCs, such as the key actors involved and the main schemes implemented in Europe, are introduced. This is followed by an overview of DR concepts in the context of active buildings through the explanation of the (1) electricity markets in Europe, (2) the main implicit and explicit DR schemes implemented, and (3) concepts related to energy communities for customer empowerment.

After this preliminary overview, the EU regulatory framework and vision are analysed, by focusing the attention on the most recent developments and policies. These policies aim to put citizens at the centre of the energy system as active consumers and prosumers by using local and user-friendly energy exchanges, and by promoting demand flexibility as a crucial element to foster the energy transition.

Then, a comprehensive overview of the current directives, policies and measures in support of the enhanced EPC concept and business model, is presented for the countries represented in the consortium, i.e., Italy, Belgium, Portugal and Spain. This analysis is also extended to cover the other EU Member States on a high level, thereby allowing an understanding as to which countries are most suitable for the AmBIENCe concept and business model to succeed.

The analysis looks at what are the current gaps in legislation and market awareness that might have a significant impact on the successful deployment of the new concepts and business models and what are the best practices in legislation creating an enabling environment to foster the deployment of the proposed concepts and business models. The current status of each country in implementing the Active Building EPC is assessed through a set of key areas including ESCO/EPC status, DR services, and other factors enabling the Active Building EPC such as distributed energy resources (DER) flexibility assessment and integration of energy and non-energy services. This critical assessment allows the identification of the main enablers and barriers to the implementation and deployment of Active EPCs in Europe.

In summary, this deliverable defines the basis for the definition of the Active Building EPC concept and business model within Work Package 2, by identifying what are the directives and policies that underpin and support the AmBIENCe concept and what are instead the barriers that should be removed to enable the implementation of this innovative concept.

In detail, in the analysis carried out at EU level, it is found that Europe is on a good track towards the empowerment of the end user to foster energy transition, by putting this latter at the centre of the energy system. DR and consumer empowerment are integral parts of the Energy Union and the Clean Energy Package for all Europeans as they help to reach a competitive, secure, and sustainable economy. There is a lot of attention on the role of “active” consumers, who can operate directly or in ad aggregate manner in the markets, by adjusting consumption profiles based on market signals while benefiting from lower electricity prices or other incentives.

At Member States level, it was found that Belgium and Italy are in a good track for receiving the Active EPC, whereas Spain and Portugal still need to overcome significant barriers to receive and implement the Active EPC. Among the main enablers and best practices found at Member States level, there are the strong legislative background and standards established for energy efficiency in buildings, the well-developed EPC market, the establishment of product requirements according to the concept of “technology-neutrality” to guarantee the supply of network services from demand side and improve integration of flexible demand in the market, and the current revision of requirements to reduce minimum bid sizes while enhancing benefits for small customers. On the contrary, in the list of main barriers that need to be removed to enable the implementation of this innovative concept, there are the insufficiency of market players as aggregators, the lack of economic and contractual incentives, the privacy issues for data and the high cost for the qualification and measurement&verification equipment to create flexibility from demand side.

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1. INTRODUCTION

Buildings are responsible for approximately 40% of energy consumption and 36% of CO_2 emissions in the European Union (EU) alone. Energy efficiency measures are essential to improve building's energy, indoor environmental quality and environmental performance by taking advantage of the available technologies, without compromising the comfort and well-being of their users. Besides lowering energy use, using energy in a smarter manner, e.g. using local and/or renewable energy sources (RES), is a complementary approach to reduce buildings emissions. Developing new smart energy services that utilise flexibility from demand-side resources in different sectors is essential in order to fully unlock the potential of buildings towards energy and cost savings, and CO_2 emissions reduction, while ultimately meeting climate goals. The use of information and communication technologies (ICT) solutions and tools, relying also on big data provided by smart meters and sensors, can trigger significant savings with reduced investment, coupled to renovating the existing building stock.

Energy Performance Contracting (EPC) schemes are an effective means to provide energy efficiency services that can bring added value to the whole value chain and contribute to the empowerment of energy end users through innovative products and services offered by dedicated providers such as Energy Service Companies (ESCOs), aggregators or energy cooperatives/communities.

After several years of slow growth in the EU ESCO market due to legal, financial and administrative barriers facing EPCs, there are several regional efforts to support the EPC process, including the 2017 Eurostat Guidance Note and the subsequent 2018 EPC Guide to the Statistical Treatment of EPCs. However, there are still several challenges facing the ESCO market. Often, demand response has a negative impact on users' perception of comfort, especially regarding the HVAC system of the building. These barriers can be addressed by using innovation in several technological fields that enables improvements not only in terms of energy savings and associated cost reductions, but also in terms of non-energy services, such as security and comfort.

The combination of this approach with current EPC schemes establishes the Active Building EPCs concept, which uses intelligent and real-time information to offer new combined services, established comfort and safety performance criteria and new levels of flexibility activation and use. These principles are at the core of the EU-funded project AmBIENCe (Active managed Buildings with Energy PerformaNce Contracting). The project aims to extend the concept of Energy Performance Contracting to Active Buildings, which are buildings equipped with active control option that can actively participate in demand response and energy efficiency programmes, and make it available and attractive to a wider range of buildings. The proposed Active Building EPC concept and business model extends the traditional EPC in three dimensions:

1) Extending energy performance guarantees related to energy efficiency with guarantees related to the valorisation of flexibility through Demand Response (DR) services;
2) Tailor EPCs to a broad scope of building types (residential, hospitals, education offices, commerce, etc.);

3) Extending the scope to groups/clusters of buildings under the concept of (local) energy communities.

AmBIENCe aims to provide new concepts and business models for performance guarantees of Active Buildings, combining savings from energy efficiency measures and the active control of assets, enabling the use of flexibility. The willingness to invest in additional sensorisation, ICT and the Internet of Things (IoT) will allow offering adjacent non-energy services. In detail, the new AmBIENCe contract model has the following features:

- Includes flexibility services through DR, distributed energy resources (DER) including RES storage, and electric vehicles (EVs);
- Integrates energy and non-energy services (security, access control, comfort, indoor environmental quality, and health, remote control and monitoring, automatic diagnosis and maintenance prediction, building condition, trouble shooting, environmental compliance, and information management);
- Applicable to all types of buildings;
- Founded on transparency and real-time information provision to empower end users;
- Relies on standards of Measurement and Verification (M&V);
- Takes into account energy exchange with other buildings under the concept of (local) energy communities.

For defining the new concept and business model of the Active Building EPC, it is essential to obtain first a clear picture of the European situation, by analysing the EU and member states directives, policies, measures and regulation in order to understand what is allowed, what is not, what is encouraged and what is penalized, thereby applying the lessons learned from this exercise in later stage of the project.

1.1. PURPOSE AND SCOPE OF THE DOCUMENT

Deliverable D1.1 falls within the scope of Work Package 1: "Assessment of (enhanced) Energy Performance Contracts and Building Demand Response services in Europe," with the main goal to analyse current directives, policies and measures already adopted, as well as those under consideration, at EU level and across the EU Member States that effect the enhanced EPC concept and business model. After the analysis of the EU regulatory and policy framework, a comprehensive overview of the current situation is presented starting from the countries represented in the AmBIENCe Consortium (Italy, Belgium, Portugal and Spain). The analysis is then extended to cover other EU Member States through surveys and questionnaires sent to key stakeholders represented in the European Energy Research Alliance – Joint Programme on Smart Grids (EERA JP SG). This report represents a starting point for the consortium in exploring new concepts and business models for performance guarantees of Active Buildings, combined savings from energy efficiency measures and the active control of assets enabling the use of flexibility, so as to understand:

- Which countries have the best legislative practices and offer the best environment for AmBIENCe concepts and business models to succeed,
- What are the current gaps in legislation and market awareness that might have a significant impact in the successful deployment of the new concepts and business models proposed in AmBIENCe.

The current status of each country for implementing the Active Building EPC is then assessed through a set of key areas covering aspects as ESCO/EPC status, DR services, and other factors enabling the Active Building EPC such as DER flexibility assessment and integration of energy and non-energy services. This critical assessment allows the identification of the main enablers and barriers to the implementation of AmBIENCe concepts.

1.2. RELATION TO OTHER ACTIVITIES

The output from the activities in Task 1.1 “Analysis of directives, policies, measures and regulation in the Member States that are relevant for Active Building EPC concept and business models” will be used for Task 1.2, which will analyse the actors, roles, and business models related to enhanced EPC and flexibility services, and for Task 1.3, which will define the required amendments/changes needed in the current directives, policies, measures and regulations, to support the Active Building EPC. Moreover, this deliverable defines the basis for the definition of the Active Building EPC concept and business model within Work Package 2, by identifying what are the directives and policies that underpin and support the AmBIENCe concept and what are instead the barriers that should be removed to enable the implementation of this innovative concept.

1.3. STRUCTURE OF THE DOCUMENT

The deliverable consists of nine chapters. The purpose and scope of the deliverable and the relation to other activities in the project are described in the first chapter. The main EPC and DR/flexibility concepts are introduced in the second and third chapters, respectively. The fourth chapter describes the methodology established to attain the results presented in the document. Chapter five addresses the European regulatory framework and policies supporting the Active Building EPC concept. The sixth chapter focuses on the detailed survey of directives, policies, measures and regulation that are relevant for the Active building EPC concept for the Member States represented in the consortium, as well as an overview covering all Member States. A critical assessment of the key findings is discussed in the seventh chapter, and the main enablers and barriers found across Member States for the implementation of the Active Building EPC is presented in the eighth chapter. The ninth chapter contains the conclusions and an outlook for the future activities, whereas in the Annex 1, the glossary of the terms and definitions used in the AmBIENCe project can be found.

2. OVERVIEW OF ENERGY PERFORMANCE CONTRACTS

Energy Performance Contracting (EPC) is one of the main ways for delivering energy savings projects with third party financing, and therefore it is considered an essential instrument in the energy transition.

An EPC (2006/32/EC) is a contractual arrangement between the beneficiary and the provider of an energy efficiency improvement measure, verified and monitored during the whole term of the contract, where investments (work, supply or service) in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement or other agreed energy performance criterion, such as financial savings (Directive 2012/27/EU).

An EPC is a particular form of contract where remuneration is closely linked to the success of the interventions carried out by the supplier that can focus on both the energy saving of the project, and on the use of renewable energy. The main forms of EPCs are discussed below.

In most cases, the (energy service) supplier is also in charge of the equipment and/or plant's maintenance during all the EPC duration. This is an advantage both for the beneficiary of the energy efficiency improvement measure(s) – the end-user, which is relieved from this duty, and for the supplier (of the energy efficiency measures), because a good maintenance level ensures greater energy savings and therefore greater and earlier economic returns for them as well.

Another important point to emphasise is the need to verify the results during and at the end of the contract: an EPC should contain a clear procedure (indicating also the measurement and verification instrumentation to be used) to objectively and indisputably measure and verify the achievement of the contractual targets.

There are two main actors in executing EPC contracts: The beneficiary of the energy efficiency improvement measures and the supplier of those energy efficiency measures.

The **beneficiary** can be the owner or the tenant of the infrastructure, i.e. the one paying the energy costs. The **supplier** normally is a certain kind of company called as Energy Service Company (**ESCO**): its function, in addition to implementing the energy savings measures, is to anticipate or pre-finance the costs of the energy efficiency intervention or to assume the burden to find the capital. The EPC approach is based on the transfer of technical and performance risks from the client (beneficiary) to the ESCO (supplier) based on performance guarantees given by the ESCO. As said before, in EPCs, ESCO remuneration is based on demonstrated performance; a measure of performance is the level of energy savings or energy service.

A third contractual party sometimes present in a EPC agreement is the **financier** which is not intended in the classic way of a financial institution that provides a loan covered by solid guarantees to the beneficiary or the ESCO, but instead as a subject which participates to the investment by providing debt or equity, whose return is linked to the achievement of the contractual targets (project cash flows), also known as project finance: for this reason it takes the operation risks on himself.

A fourth possible actor is the "**facilitator**" who has the aim of providing strategic, technical, administrative and financing assistance in the field of energy efficiency investments to a possible customer in order to guide the latter through its EPC project. This figure is particularly active with the public administration.

The main types of EPC are described below [1], [2]:

- **First out:** The revenues for the achieved energy saving are entirely used to pay the cost of the works and to remunerate the activity of the ESCO (who finances the initial investment), the beneficiary pays the same energy costs as before until the EPC expiration. In detail, the beneficiary only sees energy cost savings after the EPC expiration, but has a guaranteed energy cost during the EPC.
- **First in:** The beneficiary is immediately entitled to a decrease of its historical energy costs, and this condition is independent from the project target achievement. The additional economical savings due to the reduction of the customer real energy consumptions, are collected by the ESCO for the whole duration of the contract. Similar to the First out, also in the First in, the ESCO takes the risk that not all costs are paid back (fixed EPC expiration date). However, in this case, the EPC duration will be longer as part of the savings are transferred immediately to the beneficiary.
- **Shared Savings:** The economical revenues due to the energy savings are divided between the parties. The investment is repaid on the basis of an agreement and the portion of savings per capita is determined by means a feasibility study. The Shared Savings model is shown in Figure 1.

FIGURE 1: SHARED SAVINGS MODEL [3]

- **Guaranteed Savings:** in this case the ESCO has not the role of financier: the beneficiary (client) finances the works directly or by means of a loan himself, while the ESCO, that realizes the interventions, guarantees a minimum level of savings to the customer. In the event of lower savings/earnings than the guaranteed ones, the ESCO will pay a penalty to the customer, while in case of greater savings/earnings, the additional economic benefits will be transferred to the beneficiary/client. The Guaranteed Savings model is shown in Figure 2.

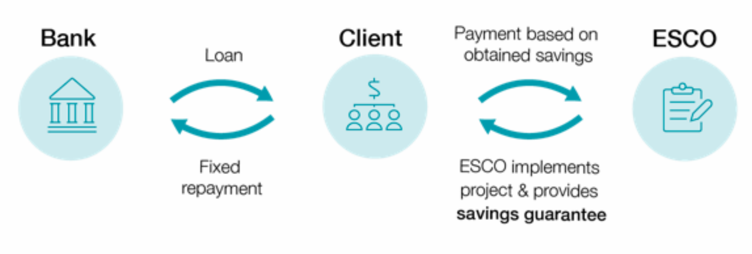


FIGURE 2: GUARANTEED SAVINGS MODEL [3]

- **Four Step:** Consists in financing the interventions in 4 phases. In the first one the ESCO optimizes the plant management and the ordinary maintenance; in the second, with the obtained savings, simple and low-cost efficiency measures are financed; in the third, the savings generated finance the medium-sized interventions; in the fourth the savings deriving from the three previous phases provide the resources for structural interventions. The Four Step can be realized both in an EPC and, more in general, in a standard energy supply contract.
- **Chauffage:** the beneficiary/client entrusts the management of his plans to the ESCO which provides the payment of the energy bills and fuel invoices for the entire duration of the contract. For this service the beneficiary/client pays a fee equal to the energy expenditure he had before the contract, reduced of an agreed discount, while the ESCO remuneration is generated from the reduction of the energy cost due to the technical improvement or also to the stipulation of more advantageous supply contracts.
- **"Plus" Energy Service Contract:** the client/beneficiary entrusts the supply of the energy carriers and the plant maintenance too, to an external subject (typically an ESCO company) which is also obliged to reduce the primary energy index for heating and cooling by at least of 10 percent compared to the initial value. The revenues due to the energy saving can be used to finance the process of transformation and use of energy, the energy requalification of the building envelope and the production of energy from renewable sources.

The last two EPC typologies are focused on the reduction of the energy supply costs and more appropriately can be defined as Energy Service Contracts (ESC) where the ESCO is not only responsible for upgrades to equipment, but also for energy supply (heat, electricity, cooling, etc) – as the name implies. ESC includes reduction of supply costs, whereas EPCs generally focus on demand side reductions, namely energy consumption reduction.

The most common EPC models are **shared savings and guaranteed savings**. Both models are used throughout Europe, although, in established markets with a well-defined banking structure, the guaranteed savings model accounts for the majority of the market. The key characteristics of these two models and the comparison with the energy supply contracting are shown in Table 1.

TABLE 1: KEY CHARACTERISTICS OF EPC AND ESC COMPARED [4]

	EPC – Guaranteed savings	EPC – Shared savings	Energy supply contracting
% of EU market (IEA, 2018)	50%	20%	30%
Key elements	Energy savings measures with **ongoing monitoring and verification** services to compare with predetermined **guaranteed energy savings.**	Energy savings measures (mainly to the demand side) to provide cost savings **associated with the overall energy bill.**	Efficient supply of energy (heat, electricity, etc) is contracted, measured and delivered in physical units.
Guarantees	**Yes** – ESCO guarantees performance based on **energy saved throughout contract.**	**Typically not** – The ESCO may guarantee a minimum performance.	**Does not assume any risk,** but may include incentives related to energy use reduction on the supply side.
Payment	Derived from energy savings achieved in **constant prices of the base year.**	Payment linked to the achieved **change in energy expenses**.	Payment **of a fixed rate/tariff**, normally without performance requirements.

3. OVERVIEW OF DEMAND RESPONSE CONCEPTS IN THE CONTEXT OF ACTIVE BUILDINGS

3.1. ELECTRICITY MARKETS IN EUROPE

The electricity system as we know it today consists of a physical grid infrastructure through which electricity flows and an organized electricity market. While such markets are in place to arrange the monetary flows linked to the production and delivery of electricity, they are also designed to avoid a potential electricity system collapse. This is essential because the generation and the consumption (plus grid losses) of energy must be matched at all times. If there is no balance between demand and supply for electricity, grid frequency will deviate from its reference value, leading to a system break down.

Keeping this balance is not always easy as grid conditions may change from day-to-day and even from second to second, especially due to the large penetration levels of distributed energy resources (DER) (for instance if suddenly there is more wind, there could be more electricity generation than predicted). In order to avoid system failure, different types of electricity markets occur in different time frames:

(1) forward and future markets,

(2) day-ahead markets,

(3) intra-day markets and

(4) balancing markets.

Forward and future markets start from multiple years before up to the day before delivery. They consist of contracts to deliver/consume electricity in the future at a certain price. Day-ahead markets trade electricity only one day before the actual delivery. They are important to ensure balance at the end of the day (planned generation and planned consumption). The intra-day market consists of electricity trading on the delivery day itself and is necessary to correct for shifts in the day-ahead nominations. This might be necessary due to updated weather forecast (wind production). Finally, the balancing markets are in place to solve real-time imbalances. It is now up to the Transmission System Operator (TSO) to ensure demand and supply match. To do this, the TSO has access to ancillary services (AS). AS serves to support the TSO to ensure that he can maintain grid stability and security. These AS are traded on the balancing market by first procuring reserves that can be activated in case of imbalances. There are three different types of reserves that are each contracted for different purposes outlined in table 2.

TABLE 2: BALANCING MARKET RESERVES

Balancing Market Reserves (4)	
Frequency containment services (FCR)	Used to automatically stabilize the frequency of the grid within a couple of seconds (maximum 30 seconds).
Frequency restoration reserves (FRR)	Used to restore the system balance in a range of seconds up to 15 minutes. FRR can be activated automatically (aFRR) or manually (mFRR).
Replacement reserves (RR)	Used when FRR are not able to restore the system balance. In addition, they help to make sure that FRR units can prepare for a potential next short-term imbalance. They can stay active for hours and they are activated within a minimum of 15 minutes.

In the past, balancing supply and demand of electricity **occurred largely through adjustments in supply of electricity**. This was possible as power plants were controllable and demand was more predictable. However, nowadays, electricity production through vRES can fluctuate significantly at different times and even **demand becomes less predictable due to increasing electrification of heating and mobility**. In addition, renewable electricity production is largely connected to the distribution grid. Consequently, balancing supply and demand is not straightforward anymore and the system needs more flexibility to continue adapting to unexpected changes in demand or supply.

3.2. DEMAND RESPONSE

An alternative approach to matching demand and supply of electricity is by adjusting consumption, which consists of adapting the demand of electricity to the supply of it, known as demand response (DR). This implies that final consumers such a household or business offers flexibility to the system by changing their electricity consumption e.g. by modulating it or by shifting it to a different point in time. Industrial or larger sites can do this by adjusting their operational processes, while smaller businesses and households could do so by shifting their heating and cooling demand, charging of their Electrical Vehicles or using their electric appliances away from peak times.

Therefore, DR is a powerful instrument to increase system adequacy, reduce investments in peak generation, reduce emissions and empower consumers. Today, a shift in this direction has already been made possible due to the introduction of smart meters, smart appliances and home management systems. DR can occur either manually, meaning consumers themselves shift their consumption by responding to prices, or it can occur automatically implying that an automated system is in place that controls electricity consumption and adjusts it based on forecasts, prices, and needs. Commercial and larger companies may even have a unit in place to ensure optimised consumption. That is, they could have a dedicated staff in charge of optimizing consumption, for instance to rearrange their production or operation schedule.

There are two major categories through which demand response can occur: implicit and explicit demand response.

3.2.1. IMPLICIT DEMAND RESPONSE SCHEMES

Implicit DR implies that end-users adjust their consumption behavior to **time-varying electricity prices.** These electricity prices reflect the value and the cost of electricity in different time periods. Therefore, consumers can shift consumption away from periods of high electricity prices (reflecting electricity scarcity) and vice vers [5] a. There are different types of time-varying electricity prices (all of which signify that electricity costs are not flat), for example:

- **ToU pricing** means that within specific blocks of time, prices are higher or lower (for instance during night time, prices are lower).
- In case of **critical peak pricing**, prices can be raised artificially during specific events when wholesale market prices are predicted to be high.
- For **real-time pricing**, prices follow on a continuous basis the cost of supply in wholesale markets.
- Finally, in case of **critical time rebates**, suppliers can also indicate critical events. Yet, instead of raising prices, they can refund or reward customers for their reduction in consumption.

This implies that consumers can value their flexibility by responding to differences in price and reduce their electricity bill accordingly. However, the exact benefits of implicit DR depend to a certain extent on the investment costs for the consumer (such as automation equipment). Furthermore, consumers need to be aware of the possible flex for DR that they have, and they need to share and have access to data.

3.2.2. EXPLICIT DEMAND RESPONSE SCHEMES

Explicit DR implies that end-users respond to a **specific request to change their consumption pattern** after that they have indicated in advance how much flexibility they have available at which moment. They offer their flexibility in advance on different markets (balancing, reserves, and wholesale markets). Their flexibility is therefore committed and dispatchable and sold upfront on electricity markets. Consumers receive direct payments to change their consumption pattern upon request. Due to the nature of this DR, this type of flexibility is mostly for large industrial consumers, or it can be provided through demand response service providers [5].

There are different types of explicit DR schemes, aligned with the different energy markets that exist. Energy markets follow different timescales. We already touched upon the **wholesale markets** which contain **future markets** (years in advance of delivery), **day-ahead markets** (one day before delivery) and **intraday markets** (less than an hour to 15 minutes before delivery). The goal of these markets is to ensure in each time frame, based on analyses and predictions, that estimated consumption and supply are balanced out. Service suppliers can offer their DR services to make this happen (for instance through aggregation of different loads with different characteristics can be pooled together).

Once the wholesale market is closed, consumption and production come closer to real-time (that is, the moment of delivery). It is now up to the TSO to make sure demand and supply match. To do this, the TSO has access to AS, which are traded in **balancing markets**, and are used to balance the system and to manage energy fluctuations (see Table 2). As explicit DR could potentially respond in very short time frames, balancing markets provide the most options to offer explicit DR.

Another type of market, in addition to balancing markets, which is also important for explicit DR (at least in some countries) are **capacity markets**. These markets ensure that enough electricity capacity is available and can span over multiple years to months. To contribute to having sufficient capacity, explicit DR can contribute here with the promise to reduce peak demand on the network where necessary.

Finally, there is also **portfolio management**. Portfolio management means a market participant offers balancing services to a balancing responsible party (BRP). Each BRP is responsible for a portfolio of access points and he must ensure a balance between injection, offtake and commercial power trades within its own portfolio. If the BRP incurs an imbalance on a quarter-hourly basis, he is subject to imbalance tariffs. Different balancing options exist to manage a portfolio. DR could be one option as BRPs are aiming to have a variety of electricity products and resources in their portfolio to spread out balancing risks. DR could be used in day-ahead and in real-time portfolio management of the BRP. DR flexibility could be used to optimize the day-ahead scheduling of production and consumption or it could be assessed in real-time when there are deviations from the original scheduling.

3.3. CUSTOMER EMPOWERMENT: ENERGY COMMUNITIES

According to some sources, “It is now clear to policymakers that Europe will not be able to achieve its energy policy goals in a secure and cost-efficient manner unless the energy system becomes more flexible. **DR and consumer empowerment are understood as integral parts of the Energy Union and the Clean Energy Package for all Europeans** because they help to reach a competitive, secure, and sustainable economy” [6]. All over Europe, individuals, cities, and communities are installing renewable energy projects and consumers are becoming more engaged.

However, as seen in the country analysis section (Chapter 6), demand response resources cannot yet completely compete on an equal level with traditional (generation) resources. In addition, for smaller buildings and household consumers, it is not easy to offer services (DR services, or specific grid services related to for instance congestion management) on an individual basis. Therefore, demand response service providers could for instance aggregate demand response of multiple similar end-users and sell it to the market as a bundle. This way service providers can make a pool of combined loads that they sell as a single resource and as such help individual consumers to value their flexibility potential (acting as a large-scale asset).

Europe is now expanding on this model by giving individuals and communities the right to produce, store and sell energy. The corresponding revised Renewable Energy Directive **RED II** [7] and the Internal Electricity Market Directive [8] proposed the **Renewable Energy Community**

(REC) and the **Citizen Energy Community (CEC)**, respectively, as part of the final Clean Energy Package as it will be discussed in detail later. As such, Europe is giving consumers a way to organize themselves individually, or as a community, to ensure a more open and democratic energy-sector. Member States now must transpose the directives into national regulations. However, even without proper regulations in place, pilot projects of energy communities are already taking place and might give opportunities to consumers to value their flexibility, and advise future policy.

4. METHODOLOGY DESCRIPTION

The analysis of the current directives and policies in support of the Active Building EPC concepts started at European level. Focus has been placed on investigating the latest developments achieved in Europe to foster the active role of end-users towards the energy transition.

At a Member States level, a detailed country analysis has been developed for Italy, Belgium, Portugal and Spain, by analyzing the following items:

1. Current status of EPC/ESCOs:
    - Main regulations, directives and policies on EPC;
    - Main types of EPC implemented;
    - Main actors involved in current EPC;
    - ESCO market overview (e.g. number of ESCOs, volume of ESCO projects, application sectors, market longevity, etc);
2. Current status of DR services and other factors enabling the Active Building EPC concept
    - Status of implicit DR and main type of schemes implemented;
    - Status of explicit DR and demand access to the market to understand to which extent demand is allowed as a resource within the different national electricity markets (i.e. wholesale, balancing, ancillary services, capacity Mechanism, strategic reserves, etc.);
    - Status of DR product/programme requirements for demand participation in electricity markets;
    - Status of independent aggregators;
    - Status of regulations/policies supporting aggregation of distributed energy resources (DER) intended as storage, EVs, RES and DG;
    - Status of transparent measurement and verification standards with the description of the standardised and transparent regulation on how demand response events are measured;
    - Status of real-time monitoring of energy consumption and generation through investigating relevant regulations/policies and/or best practices;
    - Status of regulations/policies and best practices supporting demand-side flexibility at building-level, for instance in the context of Energy Communities or in other situations if applicable;
    - Status of integrations of Energy and Non-Energy services in regulations/policies and best practices;
    - Other relevant legislation and policies supporting implementation of the Active EPC, such as legislations and policies supporting incentives in the field of energy efficiency and RES integration.

Following the detailed country status assessment, a critical assessment of the key findings is presented. In detail, three main key areas have been identified for this assessment, each of them constituted by a set of main factors, specified below:

1. Key areas for the assessment of EPC/ESCO status:
    - ESCO market longevity;
    - ESCO relative market size;
    - ESCO market growth curve;
    - ESCO relative market value;
    - EPC market value;
    - Implementation of EPC in various building sectors.
2. Key areas for the assessment of buildings' flexibility aspects for DR services:
    - Demand Response access to markets;
    - Service providers access to markets;
    - Product requirements;
    - Measurement and verification procedures.
3. Key areas for the assessment of other factors enabling the Active Building EPC
    - DER flexibility exploitation for participation to the market in the aggregated form;
    - Demand-side flexibility on building level;
    - Integration of Energy and Non-Energy services.

For each key area above, the status of each country represented in the consortium has been assigned a score from 0 to 5. These key areas and the related scoring methods have been identified by following the approach proposed by NOVICE H2020 project [9].

In detail, the group 1 allows measuring the maturity and development of the ESCO and EPC markets. The scoring matrix has been established based on the key performance indicators (KPIs) calculated for the countries under investigation.

The key areas under group 1 with the related scoring matrix are specified below:

- **ESCO market longevity**: this area investigates how long this market existed in a particular geography.

KEY AREA	ESCO market longevity
5	Higher than 14 years
3	From 9 to 14 years
1	From 1 to 8 years
0	Non-existent

- **ESCO relative market size**: this area measures the number of ESCO / 100.000 inhabitants as a relative size of the market.

KEY AREA	ESCO relative market size[1]
5	Higher than 2.5 ESCOs per 100.000 inhabitants (for Belgium: Higher than 2.6 ESCOs per 100.000 inhabitants)
3	From 1.7 to 2.5 ESCOs per 100.000 inhabitants (for Belgium: From 0.17 to 2.6)
1	From 0.1 to 1.6 ESCOs per 100.000 inhabitants (for Belgium: From 0.01 to 0.16)
0	Non-existent

- **ESCO market growth curve**: this area looks into how the market developed over the last 5 years (from 2014 to 2018).

KEY AREA	ESCO market growth curve
5	Higher than 150%- Fast growth
3	80%-150% Moderate growth
1	1% - 79% Slow growth
0	Non-existent

- **ESCO relative market value:** this area measures the average ESCO revenue / 100.000 inhabitants as a relative value of the market

KEY AREA	ESCO relative market value[2]
5	Higher than 6.0 million € per 100.000 inhabitants (for Belgium: Higher than 3.0 million € per 100.000 inhabitants)
3	From 3.2 to 6.0 million € per 100.000 inhabitants (for Belgium: From 1.5 to 3.0)
1	From 0.1 to 3.1 million € per 100.000 inhabitants (for Belgium: From 0 to 1.4)
0	Non-existent

- **EPC market value**: this area measures the average EPC revenue / 100.000 inhabitants as a relative value of the ESCO market

KEY AREA	EPC market value
5	Higher than 3.0 million € per 100.000 inhabitants
3	From 1.5 to 3 million € per 100.000 inhabitants
1	From 0 to 1.4 million € per 100.000 inhabitants
0	Non-existent

[1] For Belgium, another scoring matrix is used, since the ESCO market definition is limited to the narrow definition of an ESCO = a provider of EPC projects.
[2] For Belgium, another scoring matrix is used, and the ESCO relative market size only refer to EPC.

- **Implementation of EPC in various building sectors**: this area measures the level of opening EPC in various building sectors (public, commercial, small medium enterprises (SMEs), industry, residential)

KEY AREA	EPC market value
5	EPC are implemented in all building sectors (public, commercial, small medium enterprises (SMEs), industry, residential)
3	EPC are implemented in more than two building sectors
1	EPC are implemented in only one or two building sectors
0	Non-existent

An overall grade has been also assigned to each Member State with reference to the general status of EPC/ESCO development, based on the results found in the key areas investigated.

- **Overall grading for the status of EPC/ESCO development:**

KEY AREA	Status of EPC/ESCO development
4-5	Well-developed/Excellent
3	Moderate
1-2	Initiation/preliminary
0	Non-existent

Group 2 measures the maturity and development of building flexibility acceptance for DR services. The scoring matrix has been established based on [6]. The key areas under group 2, with the related scoring matrix, are specified below:

- **Demand Response market access:** This area includes to what extent demand response is allowed as a resource within the different national electricity markets (i.e. wholesale, balancing, ancillary services, Capacity Mechanism, and strategic reserves).

KEY AREA	Demand Response market access
5	Aggregated load is accepted in all the national markets
3	Aggregated load is accepted in more than two programmes
1	Aggregated load is accepted only in one or two programmes
0	Load is not accepted as a resource in any market

- **Service providers market access:** This area involves the clarification of involved parties' roles and responsibilities, allowing for direct access of consumers to independent service providers, alongside the retailers. In particular, it focuses on progress towards fair and standardised arrangements between BRPs/retailers and aggregators

KEY AREA	Service providers market access
5	Standardised arrangements between involved parties are in place for all markets – aggregators do not depend on prior consent of the retailer/BRP
3	Independent third parties may access some parts of the market without consent of retailer/BRP
1	Lack of standardised arrangements between involved parties, and aggregators must contract with retailer/BRP to access market.
0	No standardised arrangement between involved parties is in place and aggregation is illegal

- **Product requirements:** This area refers to the requirements of the different products/programmes (e.g. minimum bid limit, symmetric bid, maximum number of activations, notification time, duration, etc.), assessing whether these enable demand-side resources to participate.

KEY AREA	Product requirements
5	Programme requirements enable a range of resources (supply and demand) to participate in multiple markets and thus no barriers exist
3	Minor barriers to demand-side participation in market remain, however participation is still possible
1	Significant barriers exist, creating major issues for demand-side resource participation
0	Programme requirements block demand-side participation

- **Measurement and verification procedures:** This area refers to standardised and transparent rules on how Demand Response events should be measured

KEY AREA	Measurement and verification procedures
5	Requirements are well defined, standardised, proportionate to customer capabilities, dealt with at the aggregated level
3	Requirements are under development, but do not act as a significant barrier.
1	Requirements act as a significant barrier to consumer participation (the current rules constitute a barrier or there are no clear rules yet).
0	There are no measurement and verification rules for Demand Response participation.

An overall grade has also been assigned to each Member State with reference to the general status of enabling the use of building flexibility DR services, based on the results found in the key areas investigated.

- **Overall grading for the status of buildings' flexibility aspects for DR services:**

KEY AREA	Status of buildings' flexibility aspects for DR services
4-5	Well-developed/Commercially Active
3	Partial Opening
1-2	Initiation/Preliminary Development
0	Closed

Group 3 measures the maturity of other factors enabling Active Building EPCs. The key areas under group 3, with the related scoring matrix, are specified below:

- **DER flexibility exploitation for participation to the market in the aggregated form:** This area investigates to which extent flexibility from DER (distributed generation, electric storage, electric vehicles) is exploited in the aggregated form for participation to the market

KEY AREA	DER flexibility exploitation for participation to the market in the aggregated form
5	Aggregation of all types of DER is allowed for participation to the market
3	Aggregation of certain types of DER is allowed for participation to the market
1	Aggregation of only one type of DER is allowed for participation to the market
0	DER flexibility is not exploited at all

- **Demand-side flexibility on building level:** This area investigates to which extent demand-side flexibility is exploited on building level for instance in the context of Energy Communities

KEY AREA	Demand-side flexibility on building level
5	Demand-site flexibility on building level is fully active in the country
3	Demand-side flexibility on building level is assessed in the context of pilot projects
1	The policy framework is ready, but there are still barriers for active engagement by individual consumers or on building level
0	There is no policy fostering demand-side flexibility on building level in the near future

- **Integration of Energy and Non-Energy services:** This area investigates to which extent Energy and Non-Energy services are integrated in the regulatory framework.

KEY AREA	Integration of Energy and Non-Energy services
5	The regulatory framework assesses the integration of Energy and all Non-Energy services considered in AmBIENCe
3	The regulatory framework assesses the integration of Energy and a range of the Non-Energy services considered in AmBIENCe
1	The regulatory framework assesses the integration of Energy and one or two Non-Energy services considered in AmBIENCe
0	Integration of Energy and Non-Energy services is not regulated at all.

The analysis is also extended to cover other EU Member States, with reference to the EPC/ESCO status and building flexibility aspects for DR services. A country snapshot is provided for the status of EPC/ESCO based on the report “Energy Service Companies in EU – Status review and recommendations for further market development with a focus on Energy Performance Contracting” [4] published in 2017 by the Joint Research Centre (JRC) and NOVICE public deliverable [9]. With reference to building flexibility for DR services, a specific questionnaire (see Annex 2) has been prepared by the consortium and shared with members of the European Energy Research Alliance – Joint Programme on Smart Grids (EERA JP SG)[3], an extended cross-disciplinary cooperation involving many Research and Development (R&D) participants in Europe with different and complementary expertise and facilities aiming at addressing in a medium- to long-term research perspective, one of the most critical areas directly relating to the effective acceleration of smart grid development and deployment [10]. In the absence of replies from a specific EERA JP SG member, the related status of the DR services offered by buildings cluster has been constructed based on the report “Explicit demand response in Europe – Mapping the Markets 2017” [6] published by the Smart Energy demand Coalition in 2017.

The critical assessment of these key areas across Member States has allowed to identify the main enablers and barriers for the implementation of the Active Building EPC.

[3] EERA JP SG is involved in the Advisory Board of AmBIENCe project.

5. EUROPEAN REGULATORY FRAMEWORK AND POLICIES SUPPORTING THE ACTIVE BUILDING EPC

The Energy Roadmap 2050 of the European Commission and the Energy Union strategy fully support the aim of decarbonising the European economy. The **ETIP SNET[4] VISION 2050** [11] is a low-carbon, secure, reliable, resilient, accessible, cost-efficient, and market-based pan-European integrated vision for an energy system that supplies the whole economy and paves the way for a fully CO_2-neutral and circular economy by the year 2050. The vision aims to maintain and extend global industrial leadership in energy systems during the energy transition.

According to this vision, European citizens are the main actors in the transition from existing fossil fuel-based energy systems to an integrated, low-carbon, safe, reliable, resilient, affordable and cost-effective energy system by 2050. Citizens are put at the center of the energy system by becoming active consumers and prosumers, through using local and user-friendly energy exchanges. Demand flexibility also plays a key role as a product and service in energy markets. The active role of consumers as prosumers is fully implemented in the mechanisms of DR, through which the user is made an active participant in the management of network contingencies, as well as in reducing energy consumption through applications such as zero energy buildings or renewable energy communities.

In line with this scenario, on 30 November 2016, the European Commission published the **Clean Energy Package for all Europeans**, that is the set of initiatives and directives aimed at making the European Union more competitive in the energy transition and redesigning the profile of the European electricity market. The European Commission wants Europe to take a leading role in this challenge, revolutionizing the energy sector.

The Clean Energy Package is composed of eight legislative acts concerning different areas of the energy sector. The Package entered into force in mid-2019 and Member States have 1-2 years to transpose the directives into national legislation. The eight legislative acts concern the following topics:

- Redesign of the electricity market, which includes four packages: Regulation on risk-preparedness in the electricity sector (EU 2019/941), Regulation establishing a European Union Agency for the Cooperation of Energy Regulators - ACER (EU 2019/942), Regulation on the internal market for electricity (EU 2019/943) and the Recast of Electricity Market Directive on common rules for the internal market for electricity (**EMD II - Directive 2019/944**) [8];

[4] European Technology & Innovation Platforms (ETIPs) have been created by the European Commission in the framework of the new Integrated Roadmap Strategic Energy Technology Plan (SET Plan) by bringing together a multitude of stakeholders and experts from the energy sector. The ETIP Smart Networks for Energy Transition (SNET) role is to guide Research, Development & Innovation (RD&I) to support Europe's energy transition, with the key mission to set-out a vision for RD&I for Smart Networks and engage stakeholders in this vision.

- Renewable energy, regulated within the revised Renewable Energy Directive (**RED II - Directive 2018/2001**) [7];
- Energy efficiency, regulated within the revised Energy Efficiency Directive (**new EED – Directive 2018/2002**) [12];
- Energy performance of buildings, defined in the new Energy Performance of Buildings Directive (**new EPBD - Directive 2018/844**) [13];
- Request to Member States to draw up a "National Energy and Climate Plan" (NECP) covering a time horizon of 10 years (from 2021 to 2030), as expressed within the Governance of the energy union and climate action **Regulation EU 2018/1999** [14].

The **Directive 2019/944/EU** on the Internal Electricity Market (IEM) provides a comprehensive revision of the previous directive 2009/72/EC. The EMD II is aimed at adapting the current regulatory framework to new market dynamics taking into consideration the opportunities and challenges linked to the objective of decarbonising the energy system and possible technological developments, in particular those relating to the participation of the consumers and cross-border cooperation. The main objective of the EMD II is the construction of a true internal market governed by common rules that can guarantee a wide range of electricity accessible to all. In relation to consumers, the EMD II provides an important paradigm shift: The directive aims to qualify consumers as “active customers”, who can operate directly or in aggregate manner, sell self-produced electricity, including through agreements for the purchase of electricity and participate in flexibility and energy efficiency mechanisms. The directive states that all consumers should be able to take advantage of direct participation in the market, in particular by adjusting consumption based on market signals and, in exchange, benefiting from lower electricity prices or other incentives. Another important innovation envisaged by the EMD II concerns the introduction of the notion of “**Citizen Energy Community (CEC)**”, that must be able to operate in the market on equal and non-discriminatory conditions with respect to the other subjects, being able to freely assume the roles of final customer, producer, supplier or manager of distribution systems.

The **Directive 2018/2001/EU** on the promotion of the use of energy from renewable sources makes a substantial revision of the regulatory framework envisaged by directive 2009/28/EC. The RED II pays particular attention to the self-consumption of renewable energy. Indeed, the Art. 21 provides that consumers can become consumers of renewable energy, and also be able to produce, store and sell the electricity produced in surplus, both individually and through aggregators, while guaranteeing consumer’s rights. RED II introduces the "**Renewable Energy Community (REC)**”. These communities must have the right to produce, consume, store and sell renewable energy. They will also be able to exchange, within the same community, the renewable energy produced by them and access all the appropriate electricity markets, directly or through aggregation, in a non-discriminatory way.

The primary purpose of both CECs and RECs is to provide environmental, economic or social community benefits for their own members or the local areas where they operate rather than financial profits. Both definitions emphasize participation and effective control by citizens, local authorities and smaller businesses whose primary economic activity is not in the energy sector. Finally, participation in CECs and RECs must be open and voluntary.

In general, a REC can be seen as subset, or type, of CEC: the activities of a REC include generation, distribution, consumption, storage, sale, aggregation, supply, sharing of renewable energy (electrical and thermal), and energy-related services, while a CEC includes generation, distribution, supply, consumption, sharing, aggregation and storage of electricity, and energy-efficiency services, energy-related services and electrical vehicle charging-services.

The energy efficiency provisions of the Clean Energy Package are aimed at establishing new efficiency targets both on the European level and for the Member States, and expanding consumer rights in the field of heating and cooling measurement, billing and hot water production. The **revised Energy Efficiency Directive**, makes a revision of the directive 2012/27/EU on energy efficiency, modifying the current provisions directly linked to the achievement of 2030 objectives and introducing new rules aimed at extending the consumer rights and improve access to smart metering tools, smart billing and consumption information.

Another element of the Clean Energy Package in the field of energy efficiency is the revised Energy Performance of Buildings Directive (**Directive 2018/844/EU**), which came into force on 9 July 2018, modifying the directive 2010/31/EU on the energy performance of buildings. The new Energy Performance of Buildings Directive contains provisions concerning, among other things, energy efficiency targets for new buildings such as the minimum energy performance requirements, energy certification, verification methods, monitoring and control of energy use and the establishment of obligations relating to the installation of electricity recharging points. The definition of the smart readiness indicator (SRI) and a methodology by which it is to be calculated are established, in order to assess the capabilities of a building or building unit to adapt its operation to the needs of the occupant and of the grid and to improve its energy efficiency and overall performance. The SRI shall cover features for enhanced energy savings, benchmarking and flexibility, enhanced functionalities and capabilities resulting from more interconnected and intelligent devices.

The **Regulation EU 2018/1999** on the Governance of the Energy Union and Climate Action is aimed at encouraging cooperation between Member States to achieve the objectives and targets of the Energy Union. In particular, the directive calls on Member States to improve the programming and reporting obligations of individual Member States in the field of energy, climate and in relation to the implementation of the measures envisaged by the new structure of the Energy Union. Among the main changes foreseen by the regulation, there is the obligation for each Member State to prepare and send to the European Commission an integrated national plan for energy and climate which will cover a period of ten years. The plan must contain, a description of national objectives and contributions related to decarbonisation, energy efficiency, energy security, internal energy market and, finally, research, innovation and competitiveness.

6. DETAILED SURVEY OF DIRECTIVES, POLICIES, MEASURES AND REGULATION THAT ARE RELEVANT FOR ACTIVE BUILDING EPC CONCEPT FOR THE MEMBER STATES REPRESENTED IN THE CONSORTIUM

The detailed survey of directives, policies, measures and regulation that are relevant for active building EPC concept is presented below for Italy, Belgium, Portugal and Spain.

6.1. ITALY

6.1.1. CURRENT STATUS OF EPC IN ITALY

Overview of the EPC status in the country	In Italy, the use of EPCs is regulated by the **Legislative Decree 102/14** [15] which promotes the role of ESCO, as well as the use of third-party financing, and defines the minimum contents that an EPC has to contain. In general, the main actors involved in an EPC are: - the Supplier (preferably an ESCO) who is the subject responsible for realising the works and normally anticipates the costs of efficiency improvements or finances the required investment; - the Beneficiary, who is the owner of the building or its tenant. In some cases another figure can be involved, i.e., the financer, who supports the supplier in the relations with the beneficiary and takes the risks associated to the initial investment. . In fact he doesn't make a simple loan to the ESCO or to the Client, but it invests directly in the project and the return of investment depends on the success of the activities. In other words if the project does not produce the desired results, the financier losses some money not being able to retaliate on the debtors. Since some years a new subject, called "facilitator", plays the role to provide technical, administrative and financing assistance in particular for the public administration. Seven main types of EPCs can be used, which are [2]: "First-out", "First-in", "Shared saving", "Guaranteed Savings", "Four Steps", "Chauffage" and "Plus-Energy Service Contract" (for further details refer to Section 2). In all the contracts, the main topic is the achievement of a reduction of the energy costs of the Customer; the differences between them mainly regard the following aspects: • the role of the works financier. In most cases, it is covered by the ESCO, but it can be also a third party as a bank or a financial Company; • the method adopted to share the proceeds of energy savings. All the savings can be collected by the ESCO or they can be shared with the beneficiary according to an initial agreement based on a feasibility analysis; • whether or not to use these savings due to the first interventions to finance future energy efficiency measures; • if the main object of the contract concerns the supply of energy carriers or the overall energy efficiency of the site (involving building envelope, equipment, production process, etc). The ESCO market in Italy during 2018 was about € 3.7 billion overall, divided as: 35% on EPC services, 42% on energy efficiency and consulting projects, and 23% on energy efficiency certificates (so called white certificates[5]) sales. Therefore, it can be estimated a total

[5] White certificates, or energy efficiency certificates (TEE), are titles that certify energy savings achieved by various subjects by carrying out specific interventions (for example energy efficiency). Implying the recognition of an economic contribution, they represent an incentive to reduce energy consumption

	turnover connected to the EPC contracts amounting about to € 1.3 billion.
EPC-related regulations, directives and policies in the country	In Italy, the use of EPCs is regulated through **Legislative Decree 102/14**. The Decree implements the EU Energy Efficiency Directive and provides some important innovations and obligations related to energy efficiency. In detail, it promotes the role of ESCO, as well as the use of third party financing, and introduces and defines the minimum contents that an EPC has to contain. The decree also transposes the energy audit obligation and highlights the role of white certificates, already in place in Italy since 2004. The first definition of ESCOs was given by the Legislative Decree 115/2008 [16], transposition of the 2006/32/EC [17] directive on energy services, that is still a relevant legislation. The Decree defines also the requirements that an "energy service contract" and "energy service contract plus" must meet. The energy service contract, a contract for the supply of heating, efficient management, maintenance and eventually upgrading of the heating systems, was originally introduced by Presidential Decree 412 in 1993 [18]. The national technical standard for ESCOs, the UNI CEI 11352, was introduced in 2010 and a second - a more certification-oriented edition - was published in 2014. The standard refers to the European standard EN 15900 on energy efficiency services. Among the other requirements (technical, financial, managerial), to be certified, an ESCO must demonstrate to manage or have managed at least one EPC. Article 12 of Legislative Decree 102/14 provides that starting from July 2016, ESCOs that would participate with new projects to the White Certificates mechanism or would realize energy audits must necessarily be certificated UNI CEI 11352. This standard defines the minimum requirements of Energy Service Companies: it represents a quality warranty for the customer, but also for the ESCOs themselves, due to the tendency of national and European institutions to promote energy efficiency of certified quality. This standard ensures that the ESCO, through its services, guarantees an improvement in customer's energy efficiency by measuring the reduction of energy consumption compared to the initial (baseline) consumption. Therefore, the ESCO must carry out a preliminary energy audit, then define the actions to be undertaken with the aim to improve the energy efficiency, and ultimately verify the results. Moreover, the standard shows the skills that an ESCO must have: organisational, diagnostic, design, management, economic and financial, including the ability to achieve and/or maintain an energy management system in compliance with standard ISO 50001 on energy management system.
Main types of EPC implemented	In Italy, the minimum requirements that an EPC contract must contain have been defined by the Legislative Decree 102/14. They are collected in the Annex 8 of the decree and are detailed in the following: a) a clear and transparent list of the efficiency measures to be applied or the results to be achieved in terms of efficiency; b) the guaranteed savings to be achieved by applying the measures provided for in the contract; c) the duration and fundamental aspects of the contract, the terms and conditions envisaged; d) a clear and transparent list of the obligations incumbent on each contractual party; e) reference deadlines for determining the savings achieved; f) a clear and transparent list of the implementation phases of the actions to be implemented, and of the related costs; g) the obligation to fully implement the measures foreseen by the contract and the documentation of all changes carried out during

	the project; h) provisions governing the inclusion of equivalent requirements in possible concessions to third parties set off; i) a clear and transparent indication of the financial implications of the project and the description of the agreement for the saving sharing between the two parties; j) clear and transparent provisions for the quantification and verification of the real savings achieved, controls quality and guarantees; k) provisions clarifying the procedure for managing changes to the framework conditions affecting the content and results of the contract (for example: change in energy prices, intensity of use of a plant in a building); l) detailed information on the obligations of each contracting parties and on the penalty in the case of non-compliance. Actually, the main types of EPC implemented in Italy are the following: 1) First out. 2) First in. 3) Shared Savings. 4) Guaranteed Savings. 5) Four Step. 6) Chauffage. 7) “Plus” Energy Service Contract.
Main actors involved in current EPC	There are several categories of actors in the market. In an EPC contract, bilateral contractual relationships are normally established between the supplier of the energy services and the beneficiary of the energy services. A third actor, having a function of financier, is sometime involved. Since some years a new figure called “EPC facilitator” is involved as a consultant, in particular for the Public Administration 1. The supplier In Italy, the supplier (preferably an ESCO) carries out the preliminary energy diagnosis to ascertain the investment feasibility, predicting the outcome of a possible intervention; makes the checks on the plants to verify compliance with the current legislation; takes care of maintenance and monitoring, at the same time. In substance, its action is not limited to the realization of energy efficiency interventions, and subsequently to the supply of energy vectors, but, during and post-intervention, it has also the role to verify that the objectives established in the pre-contractual phase have been achieved (measurement and verification). The target achievement is the point of greatest interest for the ESCO: in fact, it finances entirely the necessary interventions, without receive a punctual payment at the end of the work. The return of the initial investment and the gain of the ESCO are guaranteed by a percentage of the savings achieved, and an annual benefit on the bill energy of the plant/building established in the contract.

We can divide the Italian ESCOs into two categories, namely the large and the small ones. In the first case, they are normally part of larger industrial groups, while in the second case they are independent companies. In Italy only 10% of ESCOs can be considered large, with a turnover of at least € 25 million, while 90% are small. However, large companies have around 65% of the total market turnover and they occupy just over half of the total employees in the sector.

The ESCOs turnover is composed for 35% by EPC contracts, for 42% by energy efficiency and consultancy services and for 23% by energy efficiency certificates sales

The classification of ESCOs according to their core business is as follows:

- 46% technical-management consultancy in the energy field
- 25% installation of electrical systems
- 18% manufacture of machines and equipment
- 11% supplier of electricity / gas

With regard to the intervention sector, 62% of the ESCOs operates both in the industrial and civil sectors, 23% works only in the industrial field, while 11% works exclusively in the civil field (Public Administration, Tertiary and Residential fields)

2. The beneficiary

Normally, the beneficiary is the owner of the building and of the plant to be upgraded or is the tenant. In the latter case, the explicit authorization of the owner is required for the stipulation of the EPC contract also because, for all the EPC duration, the ESCO assumes the plants ownership and the maintenance responsibility.

In general, EPC customers belong either to the public administration or to the industrial or to the tertiary sector.

The total investments of the Public Administration (PA) in energy efficiency amount to about 130 million euro [19] and the sectors interested are the following:

- 31% interventions on opaque surfaces
- 19% condensing boilers
- 17% ventilated closures
- 16% “relamping”, namely replacement of light bulbs and relighting
- 10% heat pump
- 4% cogeneration
- 3% solar thermal

The PA carries out these interventions using the ESCOs only in 35% of the cases and therefore it can be estimated that the part of the

ESCOs turnover concerning the PA amounts to around 50 million euro, that is only 4% of their total turnover (1.3 billion euro)

The investments in energy efficiency of the industrial sector are much more relevant than those of the PA and they amount about to 2.3 billion euros. The ESCO Companies capture about 15.5% of this turnover, that amounts to about 370 million euro.

The next figures show the incidence of the ESCOs interventions related to the different industrial areas: the most involved sector is the Chemical industry.

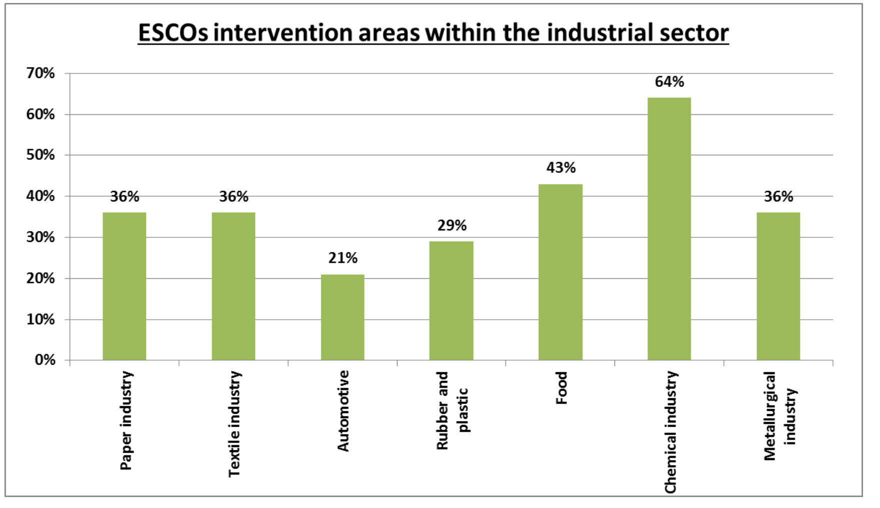


FIGURE 3: FREQUENCY OF THE ESCO ACTIVITIES WITHIN THE DIFFERENT INDUSTRIAL AREAS (DATA ELABORATED FROM [19])

The Home & building sector is the most interested one by the investments in energy efficiency. Particularly the total turnover is about 4.6 billion of euros, while the part of this income captured by the ESCO companies is about 880 million €.

In this sector most of the investments (about 80%) have been done on the residential buildings, while the remaining part is divided between the offices (15%) and the private tertiary sector (5%).

80% of the energy efficiency interventions have been implemented on existing buildings especially thanks to the Italian incentive scheme (including i.e. tax discount or direct subsides) favoring this type of intervention.

Following figure reports the distribution of the frequency of the different energy efficiency interventions for the three above mentioned market sectors. In average, “relamping”, heat pump installations and interventions on opaque surfaces are the most common works; building automation, installation of combined heat and power (CHP) and solar thermal panels, are the least implemented interventions.

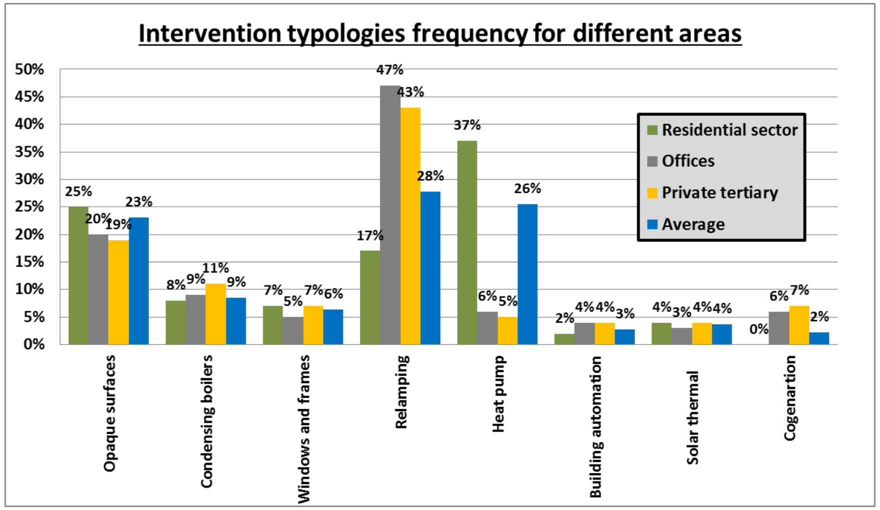


FIGURE 4: FREQUENCY OF THE DIFFERENT INTERVENTIONS FOR THE THREE MARKET SECTORS (DATA ELABORATED FROM [19]**)**

3. Financier

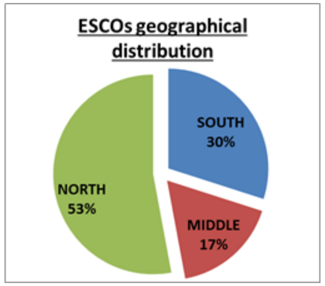
In some cases, the EPC contracts include the presence of a third contractual subject that supports the supplier in the relation with the beneficiary: the financier of the investment. It takes risks on himself connected to the initial investment: the financier, in fact, takes the investment risk together with the supplier and its profit is connected to the achievement of the contractual targets. In this case, the relationship becomes trilateral. Actually, credit institutions generally prefer to finance ESCOs using the classic tools of provision of credit (loans, mortgages, etc.), therefore it is very difficult to meet an EPC trilateral. This is due to two specific reasons:

- the great regulatory uncertainty and complexity perceived by the banking system;
- credit institutions generally do not have technical skills in the field of energy efficiency in order to assess the extent and the risks of the investment.

4. EPC facilitators

Recently in the Italian EPC market a new market player known as "facilitator" has made its appearance. Facilitators aim to provide technical, administrative and financial assistance, in particular to public administration, related to energy efficiency investments.

The European community launched, in 2013, an important public program called ELENA [20] (European Local Energy Assistance) with the aim to provide grants for technical assistance focused on the implementation of energy efficiency, distributed renewable energy and urban transport programs.

	The grant can be used to finance costs related to feasibility and market studies, program structuring, business plans, energy audits and financial structuring, as well as to the preparation of tendering procedures, contractual arrangements and project implementation units. From its inception, 63 different collaboration projects [21] have been activated with the public administrations of all the EC: within these, 8 agreements have been signed with Italian beneficiaries. Another sample of Italian facilitator is the project called LEMON [22] (Less Energy, More OpportuNities). It is a project funded as part of the European Horizon 2020 programme, with the purpose of providing technical assistance to public and private entities for the preparation of tenders for the energy retrofitting of 622 social housing units in the provinces of Reggio Emilia and Parma. LEMON supplements regional and national loans and incentives to improve the energy efficiency of the buildings and apply two new contractual instruments to govern the relations between tenants and owners of the residences, the energy supplier and the ESCOs, so as to ensure a return on investment within 15 years from the retrofitting. Another example of facilitators subjects is represented by MARTE [23] (Marche Region Technical assistance for healthcare buildings Energy retrofit).
ESCO market overview in the country	In Italy, there are about 1000 Companies (their current exact number is 1045) that are certified according to the UNI CEI 11352 Standard and which can be thus defined ESCOs. Their official list is downloadable from Accredia website and it is continuously updated. The figure below shows the geographical distribution of the ESCOs within the Italian territory: the largest number of ESCOs is in Lombardy (221 Companies), whereas Valle d'Aosta is the region with fewer accredited companies (only 7 Companies). During 2018, the number of certified ESCOs increased by 6% compared to 2017, with a consequent increase in the number of employees (10,845, + 10%) which, however, is lower than in the previous year, a sign that the market has reached a certain maturity level.  **FIGURE 5:GEOGRAPHICAL DISTRIBUTION OF THE ESCOS COMPANIES WITHIN THE ITALIAN TERRITORY (DATA ELABORATED FROM [24])** According to the 2019 Energy Efficiency Report [25], in 2018, in Italy, the global energy efficiency market amounted to 7.1 billion euro (+ 6.3%), with a positive trend over the last 5 years.

The Home & Building segment leads the ranking (65%), followed by the industrial sector (2.3 billion euro, 33%) and the Public Administration, which with just 2% is the more growing sector compared to 2017 (+ 12%).

The most adopted solutions (in terms of investment costs) in the industrial sector were efficient combustion systems and cogeneration, with investments of 459 and 443 million euro, respectively, which represent 40% of the amount spent in the sector. However, there is a very significant increase of the investments related to the improvement of production processes (+ 50%), probably due to the positive effects of the Industry 4.0 Plan [26].

Investments in Energy Management Systems increased of 28% respect to 2017, as a result of the obligation of the energy audit, but this is also a sign of how companies tend to have a holistic approach for energy efficiency and no longer focus on individual interventions. In addition, interventions in the industrial field increasingly complement those in hardware technologies and software components related to digital energy.

The figures below show the frequency of the different intervention typologies in the industrial sector: each value indicates the percentage of companies that realized the specific work.

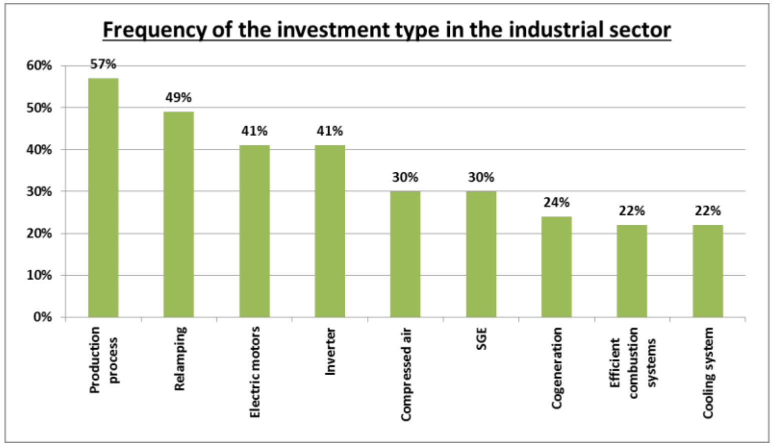


FIGURE 6:FREQUENCY OF THE INVESTMENT TYPE (DATA ELABORATED FROM [19]**)**

Only a part of this huge market, however, is achieved through EPC contracts involving ESCOs. In fact, three quarters of total investments were managed "in-house" directly by the customers, without the support of specialized energy service providers. In this case, the ESCOs could play the role of technology suppliers and carry out exclusively the interventions commissioned by the customer.

The total revenues reached during 2018 by the ESCOs amount to € 3.7 billion (+ 8% as compared to the previous year). As already mentioned, in 2018, 35% of this sum was invoiced through EPC contracts, therefore it can be estimated that the turnover of EPCs in Italy in 2018 is around of 1.3 billion euro.

If we look at the EBT of the companies that is the Earnings Before Taxes but after computation of the interests, the decreasing trend registered during 2017 is confirmed. It therefore appears that the weight of the debt component, also due to the contraction in operating margins, has further risen.

The EPC is the type of contract most used by the ESCOs. The investment capital is supported in 50% of cases directly by the ESCOs, which finance it mostly with its own funds and only minimally (17% of cases) use bank loans.

Regarding the further developments of the ESCOs market, we have to underline that it is strictly connected to evolution of the investments in energy efficiency in the next years and to the ability of ESCOs to gain market share.

In order to forecast the future market size, three scenarios can be considered:

- "as is" scenario. The boundary conditions do not change significantly; a positive trend for investments is confirmed, especially as regards the white certificates mechanism; the Industry 4.0 Plan will be used by the industrial sector, even if not in full of the "possibilities"; and finally there will be a positive impact on investments thanks to the 2019 energy audit;
- "Optimistic" scenario. The recent publication of the new sectoral Guidelines for white certificates will contribute to greater clarity in this market, the Industry 4.0 Plan will be widely used.
- "Constrained" scenario. The growth trend recorded in recent years stops and investments stabilize on levels equal to the investments recorded in 2018. Uncertainty regarding the future development of the white certificates market remains and the negative impact of the “energy-intensive consumers” decree [27] is confirmed, which leads to a fall in investments in energy efficiency in the industrial sector given by the lengthening increase of the Pay-Back Time. Moreover the Industry 4.0 Plan is only used to a limited extent

The figure below reports the foreseen market size in the next years according to the three possible scenarios.

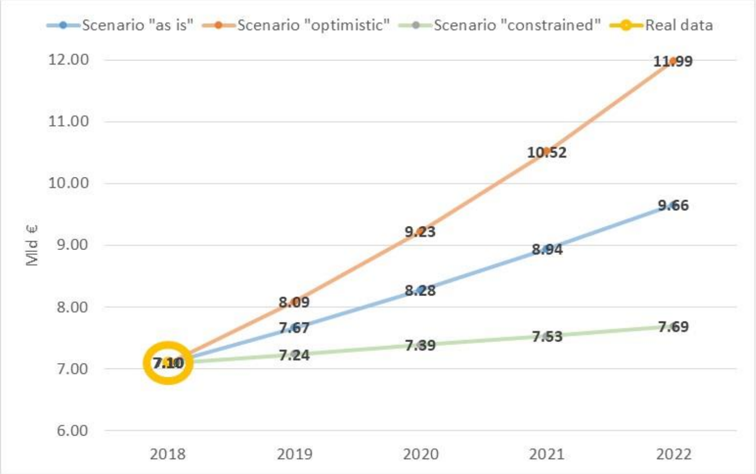


FIGURE 7: FORECAST OF THE ENERGY EFFICIENCY MARKET SIZE IN THE NEXT YEARS, DATA ELABORATED FROM [19].

The ESCOs market size in the next years can be estimated considering that their market share is about of 52% of the energy efficiency global investments.

6.1.2. CURRENT STATUS OF DEMAND RESPONSE AND OTHER FACTORS ENABLING ACTIVE EPC IN ITALY

Overview of DR status in the country	Recently, the Italian electricity market has been characterized by a rapid growth of renewable generation. Italy relies mostly on hydro and gas for its flexibility needs, while the legal framework for consumer participation in the balancing market is not yet in place, except for within pilot projects[6], as discussed later. The only exception is the interruptible contracts programme, which is a dedicated Demand Response programme separated from the balancing market. The enrolment of interruptible loads amounts to 4 GW, with a minimum size of 1 MW to allow participation. The payments are attractive and related mostly to availability payments rather than real utilisation. However, the programme has been called upon only very few times during the last years, or in some cases never.

[6] The term "pilot project", derives from the goal to test functioning of the new resources and subsequently proceed, together with ARERA, with a complete review of the ancillary services market and Grid Code, under which such resources would be fully integrated in the ancillary services market.

The map of the resources for the dispatching service in Italy in the current structure is shown in the figure below.

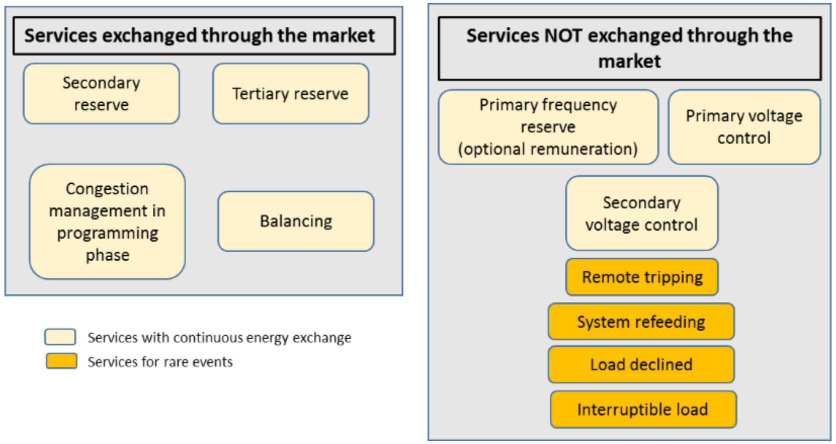


FIGURE 8: MAP OF RESOURCES FOR THE DISPATCHING SERVICE IN THE CURRENT STRUCTURE [28]

In the wholesale market, flexible consumers can make demand bids, by indicating the bid and related price.

As for the capacity market, in Italy it was launched only in 2019 through based on the Ministry Decree of 28 June 2019 [29] and foresees the participation of demand. The capacity market discipline responds to the need of ensuring the adequacy of the system through procedures that maximize benefits for the national electricity system, by privileging capacity with the necessary environmental and flexibility requirements, and ensuring the participation of all useful resources, including unauthorized new capacity, demand, generation from renewable sources and capacity located abroad. The Capacity Market is managed by the Italian TSO TERNA, through an auction system with a remuneration per MW-year for n years. The first auction will be held within 2019 and will refer to the delivery years 2022-2023. The plants which will be able to access this remuneration scheme have to comply with certain requirements, including an emission index (defined as the ratio between the amount of CO_2 produced and the useful energy generated), or total unit emissions (defined as the ratio between the total annual CO_2 emissions of the unit and the maximum withdrawable power).

With reference to the participation of the demand in the balancing market, the regulatory framework in Italy has been subject to substantial changes starting from 2017. The electricity demand reduction and the growing share of load covered by non-programmable RES as wind and solar, define key difficulties for the Italian TSO – TERNA, in ensuring security of the electricity system. This actually represents the basis for the necessity to count on flexibility services in the ancillary service market (MSD - *Mercato per il Servizio di Dispacciamento*), which is the market where TERNA procures the resources needed to manage, operate, monitor and control the power system (relief of intrazonal congestions, creation of power reserve, real-time balancing).

	Pending the definition of the new Integrated Electricity Dispatching Text (TIDE), with the Resolution 300/2017 [30], the Authority (ARERA) has defined a set of requirements to allow DR (and DER including renewables, DG and storage units) to participate to MSD within pilot projects, by also regulating the related aggregation modes. In detail, this Resolution has launched a process for progressive opening of the ancillary services market to distributed resources, through definition of pilot projects aimed at measuring the performance of these resources in order to ultimately launch an organic reform of this market. The term "pilot project", derives from the goal to test functioning of the new resources, by enabling TERNA to proceed, together with ARERA, with a complete review of the ancillary services market and Grid Code, under which such resources would be fully integrated in the ancillary services market. As for the implicit DR, in Italy, the only scheme implemented is the Time of Use (ToU) tariff, where a static price schedule is applied. The ToU tariffs allow penalizing certain periods of time with a higher price corresponding to peak hours, so customers (re)arrange their processes to minimize costs, while also supporting reducing the load during peak hours.
Current status of implicit DR in the country	In Italy, the Implicit DR mainly refers to consumers choosing to be exposed to time-varying electricity tariffs that reflect the value or cost of electricity in different time periods and react to those price differences depending on their own possibilities, without any commitment. These prices are always part of their supply contract. Therefore, implicit DR does not allow a consumer to participate alongside generation in a market. There are mainly two types of Time of Use (ToU) tariffs allowing implicit DR: • Bi-hourly tariff, which is applicable for residential users. For this tariff, the electricity price is differentiated in two-time ranges: 1. F1, where the electricity price is higher. This range includes peak hours from 8:00 to 19:00 during working days. 2. F23, where the electricity price is lower. This range includes off-peak hours from 19:00 to 8:00 during working days, and all hours in the weekend days and National holidays. • Three-hourly tariff, which is applicable for small consumers and small enterprises except for residential users. For this tariff, the electricity price is differentiated according to the following time ranges: 1. F1, where the electricity price is the highest. This range includes peak-hours from 8:00 to 19:00 during working days. 2. F2, where the electricity price is intermediate. This range includes the hours from 7:00 to 8:00 and from 19:00 to 23:00 during working days, and the hours from 7:00 to 23:00 on Saturday. 3. F3, where the electricity price is the lowest. This range includes off-peak hours from 24:00 to 7:00 and from 23:00 to 24:00 during working days, and all hours on Sunday and of other National holidays. The usage of this tariff requires the installation of an electronic meter reprogrammed on the 3-time ranges defined above.
Current status of explicit DR and	As mentioned earlier, the explicit DR in Italy is allowed only for some types of programs, as described below with reference to the various market options.

demand access to the market in the country	**Balancing market**. Till 2017, the balancing market was not open to load management. In detail, primary frequency control is a mandatory service for non-intermittent generators with a size higher than 10 MW (potentially open to compensation). As for secondary frequency control and tertiary reserve, they are paid services, which were not opened to load management. However, pending the definition of the new TIDE, with the resolution 300/2017 of ARERA, there has been the first opening of the MSD to the DR, the non-programmable RES and DG, and the storage units, within pilot projects managed and regulated by TERNA. The resolution defined that the pilot projects can address: • Participation of the DR and of the production units which were not enabled (including storage units) to the MSD. • The usage of storage units, combined with relevant production units enabled to the participation to MSD, to optimize the supply of dispatching resources while fulfilling the requirements of the Italian Network Code. • The requirements for aggregation of the production and consumption units. TERNA, also through dialogue with stakeholders, has identified the following pilot projects as being particularly innovative: • Virtually Aggregated Consumption Units (UVAC) • Virtually Aggregated Production Units (UVAP) • Virtually Aggregated Mixed Units (UVAM) • Virtually Aggregated Nodal Units (UVAN). Through pilot projects, also distributed resources which do not meet the minimum requirements defined by the TERNA Grid Code may be enabled to provide certain ancillary services, such as congestion management, balancing and tertiary reserve services. These resources cannot, however, at least in the initial phase, provide other services such as secondary reserve. According to this Resolution, the pilot project related to UVAC has been approved with the Resolution 372/2017 [31], transmitted by TERNA to ARERA on May 2017. In this Resolution, the characteristics of UVAC have been also defined. In detail, the Balancing Service Provider (BSP) can be: a subject owner of the consumption plants composing the UVAC; the dispatching user holder of the consumption units characterized by the consumption plants composing the UVAC; or a third subject. A consumption plant is associated to an UVAC (singly or as a plant composing an aggregated) for participation to the MSD, whereas it is included in a consumption unit for participation to wholesale markets (day-ahead and intra-day) and for unbalance control. The service requested to each UVAC consists, except for specific initiatives promoted by TERNA, of controlling power frequency through balancing and tertiary reserve. The characteristics of the participation of the demand in the MSD market are reported in the table below.

Unit type	Unit characteristics	Aggregation for participation to MSD	Characteristics of the aggregated for the MSD	Concurrence between aggregated for day-ahead/intra-day market and aggregated for MSD	Coincidence between dispatching user and Balance Service Provider (BSP) or Aggregator
Consumption unit	Object of volunteer participation	✓ UVAC	Consumption units falling within the same perimeter defined by TERNA	x	x

This Resolution also establishes the requirements for enabling UVAC to participation to MSD, which will be described in detail later.

Based on this Resolution, till September 2018, around 500 MW of UVAC have been enabled for participation to MSD [32].

Interruptible contracts. The participation to this type of contracts is allowed for consumers having a minimum available curtailment potential of 1 MW per site. The interruptible loads, managed by TERNA, are trigged after its order and have to react within 200 ms.

Wholesale market. Flexible consumers can access the spot market (as balancing user), in a single or aggregated form, by indicating the bid and related price. In 2018, a significant share of electricity was traded on the wholesale market. Excluding bilateral contracts, almost 213 TWh was exchanged in the day-ahead market and 25 TWh in the intra-day market [33].

Capacity market. As already mentioned, the capacity market in Italy was launched only in 2019, with the Ministry Decree of 28 June 2019. The Capacity Market is managed by the Italian TSO TERNA, through an auction system with a remuneration per MW-year for n years. The first auction will be held within 2019 and will refer to the delivery years 2022-2023. The plants which will be able to access this remuneration scheme have to comply with certain requirements, including an emission index (defined as the ratio between the amount of CO_2 produced and the useful energy generated) not exceeding 550 gCO_2/kWh, or total unit emissions (defined as the ratio between the total annual CO_2 emissions of the unit and the maximum withdrawable power not exceeding 350 $kgCO_2$ / kW).

The documentation [34] related to the participation of consumption units for the capacity market (UCMC) in the MSD has been published on August 2019 by TERNA after approval of ARERA through the Resolution 343/2019/R/eel [35]. This regulation establishes the methods for enabling the demand resources to the MSD for the purposes of participation in the Capacity Market. The withdrawal points that meet certain requirements (individually or in aggregated form) to be explained later, can be enabled for the MSD with the aim to participate in the Capacity Market.

Distribution Network Services. Flexibility from demand side represents an essential tool for local congestion management. In Italy, programmes run by DSOs are limited to the pilot phase. Among the most important pilot projects, there is “Enel Info+” [36], which

	is an energy efficiency pilot project carried out by e-distribuzione (Italian DSO). In detail, it was set up from 2012 and 2015 in some areas of Isernia e L'Aquila cities, by involving thousands of LV consumers. The participants to this initiative received an energy monitoring kit with a specific device called "Smart Info", which enabled easy access to energy consumption data, while facilitating their involvement into DR programmes. Another key pilot project in this area is "Smart Domo Grid" [37] run by A2A Distribuzione (Italian DSO). The pilot project aimed to design, implement and test a possible architectural scheme for smart grids capable of: • activate interaction, through DR logics, between the DSO and the end-user (prosumer), equipped with intelligent loads, controllable storage units, photovoltaic systems and domestic energy management tools; • improve the voltage quality and its controllability through the use of power systems installed partly at the secondary transformer substations of the DSO and partly at the prosumer side. Another best practice worth to be mentioned is related to the smart meters deployment stated from 2001. In this regard, Italy is one of the most advanced countries, being the pioneer in the development and deployment of smart meters in Europe. In fact, under the "Telegestore" project, the Automated Meter Management (AMM) system for LV concentrators and remote meter management has been deployed by e-distribuzione since 2001. The implementation of the project has led to the installation of more than 32 million smart meters. A second (2G) generation of smart meters has been also developed based on the requirements set by ARERA through Resolution 222/2017. These smart meters have a dedicated communication channel towards the Home Area Network, based on a standard open communication protocol. This allows providing consumers with more accurate information on consumption profiles, by also fostering their engagement into DR programmes.
Current status of DR product definitions in the country	**Balancing market**. The product requirements for demand participation in the form of UVAC to MSD are specified in Resolution 372/2017. First of all, UVAC are enabled to provide "Upward" tertiary reserve and "Upward" balancing services. The main requirements are defined below: • maximum controllable power not lower than 10 MW; • capacity of reduction of withdrawal by at least 1 MW within 15 minutes of the request from TERNA; • capacity to sustain the reduction of withdrawal for at least 3 consecutive hours; • the withdrawal points need to be located in the same geographic perimeter of aggregation defined by TERNA (group of provinces). The UVAC can be characterized by one or more withdrawal points connected to HV/MV/LV levels. For convenience, the UVAC are treated as production units. The reduction of the withdrawal of the consumption plants involved in the UVAC is equivalent to an increase of power injection of the UVAC. A remuneration scheme is also foreseen for the UVAC participating to the MSD. **Interruptible contracts.** In mainland Italy, the amount of interruptible resources to be supplied on a three-year basis in the period

2018-2020 has been established to be equal to 3300 MW [38]. Two sub-programmes are managed by TERNA: Fast Interruptible and Emergency Interruptible. This latter is triggered only in case of under participation in the Fast Interruptible tender. Interruptions are called by TERNA, with no limit of activation.

The product requirements for the interruptible contracts are defined below [39]:

Type of contract	Minimum size (MW)	Notification Time	Activation	Triggered (max. times)
Fast interruptible contract	1 MW	200 ms	After TSO request	No limit
Emergency Interruptible contract	1 MW	5 s	After TSO request	No limit

Wholesale market. Flexible consumers can make demand bids with indication of price. They need to belong to the same market zone, and bid a minimum of 1 MWh. The participation fee is € 7.500, for the registration to the platform, and €10.000 as yearly fee, plus some variable costs over the electricity traded [40].

Capacity market. The product requirements for the capacity market are established through the documentation [41] related to the participation of UCMC in the MSD, published on August 2019 by TERNA. In detail, in order to create an UCMC, withdrawal points can be aggregated (HV/MV/LV connected) having at least hourly measurement data, with a set of requirements. First of all, the withdrawal points cannot provide interruptible services. Also, they cannot be connected to any type of generation plant. Other key requirements for the UCMC are specified below:

- it has to be characterized by a maximum control power, at most equal to the sum of the adjustable powers of each withdrawal point involved, not lower than 1 MW. The maximum control power of the UCMC is equal to the maximum adjustable injection power, physically corresponding to a reduction in withdrawal by the same UCMC;
- it is able to adjust the absorption of power from the grid within 15 minutes of request from TERNA;
- it is able to support the adjustment of energy for at least 2 consecutive hours;
- the withdrawal points included within the UCMC, can be disconnected from the electricity grid to which they are connected within 5 minutes from the signal of disconnection from TERNA;
- the withdrawal points composing the UCMC are equipped with the “Peripheral Unit for Monitoring and Load Disconnection” (UPMDC), with specific technical requirements, which will be explained later in detail.

Current status of independent aggregators in the country	In Italy, till 2017, aggregators were not allowed in any of the key markets. However, with Resolution 300/2017, for the first time, the figure of aggregator has been introduced. As such, it corresponds to the BSP, i.e., the party managing the virtually aggregated units (UVA) and responsible for provision of services traded on the MSD, which does not necessarily have to correspond to the BRP. Indeed, the BSP does not have a contractual relationship with the BRP, by directly providing services to the grid operator, whereas the BRP is responsible for payment of the imbalancing fees. With reference to Interruptible Load Programme, for participation, a consumer needs to be a BRP or have an agreement with a BRP, which is a balancing user in that case [42]. The participation is allowed for a Consortium interpreted as an association of private companies or public bodies, which manages all energy needs for its member and could be considered as a form of aggregation.
Current status of regulations/policies supporting aggregation of resources in the country	As already mentioned, in Italy, aggregation of distributed resources has been allowed via pilot projects through Resolution 300/2017, through which they may be enabled to provide certain ancillary services, such as congestion management, balancing and tertiary reserve services. The UVA are composed of aggregation of consumption and/or generation points and storage units, including charging stations for EVs, which are connected to the grid at all voltage levels, and fall within the scope of aggregation defined by TERNA (group of provinces). Each point within the UVA must be equipped with a “Peripheral Monitoring Unit” (UPM), which is a device able to measure the amount of electricity generated/consumed, by also sending such measurement data to the hub, i.e., the device for interface with TERNA systems, which sends the aggregated measurements/estimates every 4 seconds. Only for consumption points with adjustable power lower than 1 MW and generation points with adjustable power lower than 250 kW, the frequency is every 60 seconds [43]. The main forms of aggregation are briefly described below: • UVAC: characterized by the presence of only consumption units; • UVAP: characterized by the presence of only non-relevant production units (programmable and non-programmable resources), including storage systems. • UVAM: characterized by the presence of both non relevant production units (programmable and non-programmable resources) including storage systems and electric vehicles when offer services to the grid in vehicle-to-grid mode, and consumption units. • UVAN: characterized by the presence of relevant production units, which are object of volunteer participation, and/or non-relevant production units (programmable and non-programmable resources), and potentially consumption units subtended at the same node of the transmission network.

In detail, with the Resolution 372/2017, the UVAC pilot projects have been launched to enable the demand to MSD participation, whereas with the Resolution 583/2017 [44], the UVAP pilot projects have been launched to enable the distributed generation to MSD participation. Both these pilot projects have been concluded in November 2018, in order to launch the UVAM pilot project, through Resolution 422/2018 [45] enabling consumption and production units as well as storage systems in these aggregations. The UVAC and UVAP pilot projects are thus merged within the UVAM ones.

For UVAM, similarly to what occurred with UVAP, the BSP is obliged to communicate a baseline day-ahead, i.e., the overall power programme expected for the units within the UVAM, net of consumption of interruptible loads. TERNA can modify the baseline through a correction factor estimated considering the difference against the measured value. The corrected baseline plus the sum of upward or downward quantities activated on the MSD determines the final programme that is compared with the measurement of overall electricity exchanged (consumed/generated) from the points included with the UVAM, for verification of the correct performance of the operation requested by TERNA.

Another key aspect introduced with these resolutions is the introduction of remuneration of availability in addition to activated energy. In fact, for the first time in Italy, two remuneration schemes have been introduced through regulations from TERNA. The first is linked to the energy activated (€/MWh), whereas the second one is linked to the availability (capacity cost expressed in €/MW). The current framework defines remuneration for all UVA (as occurs for large-scale power plants) for the amount of energy accepted on the MSD as well as the fees for failure to respect orders. First for UVAC and then for UVAM, in addition to valuation of the energy accepted on the MSD, the regulation defines that TERNA can purchase options on dispatching resources with the consequent recognition of a fixed fee for availability of capacity. This capacity is allocated through auctions on the fixed premium 30,000 €/MW/year, with pay-as-bid allocation. For UVAC, in 2018, only resources located in North and Centre-North market zones were enabled and the requested capacity was around 500 MW. As for UVAM, in 2019, the resources located in the entire National territory were enabled.

The table below shows an on overview of the different types of virtual units with the related characteristics, service modes and remuneration schemes.

Pilot project	Minimum power threshold	Services	Mode	Remuneration
UVAC (valid from June 2017 to October 2018)	From 10 MW to 1 MW	•"Upward" tertiary reserve •"Upward" balancing	Remuneration of withdrawal by at least 1 MW within 15 minutes of request from TERNA	Remuneration of quantity accepted on MSD/penalties + capacity contracts
UVAP (valid from	From 5 MW to	•Congestion	"Upward" and/or "downward" flexibility	Remuneration of quantity

November 2017 to October 2018)	1 MW	management •Tertiary spinning reserve •Tertiary replacement reserve •Balancing	of at least 1 MW within 15 minutes of request from TERNA	accepted on MSD/penalties
UVAM (valid from November 2018)	1 MW	•Congestion management •Tertiary spinning reserve •Tertiary replacement reserve •Balancing	"Upward" and/or "downward" flexibility of at least 1 MW within 15 minutes of request from TERNA	Remuneration of quantity accepted on MSD/penalties + capacity contracts

Finally, the figure below shows the trend of UVA capacity qualified for MSD participation, including those with a capacity contract.

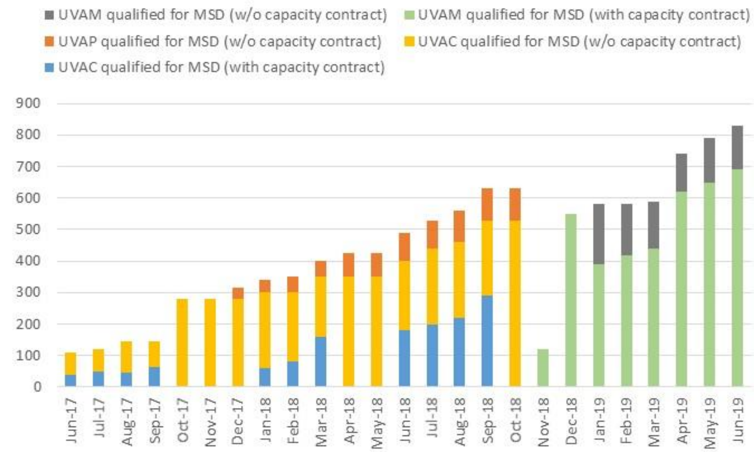


FIGURE 9: POWER ENABLED AND SUBJECT TO CONTRACTS ON THE MSD (MW) [43]

Current status of transparent	**Balancing market**. According to the Resolution 372/2017, for the purpose of participation of UVAC to MSD, TERNA must have measurements in real-time. Therefore, each withdrawal point must be equipped with a "Peripheral Monitoring Consumption Unit"

measurement and verification standards in the country	(UPMC), which is capable to perform the measurement detection every 4 seconds for real time usage. This UPMC must be able to communicate the measurement data directly to TERNA through a specific communication protocol (IEC 870-5-104). Alternatively, it can send the measurement data to a concentrator managed by the UVAC owner through a communication protocol that has the same level of reliability, integrity, coding and informational detail of the one indicated by TERNA. In turn, this concentrator must manage communication with TERNA by sending an analogue measurement every 4 seconds associated with the UVAC consumption data. **Interruptible contracts.** The load participation to interruptible contracts requires the installation of a smart meter with a remote-control function, triggered by the TSO. In order to verify the compliance with the requirements indicated by the Grid Code, TERNA can proceed with site-inspections or documentation verification. **Capacity market.** As already mentioned, the withdrawal points composing the UCMC must have equipped with the "Peripheral Unit for Monitoring and Load Disconnection" (UPMDC), which are capable to fulfill the following requirements: • detect and send an analogue measurement with a frequency of 60 seconds associated with the total consumption of the withdrawal point; • receive and implement the "load zero" command, consequently sending the "emergency system" signal; • receive the "service reset" command and remove the signal referred to the previous point; • receive and implement balancing orders. Moreover, this device must send the measurement to TERNA according to the procedures foreseen in TERNA Network Code.
Current status of regulations/policies and best practices supporting demand-side flexibility on building-level, for instance in the context of Energy Communities or in other situations if applicable	In accordance to the Clean Energy Package, with the proposed National Integrated Plan for Energy and Climate, among the general objectives pursued by Italy, there is the one aiming to put the citizen and the enterprises (especially SMEs) at the center, so that they are protagonists and beneficiaries of the energy transformation and not only financiers of active policies through promoting self-consumption and renewable energy communities. The main measures envisaged in the PNIEC are: • the exemption of charges on self-consumption for small plants (application of the variable parts of the network and system charges only on the energy taken from the public network and not also on the self-produced and self-consumed energy); • the simplification of authorizations for self-consumers and renewable energy communities; • the reorganization and rationalization of configurations with self-consumption. Beyond these actions promoted in the PNIEC, the Italian scenario is currently characterized by the absence of specific regulation about energy communities. Instead, with reference to self-consumption, the main configurations allowed in Italy are of 3 types:

	• on-site exchange (mechanism managed by the GSE); • "closed distribution systems" (SDC, in Italian); • "simple production and consumption systems" (SSPC, in Italian). The on-site exchange service is a particular form of on-site self-consumption allowing to compensate for the electricity produced and fed into the grid at a certain point in time with that taken and consumed at a different time from that when the production takes place. Therefore, in the on-site exchange, the electric system is used as a virtual storage of electricity produced but not at the same time consumed. A necessary condition for the provision of the service is the presence of plants for consumption and for the production of electrical energy underlying a single point of connection with the public network. The SDC (introduced in compliance with the EU Directive 2009/72) is a system which distributes electricity within a geographically confined area to industrial, commercial or sharing services sites and either: • for specific technical or safety reasons, operations or production processes integrated in the system; • primarily for system owner's electricity consumption. Many sites like train station buildings, airports, hospitals etc. can include closed distribution systems because of the specialized nature of their operations. The SDC category is then divided into "Users' Inner Networks" (RIU, in Italian) and "Other Closed Distribution Systems" (ASDC, in Italian) defined like SDCs except RIUs. In the context of the SSPC there are the "Other Simple Production and Consumption Systems" (ASSPC, in Italian), which are private electrical systems connected to the public network, characterized by the presence of at least one electricity production plant and a consumption unit (which can be made up of one or more buildings) directly connected to each other, within which the transport of electricity does not take the form of transmission and / or distribution activities, but as an energy self-supply activity, in the presence of one final customer and one producer, in the case represented by corporate groups or by cooperatives or historical consortia.
Status of real-time monitoring of energy consumption and generation in the country	In Italy, the whole energy sector is moving towards digitization. In such a context, all data and information must be stored, examined and transmitted as quickly and easily as possible to the trader or utility. Moreover, even prosumers and active users, must be able to access this data. In order to foster this transition, in Italy, the old smart meters (1G) are going to be replaced by the new second generation (2G) smart meters, which allow the customer to monitor real-time electricity production and consumption data. In detail, with Resolution 222/2017/R/eel [46], ARERA has approved the commissioning plan of the 2G smart meters presented by e-distribuzione. This new smart meter has been designed as a real network sensor able to measure all electric parameters at each

connection point. This will actually allow the DSO to have detailed information for in-depth monitoring of the operating status of the electricity grid as well as to receive real-time notifications real-time via a dedicated reporting channel (RD 169 MHz) in case of events of particular interest (e.g., interruption of the electric service).

The benefits associated to the deployment of the 2G smart meters are of interest for a range of electricity system actors and they are summarized below:

- use measurement data in real time; this benefit allows increasing the awareness of the customer about his own consumption behaviors. Indeed, the consumer's awareness of his own energy footprint fosters the transition of his role from a passive to an active part of the energy supply chain. Through this device, the customer becomes able to choose proactively the supplier, and to influence dynamically the system through actions of demand side management;
- facilitate the programmability of the volumes in power withdrawal and injection from the users of the dispatching service and TSO;
- revise the settlement process through the available hourly data for all customers and the possibility for sellers to transfer hourly price signals based on real data instead of conventional profiles;
- foster competitions in the market for services of analysis and reporting as added values offered by subjects enabled by the end customer (sellers, ESCOs, aggregators);
- improve the management of the electricity grid through the availability of capillary data on the range of electrical parameters measured, by also improving the performance in terms of data availability ready to use and the optimization of the processes they bring to the provision of data to third parties.

Considering all the benefits above, it can be concluded that through the 2G smart metering system, it will be possible to enable end customers, both passive and active connected in LV grid, to participation in the MSD through appropriate DR products.

Status of integrations of Energy and Non-Energy services in the country

In Italy, with the aim to guarantee a high level of thermo-hygrometric **comfort** of indoor environments, the following indoor air temperature, relative humidity and air velocity exchange conditions, differentiated for winter and summer seasons, are recommended:

Season	Temperature	Relative humidity	Air velocity
Winter	19-22°C	40-50%	0.05-0.1 m/s
Summer	24-26°C	50-60%	0.1-0.2 m/s

In line with the above, the D.P.R. 16 April 2013, n. 74 [47] defines the general criteria for the operation, control, maintenance and inspection of heating systems for winter and summer air-conditioning of buildings and for the generation of sanitary hot water. In detail, the Decree sets the maximum values of room temperature so as to improve the energy savings of buildings: during

	operation of the winter air-conditioning system, the weighted average of the air temperatures, measured in the individual heated rooms of each building unit, must not exceed: • 18 °C + 2 °C of tolerance for buildings used for industrial, craft and similar activities; • 20 °C + 2 °C of tolerance for all other buildings; during the operation of the summer air-conditioning system, the weighted average of air temperatures, measured in the individual cooled rooms of each building unit, must not be less than 26 °C - 2 °C of tolerance for all buildings. The decree states that the maintenance of the air temperature in the rooms within the above limits is obtained with measures that do not involve waste of energy. As concerns to the Italian public buildings, with a view to of improving their internal comfort in respect of energy saving, the minimum environmental criteria (CAM – Criteri Ambientali Minimi) of the Ministerial Decree of 11 October 2017 [48] applicable. In detail, in the annex, regarding the minimum environmental criteria for the assignment of planning services and works for the new construction, renovation and maintenance of public buildings, the criteria that allow to ensure environmental performance above average are indicated. Among the technical specifications of the building indicated by the CAMs, in addition to the constraints on energy diagnosis, energy performance and water saving, criteria on internal environmental quality (comfort) are also indicated, and among the comfort indications, thermo-hygrometric and acoustic comfort are regulated. According to CAMs, in order to ensure optimal conditions of indoor thermo-hygrometric comfort and air quality, all energy saving measures must guarantee conditions that comply at least with class B according to ISO 7730:2005. According to this latter, the PMV (Predicted Mean Vote) must be between -0.5 and 0.5, and the PDD (Predicted Percentage of Dissatisfied) must be at most 10%. As concerns to the building condition, with the aim to increase the energy efficiency of new buildings, the Ministry Decree 26 June 2015 [49] is applicable. According to it, starting from 31 December 2018, new buildings or existing buildings undergoing renovation, occupied and owned by Public Administrations, including school buildings, have to be nearly zero energy buildings (nZEB); starting from 1 January 2021, all new buildings or existing buildings undergoing renovation, both public and private, will have to be nZEBs.
Relevant legislation and policies supporting implementation of the Active EPC	In Italy, the first provisions about energy saving date back to 1976 with the Law 373/1976 [50] regarding the regulations for the containment of energy consumption for thermal uses in buildings. In detail, the law provided constraints for the design, installation, operation and maintenance of heating systems and requirements for thermal insulation of buildings. One of the most relevant law about energy saving is the Law of 9 January 1991, n. 10 [51] containing the rules on the rational use of energy, energy saving and the development of renewable energy sources. This rule, currently in force even with the modifications introduced later, abrogates Law 373/1976 and, together with the two implementing decrees (Presidential Decree 412 of 1993 [18] and Presidential Decree 551 of 1999 [52]) has constituted one of the main points of reference in this field, thanks

above all to the avant-garde of its contents, such as the division of the territory into geographical areas with specific periods of operation and climatic data. It also introduces for the first time the use of renewable sources as a further tool to achieve energy savings objectives.

After the Kyoto Protocol, ratified in 1997, Europe issued the EU directive 2002/91/EC [53], which imposed the obligation on member countries to develop and adopt a methodology for calculating the energy consumption of buildings. In Italy the directive was implemented with Legislative Decree 192 of 19 August 2005 [54], which defines a method for the calculation of the buildings energy performance, the minimum requirements regarding the buildings energy performance and the general criteria for the energy certification of buildings with the purpose of promoting the improvement of the energy performance of buildings, taking into account the local external and climatic conditions, as well as the prescriptions related to the indoor climate and effectiveness in terms of profile of costs.

The Legislative Decree 192 of 19 August 2005 was integrated and modified with Legislative Decree 311/2006 [55], generally making the limits to be verified more stringent. The Presidential Decree 2/04/2009, n. 59 [56] and the Ministry Decree 26/06/2009 [57] have followed. With these standards, in addition to defining the methodology for assessing the energy performance of buildings, the minimum requisites are set for both new buildings and those undergoing major renovations.

In force since March 2011, Legislative Decree 28/2011 [58] implements the Directive 2009/28/EC [59] on the promotion of the use of energy from renewable sources. The most relevant innovations introduced by the Decree are relative to the definition of the use of renewable energy sources in new building and in building subjected to major renovations, depending on the license date of the building.

The Decree of 22 November 2012 [60], containing the National guidelines for the energy certification of buildings, was introduced to modify the Ministerial Decree June 26, 2009. Among the most important updates, it introduces the need to request the advice of a qualified technician for the preparation of an energy certification of any type of building and defines in detail the type of buildings exempt from the energy certification. A subsequent update of the decree modified the definitions of Annex A of the Legislative Decree 19 August 2005, n. 192 [61] according to the art. 9 of the EPBD Directive [62]which requires to the Member States to adopt a system of periodic inspections of air conditioning systems with a power exceeding 12 kW, which also include an assessment of the efficiency of the plant and advice to users on possible improvements or alternative solutions.

The Legislative Decree n. 63 of 4 June 2013 [63] (c.d. eco-bonus/energy decree), converted by Law 90/2013 [64] which amends Legislative Decree 192/2005, is an urgent provision for the transposition of the Directive 2010/31/EU [65]. It introduces a series of innovations in the field of energy performance, among which: the certification changes the name from ACE (Attestato di Certificazione Energetica - Energy Certification Certificate) to APE (Attestato di Prestazione Energetica - Energy Performance Certificate) and the obligation to issue the certificate also for the leases of buildings/building units is introduced, as is the case for sales. Another important novelty regards the release of the certificate by a professional technician in the form of a substitutive declaration of a notarial deed. Therefore, the APE in the final part has to provide for the declaration of the professional technician. The methods for calculating the energy performance of buildings are defined by the regulations UNI/TS 11300 parts 1, 2, 3 and 4, CTI 14/2013 and UNI EN 15193 (Energy performance of buildings - Energy requirements for lighting).

On 07/12/2013, the Republic President Decrees 74/2013 [66] and 75/2013 [67] came into force. The first, already presented in the section above, among other things, defines the general criteria regarding the operation, control, maintenance and inspection of heating systems for winter and summer air conditioning of buildings and for the preparation of water for hygienic and sanitary uses. The second regards the regulation governing the accreditation criteria to ensure the qualification and independence of the experts and bodies to whom the energy certification of buildings is entrusted, pursuant to Article 4 of the Legislative Decree 19 August 2005, n. 192.

The most relevant Italian regulation about energy efficiency and saving is the **Legislative Decree 102/2014**, in part already presented in the previous sections. In force since 07/19/2014, it Implements the 2012/27/EU directive on energy efficiency.

The Decree sets the national indicative energy savings target, which consists of reducing primary energy consumption by 20 million tons of oil equivalent (Mtoe) by 2020, equal to 15.5 Mtoe of final energy, counted starting from 2010.

It provides for the establishment of a mandatory energy efficiency regime, consisting of the White Certificates mechanism which will guarantee the achievement of energy savings of no less than 60% of the national energy saving target.

As for the industrial sector, the Decree introduces the obligation for large companies and energy-intensive companies to carry out an energy diagnosis every four years, to identify the most effective interventions to reduce energy consumption, and to promote their implementation in the SMEs. As regards the apartment buildings, the Decree has provided for the obligation to install, by 31 December 2016, accounting systems, capable of detecting the actual energy consumption of the individual apartments, and the thermostatic valves.

In the regulation of energy services and energy transmission and distribution activities, the decree introduces standards to support energy efficiency, eliminating barriers to the increase of the network efficiency, to the efficient dissemination of renewable sources, to the distributed generation and to the high-efficiency cogeneration, to promote more strongly the participation of demand in the energy markets.

For energy end-consumers, provisions are envisaged with the aim to increase awareness of energy consumption among citizens by promoting individual measurement systems, such as smart meters for electricity and gas, and a more precise billing system based on real consumption.

For the improvement of buildings energy performance, both public and private, the Decree provides for sectoral plans for energy efficiency:

- the *Strategy for Energy Redevelopment of the National Housing Stock (STREPIN)*, aimed at mobilizing investments in the restructuring of the national park of buildings starting from the recognition of the national housing stock. The document analyzes the technical, economic and financial barriers that hinder the implementation of energy efficiency measures and proposes the improvement of support tools to increase the savings expected by 2020, bringing it closer to the estimated potential for the civil sector;

- the *Action Plan for Almost Zero Energy Buildings (PANZEB)*. From 2021 new buildings will have to be at almost zero energy. In view of this obligation, the PANZEB outlines the national guidelines and development lines to increase their number through the available regulation and incentive measures;
- the *Plan for the Energy Re-qualification of Central Public Administrations (PREPAC)*. Annually, from 2014 to 2020, the Ministries of Economic Development and the Environment and the Protection of the Territory and the Sea prepare, by November 30th of each year, a program of annual energy requalification interventions in the buildings of the central Public Administration, including peripherical buildings, relating to at least 3% per annum of the covered air-conditioned useful surface, whose implementation methods have been defined by Interministerial Decree 16 September 2016.

Finally, Legislative Decree 102/2014 establishes the *National Energy Efficiency Fund*, an important financial instrument supporting the energy requalification of Public Administration buildings and interventions for reducing energy consumption in the industry and services sectors.

The Interministerial Decree of 26 June 2015 [68], issued to complete the transposition of Directive 2010/31/EU, which took place with the Legislative Decree 4 June 2013 n.63, consists of three separate decrees:

- the first defines the energy performance calculation methodologies and the new minimum building requirements and establishes the requirements for nearly zero energy buildings;
- the second defines the patterns of technical project reports;
- the third one defines the new national guidelines for the APEs.

The Interministerial Decree of 16 September 2016 [69] defines the procedures for implementing the action program for improving the energy performance of public administration buildings, indicating the methods of financing, and defines the methods and criteria for identifying and selecting the interventions admitted to financing.

Finally, Legislative Decree n. 141 of 18 July 2016 [70] modifies and integrates the Legislative Decree 102/2014. The main correction concerns the method of allocating heating costs in apartment buildings and includes the possibility of increasing, with additional resources, deriving from the proceeds of CO_2 emission quota auctions, the allocation of the National Energy Efficiency Fund.

6.2. BELGIUM

6.2.1. CURRENT STATUS OF EPC IN BELGIUM

Overview of the EPC status in the country	Although some early stage EPCs were seen in the nineties (e.g. at the Ministry of Defense, the City of Charleroi) - in addition to a variation of Energy Supply Contracts for heat - the real market development of a new generation of EPC and ESCO models in Belgium started in 2005 with the creation by the Belgian Federal Government of Fedesco (Federal Energy Services Company). Fedesco, a company under public law, at the time acted as a third-party investor and one-stop-shop for the renovation of federal public buildings. In the first 5 years of its existence Fedesco applied a more traditional approach to energy efficiency projects, working both with building occupants (administrations, ministries…) and the Federal Building Agency (the building manager) while acquiring knowledge on EPC and preparing itself for becoming a public facilitator of EPC-projects. This also led to the creation of the Knowledge Center by Fedesco, a national competence center on energy services. This Knowledge Center initiated the first new-generation EPC-project in Belgium, for the City of Ostend (later ultimately abandoned following the municipal elections of 2013 and the installation of a new city council). The second EPC project, initiated in 2011, was an EPC-project for 13 privately owned federal public buildings. The so-called “Fedimmo” project [71] was the basis for the development of the smartEPC model, which has set a new standard for Maintenance and Energy Performance Contracts (M-EPC) in Belgium. After investing over 30 M€ in EPC projects, Fedesco was dissolved in 2015 due to political reasons (State reform). Responsibility for EPC transferred to the Federal Building agency who continued the tendering and implementation of the Fedimmo project. At the same time the Flemish and Walloon regions created their own one-stop-shops, using EPC as the main model for implementing energy efficiency in public buildings. In Wallonia, GRE Liège (now Renowatt [72]) focused on municipal and provincial buildings, using EU funding from the EEEF-fund [73] (since 2014) and the ELENA facility (since 2018) from the EIB, to pay for technical assistance and EPC-project facilitation. A first program (implemented between 2014 and 2017) allowed for roughly €59M investments, in 136 builldings from 10 local authorities in the Liège Province. The second program (to be implemented between 2019 and 2022) aims at $100M investments in 500 buildings from other municipalities, and also in other Provinces. In Flanders, the Vlaams Energiebedrijf (VEB) acts as a one-stop-shop, also extensively using the EPC model. After a few initial projects, in a Psychiatric Hospital, a University and a Municipality, it set-up large-scale energy auditing campaigns in elderly care homes with the intention to lay the basis for large implementation of EPC projects. Similarly, a large-scale programme was initiated in public schools, while other public building segments were targeted (federal and regional governmental buildings, municipalities, the Ministry of Defense, etc.), creating a very dominant position on EPC in the public sector in Flanders. VEB equally obtained an ELENA grant for technical assistance, which allows it to provide EPC facilitation at a reduced cost to the building

owners.

Both Renowatt and VEB are expected to become key drivers of the development of EPC in Flanders. Another actor that has started offering EPC facilitation is Fluvius, the network distribution company (fusion of municipality owned distribution companies Eandis and Infrax), creating the peculiar situation that 2 public entities (VEB and Fluvius) go after the same municipal customers in terms of EPC facilitation.

Another programme that kick-started several EPC projects in Flanders was an initiative that consisted of the creation of an “EPC helpdesk” by the Province of Flemish Brabant, which initiated 5 projects with 7 municipalities. The project included an initial coaching by the Province of those municipalities to assess the feasibility and business case for an EPC, in a pool of municipal buildings. The final goal was to assist the involved municipalities with the selection of a private facilitator to help them through the entire ESCO selection and implementation process. However, the programme, which was considered very useful by many stakeholders, was not extended.

Most EPC projects in the public sector today are initiated and facilitated by either private facilitators or by public one-stop-shops. Thus, they play a key role both in the sales process towards the end-customer as in the process of putting in place a competitive process between ESCOs, focused around the guaranteed energy performance.

In the private sector however, most ESCOs try to convince customers to engage directly with them. In that case they do the commercial effort of finding and convincing customers. The downside of this approach is that they avoid any competition, which represents real added value to the customer. Some private customers though still look for competitive offers and potentially look at a facilitator for knowhow and assistance. In the private sector, more players are active, including smaller ESCOs that target (industrial) SMEs and larger ESCOs (the same that are active in the multi-building public sector projects) that mostly target larger enterprises.

The ESKIMO programme was initiated in 2014 (ESCO for SMEs), which was managed by the Flemish innovation agency VLAIO. VLAIO granted 2 M€ to 4 consortia (500k€ each) of public and private stakeholders (e.g. Provincial Development Companies, EPC consultants and facilitators, ESCOs, universities, etc.) to test and promote EPC with SMEs. Only a handful of ESCO projects were implemented, but there were many lessons learnt and the programme gave a serious boost to the development of energy services for SMEs in Flanders. It led to the creation of the first public “ESCO fund” by the Flemish Participation Company (PMV), offering both equity to new ESCOs and other market players, as well as project financing. The fund’s investment volume is 20 M€.

Belgium was also a pioneer in structuring the market, with – as early as 2010 – the creation of the Belgian ESCO Association (BELESCO) [74], a non-profit organization that promotes and supports the development of EPC, ESCO good practices and M&V in Belgium. It currently has 16 members, mostly private ESCOs, private EPC facilitators, public facilitators or one-stop-shops for EPC, engineering companies active in EPC and a bank focusing on EPC financing.

It took several years to initiate and develop the Belgian EPC market, but it has seen significant growth over the last 3 to 4 years. There are now dozens of projects initiated or operational in the public sector that is still pulling the market, served by large (multinational or national ESCOs). But smaller ESCOs are also active in the (industrial) SME market with a variety of solutions. Some projects have been done in social

	housing apartment buildings. No projects have been done in private apartment buildings yet. As far as Energy Conservation Measures are concerned, a whole range of solutions is being implemented, with the focus on HVAC, regulation and lighting (both relamping and relighting). Several EPC projects have included building envelope measures, such as roof of attic floor insulation and replacement of doors and windows. Belgium has always had a good reputation in terms of knowhow on EPC and ESCO models in general and EPC contracts, and facilitation specifically. Belgian experts have been among the first to participate both in International expert groups (like the IEA's DSMIV Task 16 on "Innovative Energy Services" and in many EU Projects (IEE, Horizon2020) like EESI (European Energy Services Initiative), EESI2020, Transparense, GuaranteEE, BEAST, CITYnvest, CITIZEE and StepUP. There has been some work done on EPC-like models for renovating identical housing units under the REnnovates project, but without pilots in Belgium so far, although this may change soon. There is also expert knowledge available on "Eurostat" compatible EPC financing, but also quite concentrated. Work is ongoing within BELESCO to implement the rules in practical projects. This type of financing, which allows for whole or partial off-balance investments (with debt deconsolidation) in the public sector, is expected to grow significantly in the coming years. Finally, an interesting initiative was the creation of a Postgraduate training program on "Energy Efficiency Services" at the PXL University College in Hasselt, which has seen many students get training on EPC principles. Several of them have ended up in the EPC and ESCO sector, working for public one-stop-shops, ESCOs, EPC facilitators or as independent consultants.
EPC-related regulations, directives and policies in the country	Besides the EU Directives (Energy Services Directive, later the Energy Efficiency Directive) that have been translated into regional/national law, there are no country specific directives or rules on EPC in Belgium or any of the regions. In terms of policy support from national or regional governments, the effort from public authorities has been mainly on the creation of one-stop-shops (first Fedesco, at the federal level, later Renowatt and VEB at the regional levels). Brussels is still a blind spot in this area. Both Renowatt and VEB have de facto recognized and embraced the EPC model as the major project delivery mechanism for energy renovation of public buildings. They act as "purchasing and/or tendering service centers" for their public customers. This means they apply the public tendering process on behalf of the end-customers, significantly simplifying the tendering of EPC contracts. The business plans of Renowatt and VEB are thus also largely based on EPC projects. A significant policy statement has been made by the Walloon government who has included EPC in its "Wallonia's Long Term Strategy for the Renovation of Buildings", with several specific measures to promote and use EPC in the renovation strategy. Also the Flemish Region has referenced EPC in its 2016 Climate and Energy Pact and its Regional Energy Efficiency Action Plan (REEAP), however without strong targets.

Main types of EPC implemented	Both EPC (Energy Performance Contracting) and ESC (Energy Supply Contracting) are used in the Belgian ESCO sector. But for Energy efficiency (HVAC, relighting, insulation, but also integration of renewable energy like PV solar or biomass CHP, etc.) only EPC is being used, whereas ESC (like with the Chauffage model or UPA) is mainly used for the local production and delivery of useful energy (e.g. heat, cold, compressed air). There have been some offerings using Shared Savings models (e.g. no-cure-no-pay) in the private sector, but 95% of the EPC market – particularly in the public sector – is based on Guaranteed Savings models. Many EPC projects, especially in the public sector are in fact M-EPC projects (Maintenance and Energy Performance Contracts). This means that the maintenance of the installation that is part of the energy conservation measures or even the maintenance of the installations of the whole building is included in the EPC. The smartEPC model, developed in Belgium by Energinvest, one of the private facilitators, in collaboration with Fedesco, the Federal Building Agency and other partners, is an extended version of the M-EPC model, including performance based comfort, technical building value measurement and BREEAM certification, as well as a (partial) off-balance financing model. It is supported by Belgian ESCOs that are active in the public sector.
Main actors involved in current EPC	There are several categories of actors in the market: 1) ESCOs: They can be divided in 3 groups and several subcategories, linked to their historical business, although this division is somewhat artificial as most of them offer the full range of EPC services. Some of them will work together in (temporary) consortium structures: A) Large ESCOs • Maintenance/Technical Building ESCOs (e.g. ENGIE Cofely, VINCI Facilities…) • Building Automation ESCOs (e.g. Siemens, Honeywell…) • Utility ESCOs (e.g. EDF Luminus) • Building Contracting ESCOs (e.g. Van Roey, VMA…) B) Medium-sized ESCOs (e.g. Wattson) C) Small ESCOs (e.g. Factor 4 *(for SMEs),* Inesco…) 2) EPC-facilitators or consultants (e.g. Energinvest, Factor 4 *(for public building owners)*) 3) Subcontractors to ESCOs • Technology providers • HVAC/Lighting Installers

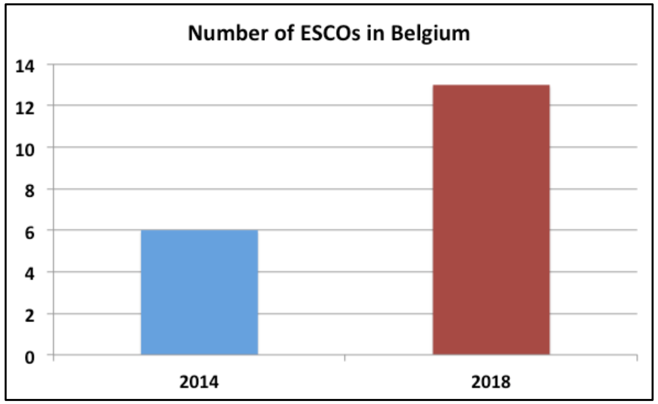
- Building contractors

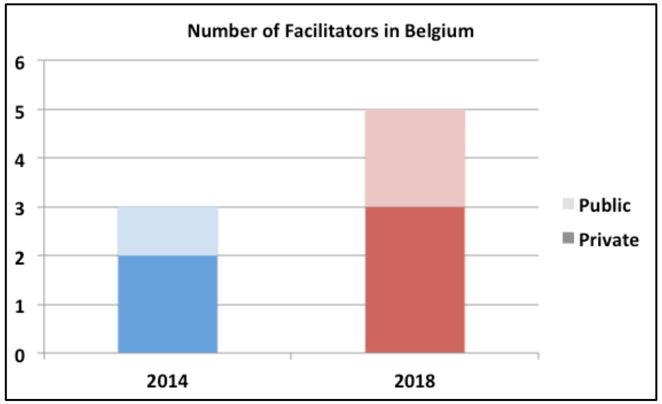
4) Financiers
   - Banks (e.g. Belfius Bank, BNP Paribas Fortis…)
   - ESCO Funds (e.g. PMV's ESCO Fund)
5) Technical experts (working mostly as subcontractors for the other categories)
   - Energy auditors/Engineering companies (e.g. Tractebel Engineering, Cenergie, E20, Sweco…)
   - Maintenance experts/inspectors (e.g. in NEN2767 performance based maintenance
6) Other experts
   - Legal experts (e.g. lawyers specialized in public tendering law or private contracts (e.g. Stibbe, Fieldfisher…)
   - Financial experts/financial consultants/accountants)
7) Public One-stop-shops for energy efficiency and EPC (e.g. VEB, Renowatt…)

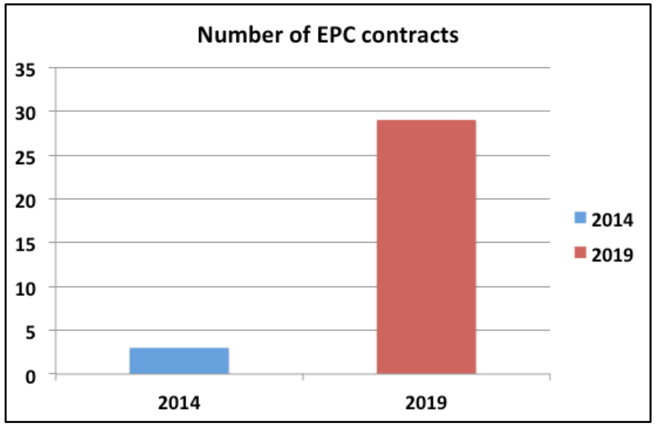
ESCO market overview in the country

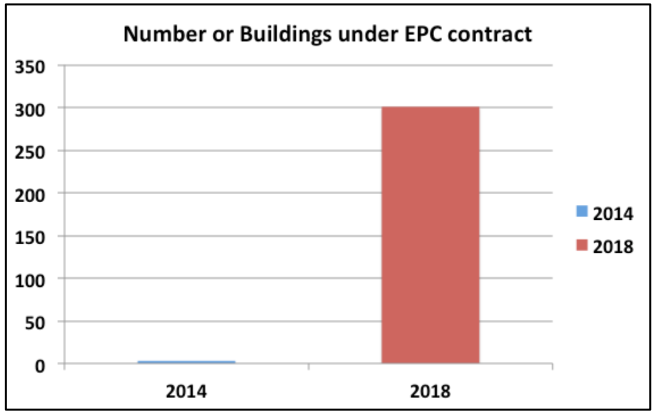
There is little reliable data available on the market as there is no structured approach to collecting data. Also, many private ESCOs don't share or publish data on their private customers. If they do, it is often through case studies and public seminars or workshops. The Transparense and GuarantEE projects have collected some data on EPC projects, but it is not comprehensive or up to date either. Furthermore, the data on Belgium in the annual state of the EU ESCO market report by the JRC (P. Bertoldi et al.) is not always up to date. The most recent and reliable data comes from the BELESCO Energy Services and Financing Day 2018 were BELESCO published recent estimates (compared to the 2014 edition) of number of EPC projects, number of Buildings under an EPC project, number of private EPC facilitators, number of public EPC facilitators (or one-stop-shops) and number of private ESCOs.

They are summarized hereafter:









The following table shows some examples, providing an indication of number of buildings and surface per project (which often includes a pool or cluster of multiple buildings), as well as investment amounts per sqm and energy savings guarantees. Most projects have a contract duration between 10 and 15 years and a savings guarantee between 20 and 35%.

Customer	# buildings	Surface (m^2)	Investment (€ per m2)	ESCO	Facilitator	Energy savings
Beersel Municipal Buildings (All) *of which Primary School Huizingen*	7	20.937 *2.235*	79,8 *293*	Vinci Facilities	Energinvest	25% *80%*
Dilbeek Municiality buildings	12	41.403	43,6	EDF Luminus	Energinvest	20%
University of Antwerp		62.000	9,4	Honeywell	VEB	26%
SGS Polderdijk	1			Siemens		50%
OPZC Rekem	22	46.000	15,6	Cofely	VEB	30%
Van der Poorten	1	10.000	10	Factor4		18%
Federal Building Agency (Fedimmo)	13	75.530	20	SPIE/Siemens	Energinvest	31%
Province of Hainaut School	1	16.000	8	Veolia		41%
Renowatt Municipal Schools	48	190.738	128,9	1.EDF 2. Cofely	GRE Liège	30%
Renowatt Municipal Sports Facilities	13	30.907	165	Cofely	GRE Liège	36%
Renowatt Municipal Buildings	10	22.228	132,1	Cofely	GRE Liège	34%
Ottignies Municipal Buildings	4	12.000	0	Optiwatt		31%

6.2.2. CURRENT STATUS OF DEMAND RESPONSE AND OTHER FACTORS ENABLING THE ACTIVE EPC IN BELGIUM

Overview of DR status in the country

In the past, Access Responsible Parties (ARPs) (also known as balancing responsible parties (BRPs) provided all ancillary services through large production facilities to ELIA, the Belgian transmission grid operator. Such ARPs concluded a so-called CIPU contract (Contract for the coordination of the injection of production units) through which some major market players (who have a large influence on the high-voltage system) are legally bound to support ELIA regarding the coordination of electricity in the grid. As can be seen in the figure of ELIA [75] below, a CIPU contract consists of four building blocks. Only production units with a CIPU contract could originally provide these services.

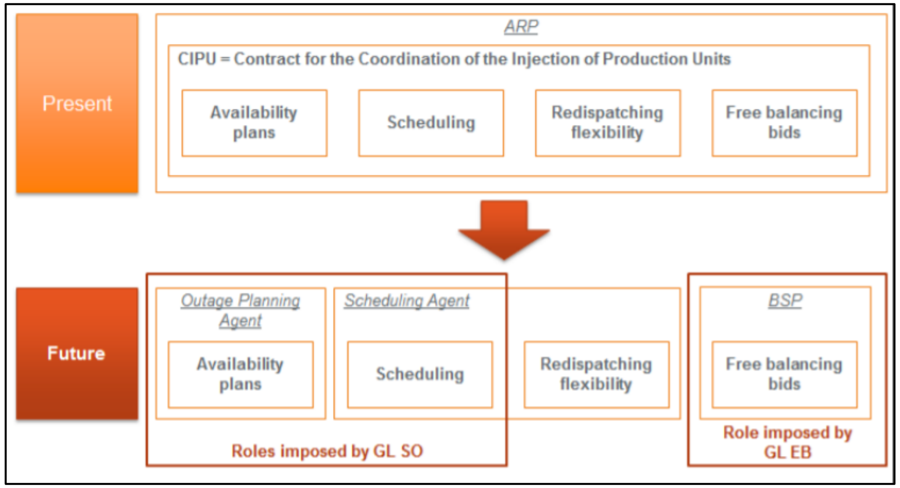


FIGURE 10: EVOLUTION OF RESPONSIBILITIES COVERED IN CIPU [75]

As depicted in the above figure, today and in the future, this CIPU contract is split across new roles that are emerging as the result of the new energy context and of shifts in the regulatory context (both European and regional legislation). As such, over the last years, ELIA created a new framework to enable participation of other energy sources (such as demand flexibility) with new types of market players (such as aggregators). While the implementation of this framework is still ongoing, the end-goal is to "*open up the different products and services to all technologies (demand side management, storage), independent to the type of connection (TSO/DSO) and the type of provider (incl. Non BRPs)*" (p.2) [75]. This means that in the future, all products will be adapted to become accessible to new future market parties as visualised in the figure below [75].

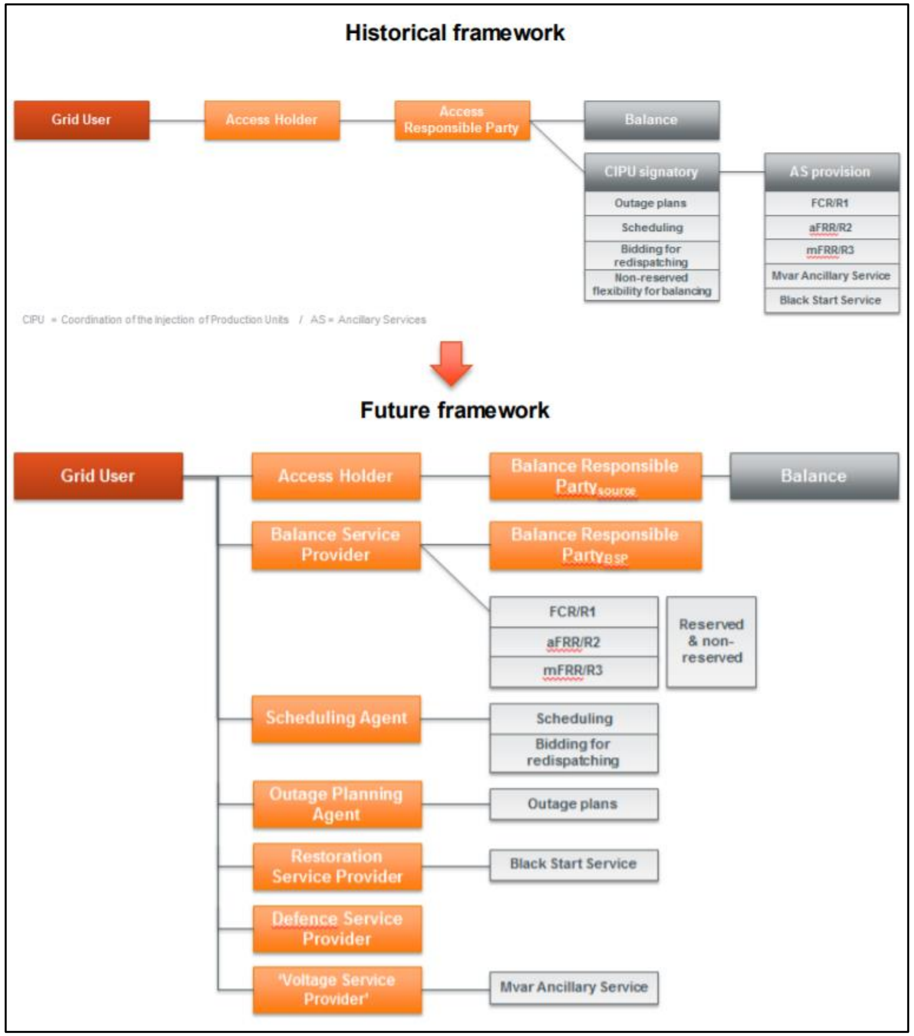


FIGURE 11: EVOLUTION FROM THE CURRENT TO FUTURE FRAMEWORK [75]

This evolution from the current to the future framework will be implemented in a phased approach: first the balancing products will be made technology neutral, even though the separate contracts will remain depending on the flexibility source. In a second phase the

	contracts will be merged into one general framework agreement for both CIPU and non-CIPU flexibility [75]. As to demand response, the current status in Belgium is defined by the electricity law which specifies in Art. 19bis. § 1 that each end-consumer has the right to valorize their demand flexibility if in line with technical requirements. They can request this valorisation from their supplier or a supplier of flexibility services of their choice. In this regard, the federal regulation (federal government) works out the rules to organize such a transfer of energy in Art. 19bis. § 2 [76]. Also, the “energiedecreet” [77] , the energy decree" is in some of its regulations defining and referring to flexibility. Furthermore, the CREG (federal regulator) defines in the study (F)160503-CDC-1459 [78] the means that need to be deployed to facilitate demand flexibility on Belgian electricity markets. The necessary means identified ranged from market model definitions, more open access to electricity markets, changing product definitions that facilitate access... Finally, as not all regulations concerning flexibility are clear, the VREG (Flemish regulator) published two advisory documents to ensure proper interpretation of regulations (ADV-2016-1 [79] and ADV-2017-04 [80]). For instance, they give clarification regarding data management for flexibility and propositions for regulations regarding the technical flexibility of decentralized production units to resolve congestion problems. With respect to current regulations and products, FCR and mFRR are the key products for demand participation. However, by 2020-2021, aFRR, which is the most important balancing product of Elia, will be offered as well for non-CIPU contracts. Elia has clear measurement and verification standards which are adapted to the specific needs of these products. Regarding measurements, peak-measured-customers usually have an MMR (Monthly Meter Reading) meter or an AMR (Automatic Meter Reading) meter. An AMR or MMR meter is possible if starting from a connection of 56kVA. An AMR meter is mandatory starting from 100kVA. Non-peak-measured consumers (low-voltage) usually register their electricity consumption from the grid only once a year via a YMR (Yearly Meter Reading) meter. To ensure there is transparency regarding the delivered amount of flexibility, the Transfer of Energy rules of Elia [81] describe how this volume needs to be calculated. In general, a baseline is calculated to see the level of demand before flexibility demand activation. Secondly, the difference between the baseline and the validated quarter-based measurements of the activation period is considered. This, however, slightly differs depending on the product.
Current status of implicit DR in the country	In Belgium, one should distinguish two types of customers: peak-measured customers and non-peak-measured customers. Peak-measured customers are customers who have measurement equipment from the distribution grid operator on the access point to measure peak power [82], non-peak-measured customers usually do not have this. *Non-peak-measured customers* These customers can implicitly offer demand response by responding to time-varying electricity tariffs during time periods that range from 6 or 7:00 (depends from the region) to 22:00 (day) and from 22:00 to 6 or 7:00 (night) on working days. On Saturdays and Sundays, night tariff applies 24h. The explanation in the choice of these hours lies in the fact that between 6-22h, there is a higher electricity demand because people are awake and active. While between 22-6h it is night and electricity demand is lower. There is no further opportunity for these customers to respond according to own generation given the applied net metering principle. Nor are there implicit signals in relation

	to generation in the market. Specifically, for these customers, the applicable tariff components are: - Volumetric energy tariff (€/kWh) with a distinction between day and night prices (periodic). - Distribution grid tariff based on the amount of active energy (kWh) consumed with a distinction between normal and silent hours (usually day versus night) (non-periodic). • See the tariff methodology for distribution of electricity and gas from 2017-2020 (VREG, 2016). [82] • Currently, there are ongoing discussions regarding the distribution tariffs to shift to a capacity-based tariff. In this context the periodic grid tariff will be based on a contracted capacity (VREG, 2019). [83] • non-peak-measured customers are usually customers connected to the low-voltage grid. *Peak-measured customers* These customers also do not have the possibility to respond according to generation in the market. However, provided that the own production installation exceeds the capacity of 10kW, a separate production meter is installed. Hence, in contradiction to the net metering principle applicable for non-peak measured customers, the peak-measured customers receive implicit price incentives to maximize self-consumption. Furthermore, they do get incentives to reduce their own peak consumption through the following tariff components: - Capacity-based Tariff: based on the consumed capacity (€/kW) - Peak-based energy Tariff (€/kWh) - Volumetric energy tariff (€/kWh) with a distinction between peak and off-peak hours (usually day versus night) The response to these tariffs can be done manually or through automatic control. • See the tariff methodology for distribution of electricity and gas from 2017-2020 (VREG, 2016). [82] • See consultancy document VREG (VREG, 2019). [83] • Peak-measured customers are usually customers connected to the high or medium voltage grid, >26-36 kV, 26-1 kV or distribution grid customers that are connected directly to a transformer in between the low and the medium voltage grid (Trans LS). Current tariffs can be found in the document of the VREG on distribution grid tariffs [84].
Current status of explicit DR and demand	In general, the electricity law specifies in Art. 19bis. § 1 that each end-consumer has the right to valorise their demand flexibility, if in line with technical requirements. Special attention is foreseen to allow for independent aggregation (for instance by an independent aggregator). The end-consumers can valorize their flexibility via their own supplier or a provider of flexibility services of their choice. In the latter case, the regulation foresees the rules to organize the entailing transfer of energy in Art. 19bis. § 2 [76]. The process to ensure that all end-consumers can valorize their flexibility in demand is still under implementation. The federal regulator,

access to the market in the country

CREG [85] specified in 2016 three solutions to consider for the transfer of energy:

- market model with freedom to valorize flexibility through a chosen flexibility service provider (FSP). A legal framework is needed to open the markets.
- adapt products of the TSO by replacing the definition based on the needs of the TSO and not based on technological characteristics. Product definitions should strive for a technology agnostic viewpoint so that it does not matter which technology solves the TSO needs.
- access to electricity markets through the Belpex DAM (wholesale power exchange), for instance through the development of products per 15 minutes.

The following markets and/or environments allow specific products for flexibility provision:

<u>Wholesale</u>

As explained on the belpex.be website [86]: “EPEX SPOT Belgium (formerly Belpex) is a power exchange for anonymous, cleared, short term trading in electricity, providing the market with a transparent reference price.” The two relevant wholesale markets here are:

- EPEX SPOT DAM, which is the day-ahead market with standardized hourly products for producers, distributors, traders, brokers… so that they can sell and purchase electricity which will be delivered the day after via Elia. [87]
- EPEX SPOT CIM, which is the continuous intraday market where there are both hourly and multi-hourly standardized products to sell and purchase electricity on a continuous basis up to 5 minutes before delivery via Elia. [88]

Only parties that are recognized by Elia as ARP / BRP (Access Responsible Party / Balancing Responsible Party), through entering into an access responsibility party contract (ARP contract) with Elia or designate a third party as ARP for the purpose of nominating the contracts concluded on the EPEX SPOT Market to Elia, are allowed to trade on the EPEX SPOT Market. Further market rules and procedures can be found through [89].

As explained previously [90], the following table shows the products with their characteristics on the DAM and CIM.

	DAM	CIM
Underlying ("Instruments")	Electricity of constant output to be delivered within the control area of the Belgian system operator Elia.	
Instrument Series	1H blocks	
Listed for Order submission	14 trading days before delivery until 12:00 trading day before delivery	From 14:00 trading day before delivery until 5 min before delivery
Trading days	Every calendar day	
Quotation	€/MWh	

Price tick value	0.01 €/MWh (1 euro cent per MWh)	
Contract volume	The minimum contract volume is 0.1 MWh	
Order Type	Limit orders and block orders* (regular, linked and exclusive execution types)	Limit orders and block orders
Instruments eligible for trading on a trading day	All instruments with delivery day following the trading day	All listed Instruments
Trading Platform	The EPEX SPOT Trading Platform is based on the electronic EuroLight system	The EPEX SPOT Trading Platform is based on the electronic Elbas system. Contract information will also be available in EuroLight.
Fixing Process	Auction	Continuous trading
Trading hours	Order book closing at 12:00	24/7
Publication Time contracts	Under normal circumstances not later than 13:05	Immediately
Delivery	Through Day Ahead Hub of Elia Nomination System	Through Intraday Hub of Elia Nomination System
Minimum Order Price	-500 €/MWh	-9999.99 €/MWh
Maximum Order Price	3000 €/MWh	9999.99 €/MWh
EIC Code Belpex ARP	22XBELPEX------N	
Elia Nomination Gate Closure Time	Day-ahead hub: 14:00 day-ahead	Intraday hub: 14:00 day after

Portfolio management

Some suppliers (Engie [91] for example) are already offering portfolio management services. These services are provided by either linked aggregators or via the end-consumers themselves. In the latter case, these services are reserved to large consumers and/or large (distributed) producers. The relationship between the BRP and the provider of the flexibility is in most cases defined by bilateral negotiations and contracts.

Pass-through-contracts

The CREG is aware that in some cases suppliers pass on market prices directly to consumers. As discussed in [92], a "pass-through" contract can be set up as follows: a consumer and supplier agree that the supplier will deliver 10 MW for all hours of a certain period (baseload) at a fixed price, say 40 €/MWh; any deviation by the consumer from the 10 MW (in real time) will be settled against the imbalance tariff. So, if for a given hour a consumer only consumes 6 MW when the positive imbalance price is 1.000 €/MWh, then the consumer will pay the supplier for that hour 10 MWh * 40 €/MWh = 400 € and receive from the supplier (1,000 €/MWh – 40 €/MWh) * 4 MWh = 3,840 €. By using their flexibility, the consumer is paid 3,460 € for that hour for consuming 6 MWh, even though the consumer has signed a fixed contract. Note that the imbalance risk from this customer for the supplier is reduced to zero. This kind of arrangement can also be set up with a market party, other than the supplier, by using the 'transfer of energy' scheme".

In totally, more than 500 MW of consumption is already contracted as such. Unfortunately, this kind of flexibility is hard to measure since the market price passed through in these contracts is often the imbalance tariff. As such, the market player is only reacting to the imbalance tariff and not to the day price. Such contracts therefore lead to an underestimation of the available demand response [92].

Ancillary services

For High and Medium Voltage consumers

As described by the following table of Elia [93], R1 (FCR) and R3 (mFRR) are the currently existing products for offering balancing services by activating flexibility.

Product	Availability	Reaction time	Maximum duration of activation	Time between activations	Maximum number of activations	TSO/DSO connected users ?
R1 CIPU	100% (15min average)	30sec	Constant	-	-	TSO&DSO
R1 Non-CIPU	100% (15min average)	30sec	Constant	-	-	TSO&DSO
R2	100% (15min average)	7,5min	Constant	-	-	TSO
R3 CIPU	100% (15min average)	15min	8h/day (Standard Service Type)	-	Unlimited	TSO&DSO
			2h (Flex Service Type)	12h	8 per month	
R3 Non-CIPU	100% (15min average)	15min	8h/day (Standard Service Type)	-	Unlimited	TSO&DSO
			2h (Flex Service Type)	12h	8 per month	
R3 Non-Reserved	None outside offered periods	15min	Depending on offer, maximum 2 hours	Depending on offer	Depending on offer	TSO&DSO

Evolution in services:

The products mentioned in the table above, are the products that are currently available. However, for R2 (aFRR), the CREG proposes to open up aFRR for demand flexibility, possibly through a pilot project. Currently, the market for aFRR products is only accessible by units under a CIPU contract (see further for the explanation of CIPU).

In the past, and to a certain extent today, Access Responsible Parties (ARPs)[7] provided all ancillary services to Elia, mostly through large production facilities. This was to a large extent done through a CIPU contract as initially, only production units with a CIPU contract could provide their services. As can be noticed in the Figure 10 presented earlier, a CIPU contract consists of four building blocks.

Today and in the future, however, a CIPU contract is split across different future roles. An ARP is not doing everything anymore. As stated by Elia on p. 2 of [75]: "*The past years ELIA has created for some balancing reserves a separate (operational and contractual) framework enabling the participation of new technologies (non-CIPU production, storage, and demand flexibility) provided by new types of market players (aggregators).*" Furthermore, the same document also states: "*Otherwise stated the different Guidelines are having the same objective as the road maps which have been launched by ELIA since 2016 for some of the balancing products: open up the different products and services to all technologies (demand side management, storage), independent to the type of connection (TSO/DSO) and the type of provider (incl. Non BRPs).*"

It means that in the future all products will be adapted to become accessible to new future market parties as shown in Figure 11 presented earlier. This evolution from current to future framework will be executed in a phased approach: first the balancing products will be made technology neutral, even though the separate contracts will remain depending on the flexibility source. In a second phase the contracts will be merged into one general framework agreement for both CIPU and non-CIPU flexibility. [75]

Furthermore, Elia has a user group "Balancing Working Group" who works to prepare the balancing market for future challenges [94]. The group (customers and partners) is in fact the platform that Elia uses to consult the market when it proposes market adjustments to balancing mechanisms and ancillary service mechanisms. One of their tasks is therefore to address adjustments to existing balancing services (FCR, mFRR, aFRR).

Original CIPU contract:

Elia needs to be able to coordinate electricity interconnections in the grid and to balance the power not used by producers. Therefore, some market players are legally bound to sign a contract with Elia for the coordination of injection by production units. These are the CIPU contracts with Elia. As described in the figure above, a CIPU contract consists of four blocks. Specifically, ARPs (or BRPs) who are responsible for injection of units who have an influence on the high-voltage system are obliged to do so. They are responsible to send long term (year)

[7] ARPs are transmission system users such as generators, suppliers and traders which ensure that supply and demand are in balance for the grid access point(s) concerned (https://books.google.be/books?id=L7iYCgAAQBAJ&pg=PA243&lpg=PA243&dq=access+responsibility+parties+Elia&source=bl&ots=S5Bt-ZEG1z&sig=ACfU3U1C2tVQo6PLjV4CxCwE3il4u184Og&hl=en&sa=X&ved=2ahUKEwiGgbfPu4LlAhWYiVwKHVb2CzwQ6AEwB3oECAkQAQ#v=onepage&q=access%20responsible&f=false)

	and short term (day) forecasts to Elia. [95] <u>Volumes</u> As for the total quantities of demand response, Elia created a new category “market response” where demand response is a subcategory. According to Elia, by 2020, Belgium would have 1.4 GW in market response. However, in the winter of 2018-2019 only one or two nuclear reactors were available in Belgium and there was an unexpected unavailability of nuclear power capacity. [92] The CREG-study 1950 [96] shows that during that period at least 3.7 GW of additional capacity was available.
Current status of DR product definitions in the country	As explained in the previous section, R1 and R3 are the key products for demand participation. We explain the product requirements in more detail below: **Primary frequency control (0-30 sec) – Frequency Containment Reserve (FCR, ex-R1) (for more information see the FCR design note** [97]**)** In order to allow for different types of flexibility, Elia has different services types which react at different frequency deviations: - FCR symmetrical 200mHz: this product is activated between -200mHz and + 200mHz, whereas the total contracted volume must be activated at the most extreme bands of the frequency interval indicated here above. Specifically, this product implies that a flexibility provider agrees to increase or decrease consumption, or to reduce or increase injection when a change in frequency occurs. The reaction must be in proportion to the deviation. - FCR symmetrical 100mHz: this product is activated between -100mHz and +100mHz, whereas the total contracted volume must be activated at the most extreme bands of the frequency interval indicated above. This maximum contracted volume must however also remain activated for frequency deviations between [-200mHz,-100mHz] and [100mHz, 200mHz]. Specifically, this implies that this product is the same as the FCR symmetrical 200 mHz, but Elia will expect the flexibility provider to react in proportion to the deviation within a frequency range of 100 mHz. - FCR upwards: this product is activated between [-200mHz, -100mHz], whereas the total contracted volume must be activated at -200mHz. Specifically, this implies that the flexibility provider agrees to reduce its consumption or increase its injection when frequency falls below 49.9 Hz. - FCR downwards: this product is activated between [100mHz, 200mHz], whereas the total contracted volume must be activated at 200mHz. Specifically, this implies that flexibility provider agrees to increase its consumption or reduce its injection when frequency rises above 50.1 Hz. All these service types can be offered from CIPU & non-CIPU generation or load resources. The main requirements for FCR are: - Must be fitted with an automated speed, rotation and frequency control system - Must be able to provide half of the contractual primary reserve within 15 seconds. The whole of the primary reserve must be

	deployed after 30 seconds and stay activated for at least 15 consecutive minutes. - Round the clock availability - The volume offered must have a minimum of 1 MW **Tertiary control with reserved volumes (15 min) – (R3 Std/R3 Flex)** [98] There are two types of products in this category: • R3 standard: activation of up to 8 hours per day, with an unlimited number of activations • R3 flex: activation of up to 2 hours every 12 hours, with a maximum of 8 activations per month. The main requirements for mFRR (R3) are - Offered by both CIPU and non-CIPU technical units - Activated manually upon reception of a signal by Elia - Services are activated within 15 minutes from reception of Elia signal and for a period of 2 or 8 hours - The volume of the tertiary power reserve is stipulated in the contract - A minimum of 1 MW - 100% availability during the supply period **Tertiary control with non-reserved volumes – (R3 Non-Reserved)** [98] Non-reserved products are activated manually when Elia requests this. The main requirements for mFRR are - As of July 2017, non-CIPU generation and load can offer non-reserved power volumes to Elia. The offered volumes are submitted through the BMAP (Balancing Market Platform) web platform. - Suppliers are activated by Elia in case of need and are only remunerated for the provided energy (and not for their availability). - When activated by Elia, the Supplier should activate the offered volume as soon as possible within a margin of 15 minutes. - The volume of the tertiary power reserve is stipulated in the contract - The reserve activation request is made "manually" - A minimum of 1 MW **Portfolio management** Requirements and contracts in this category are subject to confidentiality as these are often bilateral negotiations.
Current status of	Directive 2012/27/EU regarding energy-efficiency defines some important articles that forbid discrimination between demand response and a request for production. Member States are obliged to ensure demand-response suppliers, including aggregators, considering technical

independent aggregators in the country	limitations, are not discriminated by transmission and distribution grid operators (Art. 15.8). In this regard, specific recommendations have been done to improve regulations in that respect. In the "Energiedecreet", an aggregator is defined as "a service provider who has multiple opportunities to sell in organized energy markets his capabilities for consumption, production or injection, or the combination of these". (Flemish regional regulator: Article 1.1.3. 12/1°) [77]. *Independent aggregation* Independent aggregators are fully accepted in Belgium, referring to the case in which the activation of flexibility involves a supplier and a provider of flexibility services with a separate BRP and/or a provider of flexibility services that is not the appointed supplier. In Belgium independent aggregation is facilitated and no preconditions or contractual relationships between the BRP of the electricity supplier and the flexibility service provider are prescribed by regulation. For clarification purposes: an aggregator and an FSP can be the same. FSP is a broader name for different market players (BRP, aggregator, end-user). The aggregator itself specifically focusses on offer flexibility through its portfolio. *Transfer of energy* The issue of the transfer of energy, hinders the right of the grid user to freely choose its FSP in case he wants to choose an FSP who is independent of his supplier. This is also acknowledged by previous VREG documents. In this regard, Elia is describing the rules for the organization of the transfer of energy by an FSP in line with art 19bis §2 regarding the organization of the electricity market (29th of April 1999). See [81]. These rules determine: - The guidelines for the determination of the delivered volume of flexibility - The guidelines to correct quarter hour unbalances who occur due to activation of demand flexibility by the FSP - The exchange of information and data required for the implementation of the energy transfer
Current status of regulations/ policies supporting aggregation of resources in the country	With reference to supporting policies, subsidy schemes in Belgium which are in place for renewables (for instance green certificates [99]) are also encouraging for aggregation of renewable resources. With respect to regulation supporting aggregation, in 2016, in the study (F)160503-CDC-1459 [85], the CREG (federal regulator) discussed the means that need to be deployed to facilitate demand flexibility on Belgian electricity markets. This was done by applying Art 23, §2, paragraph 2, 2°, of the law of the 29th of April 1999 regarding the organization of the electricity market. The CREG requests, among others, changes in the electricity law (specifically Art 2 and 8, and to add Art 16). In the "Energiedecreet", some regulations and definitions about flexibility have been mentioned. For instance, an aggregator is defined as "a service provider who has multiple opportunities to sell in organized energy markets his capabilities for consumption, production or injection, or the combination of these". (Flemish regional regulator: Article 1.1.3. 12/1°) [77]. The role of aggregator comes back in the following articles regarding the role of the grid operator: Art. 4.1.8/1, Art. 4.1.18/1, Art. 4.1.9, Art. 4.2.1, Art. 4.6.3 and Art. 4.6.5. That is, a

	grid operator cannot take up the role of an aggregator. However, further specifications and clarifications of the role of aggregator were needed. Therefore, in 2016, the VREG (Flemish regulator) published its advice regarding a framework for flexibility on the electricity grid (ADV-2016-1 [79]). In this document, the VREG suggests using a different definition for aggregator: *"an aggregator is a natural person or entity who aggregates multiple capacities for consumption, production or injection"*. Furthermore, in this document, the role of "flexibility service provider" (FSP) has been introduced as "*each natural person or entity who offers flexibility"* (chapter 4.4.1.). This person or entity can be a supplier, a BRP, an independent aggregator or a grid user. A grid operator cannot take up the role of an FSP. Chapter 5 of the same document is creating a number several rights and duties of the FSP. However, as these rights and responsibilities needed to be aligned between all Belgian regions and the federal state, this document did not specify all rights and responsibilities in detail yet. Based on the CREG document which suggests introducing a simple administrative qualification procedure, ADV-2016-1 of the VREG states that an FSP first needs to qualify before being recognized by the VREG (although there are exceptions for technical flexibility) (Art. X). In 2017, the VREG published a follow-up document regarding regulations concerning flexibility (ADV-2017-04 [80]). Chapter 3.3. "Rights and duties of a Flexibility Service Provider" is entirely devoted to the role of the aggregator (this include for instance the responsibility for the balance of the flexibility he manages and communicating the activation of flexibility, but also the right to have insights in data management to receive specific data measurements…).
Current status of transparent measurement and verification standards in the country	Below we summarize some measurement and verification requirements for the key reserve products. **FCR** [97] Elia requires measuring equipment which is in line with the technical requirements on each delivery point part of the FCR group. The requirements are specified in [97] and copied here below. 1. *"The supplier must install local frequency meter for each FCR reserve providing unit (i.e per delivery point participating to the FCR service), even though they are part of a FCR providing group. Accuracy of frequency measurements must be better than 10 mHz. A delivery point is participating to FCR service when it provides FCR capacity. In other words, for delivery points used as energy management strategy for another delivery point which has energy limited reservoirs, the supplier must only install a frequency meter for the delivery point with energy constraint that delivers FCR capacity. As introduced previously, if FCR capacity of FCR providing group is < 1.5 MW, the supplier only needs to install 1 frequency meter for the FCR providing group.* 2. *The set point of frequency is 50,00 Hz. Local frequency meter must be calibrated accordingly during the prequalification process* 3. *Elia uses its own frequency measurements for its settlement processes* 4. *Elia requires power measurement with a maximum resolution of 2" to verify the offered service. The measuring equipment needs to have a precision of 1% or better for the whole metering chain (current transformers, energy meter), or a maximum precision margin of 100kW In case the measuring equipment for one or more Delivery Points within a Providing Group does not correspond to*

requested precision, ELIA will calculate an Emax factor during the prequalification for the Providing Group by taking into consideration the worst precision among all Delivery Points within the Providing Group. The Emax factor is calculated as the difference between the worst measuring precision among all Delivery Points and 1% (requirement by ELIA).

5. *Elia accepts the use of the real time measurements available at the delivery point (in other words : behind the access point), coming directly from the Supplier's own measurement devices if its characteristics and physical location respects the standards set by Elia and have been verified and accepted during the prequalification process (at step 3 – offline check).*
6. *Elia requires a measuring equipment compatible with the above mentioned requirements on each delivery point part of a FCR group, no matter the type of FCR group being prequalified (using centralized or local frequency measurements)."*

aFRR [100]

- aFRR is only delivered by CIPU units who have a remote technical unit (RTU). Currently these RTU are installed and owned by Elia, but in the future, privately owned measurement devices will be allowed. However, Elia will hold the right to check these (even if privately-owned) and can suspend aFRR providers who manipulate the measurements.

Furthermore, regarding metering configuration and accuracy, Elia [100] states:

"Elia requires power measurements with a maximum resolution of 2" to verify the offered service. The measurement equipment needs to have the highest precision of either 1% or better for the whole measurement chain (current and voltage transformers, measurement equipment), or 100kW. In case of delivery points using private measuring devices, Elia will evaluate during the delivery point acceptance procedure the precision class of the aFRR provider's measuring chain by considering the worst precision class value amongst the measuring chain components (current and voltage transformers, measurement equipment). In case the measuring equipment for one or more delivery points within a providing group does not correspond to the requested precision, Elia will calculate an Emax factor for the providing group by taking into consideration the worst precision amongst all delivery points 31/10/2018 aFRR product design note within the providing group. The Emax factor is calculated as the difference between the worst measuring precision amongst all delivery points and 1% (requirement by Elia). Elia will reduce the aFRRmax prequalified volume of the aFRR provider for the providing groups concerned with the Emax value. A minimal measurement availability of 95% is required. In order to prove compliance, the aFRR provider must provide Elia with the following information before performing any prequalification test: An electrical scheme indicating the measurement equipment's precise position; A statement from the manufacturer certifying the measurement precision of the measurement equipment. Elia has the right to perform an audit."

mFRR

For tertiary products, a distinction is made between

- Tertiary Control Non-Reserved Service provided by Non-CIPU Technical Units
- Slow Tertiary Control Non-Reserved Service provided by Non-CIPU Technical Units

<table>
<tr><td></td><td>

Tertiary Control Service provided by Non-CIPU Technical Units
Tertiary Control Service provided by CIPU Technical Units

The product specific notes of all these products can be found through [101].
<u>Definition of the baseline</u>
To ensure there is transparency regarding the delivered amount of flexibility, the Transfer of Energy rules of Elia [81] describe how this volume needs to be calculated. In general, a baseline is calculated to see the level of demand before flexibility demand activation. Secondly, the difference between the baseline and the validated quarter-based measurements of the activation period is taken. This, however, slightly differs depending on the product.
The choice of the baseline methodology is limited to a predefined list of flexibility products which can evolve over time. Baselines which apply per market segment are described below:

Market segment tertiary arrangement for non-CIPU technical units

Baseline based on the last quarter before the activation demand
Baseline ‘High X or Y’

Market segment strategic reserve market SDR-units

Baseline ‘High X or Y’

Description of the current baselines:

Baseline based on last quarter before activation demand: this baseline is based on the last quarter of the activation demand and is the value of the mean quarter power measured at the point of delivery during the last full quarter before the quarter during which an activation demand has been done. This capacity value of the baseline is applied during the full activation period, even if it last multiple quarters.
Baseline High X or Y: for each delivery point, the baseline is determined based on historical consumption/production data of this delivery point according to the method described in more detail in section 9.3.2.

Determination of the ‘standard days’
Calculation of the profile for the baseline
Adaptation to the level of the baseline

Note that the baseline methodology is not only described under the TOE issue, but also for instance in design notes of aFRR. Regarding aFRR [100], Elia states that the baseline test is a completely new process which will be re-evaluated one year after the go-live when enough data are available.
</td></tr>
<tr><td>Current</td><td>Since July 2019, Flanders started with the roll-out of digital meters for electricity and natural gas. This will help to make end-users, including</td></tr>
</table>

status of regulations/ policies and best practices supporting demand-side flexibility on building-level, for instance in the context of Energy Communities or in other situations if applicable	residential households, more engaged and active regarding offering demand-side flexibility and other grid services. Nevertheless, currently, there are still barriers for active engagement by individual consumers or on building level. This is not only the case for Belgium, but also for other European Member States. To reinforce the role of individual buildings and consumers in the energy transition, the European Commission emphasizes that citizens should receive the right to share, produce, sell and store energy, provide energy services… within a level playing field. Consumers should be allowed to do so as individual active consumers, but also collectively through renewable or citizen energy communities. Such communities should (among others) have equal access to energy markets. Member states are now expected to transpose the European directives in National and/or regional legislation by 2021. Currently, on Flemish level, there is no clear definition on energy consumers. On Flemish level, there is, however, the concept of a “prosumer tariff”, yet, there is no legal definition of it. In the Walloon region, the concept of “self-producer” has been developed. Other concepts that are related are direct lines, closed distribution grids and exceptions regarding grid infrastructure (“uitzonderingsnetinfrastructuur”). A direct line outside the site (art. 1.1.3, 26° and 4.5.1 of the Energy Decree) allows a production installation (such as a wind turbine) to be connected directly to an electricity consumer. This implies that the public grid is not used anymore. However, with the new European directives, such parallel structures (e.g. direct lines) are to be avoided as much as possible to make sure that investment costs are spread out over as many consumers as possible, and because it is not efficient that some users have a connection while only using it partly [102]. The administrative difficulties should therefore be reduced significantly when changing the Flemish legislation. Energy Communities should be stimulated much more. Nevertheless, there are already quite some examples of Energy Communities in Belgium which are being developed or which are starting up. Such communities could give opportunities for building owners to offer their flexibility. We summarize some examples below: • Oud-Heverlee: In cooperation with the local DSO, new operating strategies will be tested while using neighbourhood batteries, and flexible devices such as heat pumps and electric vehicles. The goal is to achieve grid balancing (matching supply and demand) by using consumer flexibility. • Energy cooperatives: Belgium has multiple energy cooperatives (Ecopower, ECoOB, Energent, PajoPower, CORE, Volterra, Coop Stroom, Denderstroom, Zuidtranct, Zonnewind, Campina Energie, ECOOB, Klimaan cvba, HesbEnergie, BoragEn, Vent d’enfant, Courant d’air, Ferréole, Condrez Energies, Citoyenne, Vlaskracht, CLEF, StroomVloed…) who invest in wind and solar projects. In some cases, such as in the case of Ecopower, residual energy which is not immediately used by the project is sold to the members of the energy community. • Power For You (Crisnée): the village of Crisnée is planning to invest in additional wind and solar power, and to deliver this to the community micro-grid. They aim to foresee batteries to store potential residual energy. • Campus Weide (Kortrijk): Open Smart Grid in which generated energy is used as much as possible directly by the consumers (where necessary through storage). Intelligent management systems are used to manage CHPs and heat pumps. • Thor Park (Genk): all buildings at the park are managed collectively as if they were one consumer. The goal is to reduce the total

	peak consumption and to adjust consumption to price signals of the market, potentially by using flexibility for reserve products. • C-Valley (Leuven): is a group of companies that form a local energy community to achieve a high penetration of renewable energy by sharing energy through their potential to offer flexibility (for instance to smart management of their HVAC building system). • Green Energy Park (Zellik): smart multi energy grid in which electricity, heat, cold and water are managed collectively to interact with each other in order to have an optimized system. • Circular South (area in the South of Antwerp): energy community with an online platform to manage their energy system. These and other energy communities provide options for individual buildings to offer their flexibility and receive the benefits from it.
Status of real-time monitoring of energy consumption and generation in the country	Measurement of grid interaction [103] The measurement equipment installed at the grid users depends on the type of grid user and the connected grid. Peak-measured-customers usually have an MMR (Monthly Meter Reading) meter or an AMR (Automatic Meter Reading) meter. An AMR or MMR meter is possible starting from a connection of 56kVA. An AMR meter is obliged starting from 100kVA. As such, the transmission grid is fitted with AMR metering devices. Medium voltage grid users can have MMR or AMR. In case of an MMR-meter, the meter recordings are registered each month. In case of an AMR-meter, the tele-read meter devices take energy measurements at 15-minute intervals as specified by Belgian legislation [104]. Non-peak-measured customers are mostly connected to the low-voltage grid. These are residential and small professional grid users. To a certain extent, few non-peak-measured customers can also be found in the Trans-LS customer group. The electricity consumption from the grid by these customers is registered ones a year via a YMR (Yearly Meter Readings) meter which implies that the meter recordings are recorded once a year. On a yearly basis the accumulated (net) offtake is manually read and verified. The table below gives an overview of the Flemish grid customers, categorized by meter equipment. As can be seen, only 1.25% of the users have peak-measured equipment. Nevertheless, this should be compared with the total volume of consumption by these consumers. That is, in 2016, 63.84% of the total supplied volume of electricity was for consumers equipped with an AMR meter and 3.16% was delivered to customers with an MMR meter.

Category	Total	Percentage
AMR	27,962	0.83%
MMR	14,124	0.42%
Yearly read household consumers	2,753,028	81.33%
Yearly read non-household consumers	589,975	17.43%

	Finally, it should be noted that Flemish households will all have a digital meter by 2030. The roll-out started in July 2019 [105].
Status of integrations of Energy and Non-Energy services in the country	Non-Energy Services are secondary services that are offered in the context of an (Active Building) EPC, in addition to the primary services that are focused on saving energy consumption and energy costs. Some of these Non-Energy services can be associated with some of the Non-Energy benefits or so-called Multiple benefits of energy efficiency and EPC (like improved comfort), whereas others are rather auxiliary services that are required to satisfy customers' more global needs (like maintenance). Below the distinction is made between Non-Energy services (as offered in the EPC) from other Non-Energy Benefits (as positive side-effects of the EPC). Today many EPCs in Belgium include Non-Energy Services, although it differs from contract to contract (e.g. EPC vs. M-EPC) or sector (e.g. public buildings vs. SME buildings). • The most common one is **maintenance**. This sometimes includes not only maintenance of the energy efficiency related investments (so-called EPC assets) but also maintenance of other existing energy assets and even of non-energy related assets. Maintenance may be needed to assure guaranteed energy savings, but also with the goal to maintain the overall quality of the installations and increase their lifetime. Typical KPIs are related to repair times in case of equipment defaults, number of defaults per year, etc. There is no legislation on this, but it is part of the Service Level Agreement (SLA) in many EPCs. A widespread method for maintenance in M-EPC projects in the public sector in Belgium is the use of the Dutch NEN2767 standard for performance-based maintenance. It was first used in EPC within the smartEPC model, from 2012 onwards and is now very common. The NEN2767-standard has become a de facto industry standard that allows to fix and monitor "condition scores" at element and building level, which are the outcome of mainly visual inspection of all types of equipment in a building and even building envelope elements. • **Comfort and Indoor Environmental Quality (IEQ)** are both a Non-Energy service in most EPC contracts and a Multiple benefit. ESCO are required to maintain or improve comfort, to avoid achieving energy savings at the cost of comfort quality. Comfort and Indoor Environmental Quality concerns areas as temperature (in the summer and in the winter), air quality, light quality, etc. It is often covered by comfort-specific KPI's that are either fixed by the customer, per building or space, or that are defined in national or international standards. Some of the most common ones that are used in Belgium are: Ventilation Categories in Table B.2 of the Belgian NBN EN 15251 standard (Air Quality, etc.) Classes for Operative temperatures in EN ISO 7730:2005 (Winter temperatures) NBN-EN 12464-1 (Relighting) In addition to specific technical requirements on comfort and IEQ parameters, some EPCs use a more global bespoke assessment methodology of comfort before and during the contract. It is based on a building occupant survey. By using a statistically sufficiently large percentage of occupants, the result of this comfort score is a reliable method to measure and monitor comfort. One of most common ones used in office buildings in Belgium (e.g. in the SmartEPC model) is "Comfortmeter" • Linked to Comfort and IEQ improvements are the **improved Health benefits**.

- Both better comfort and improved health can lead to **improved productivity** of employees. This is rarely a Non-Energy Service but could be considered as a possibly quantifiable multiple benefit. Within "Comfortmeter", the relation between improved (self-declared) comfort and improved (self-declared) productivity has been studied and quantified.
- Another Non-energy benefit, which can sometimes be a Non-Energy Service in an EPC is the **increased asset value** at the end of the EPC contract. This can be objectivized and linked to "technical building value" using the above-mentioned NEN2767 standard. It uses the condition scores in combination with replacement values for each element to determine the on–site residual value of each element and thus of the building. More research is needed though to link technical residual value to (real estate) asset value.
- **Financing** is a typical service offered in many EPCs, and Belgium is not an exception. Most common are Bank Financing (lending) and ESCO Financing, the latter being an integral part of the EPC contract and thus a Non-Energy service. There is no regulation on this, although since September 2017 Eurostat has published a new guidance note, further specified by the EIB in its EPC - A guide for statistical treatment of Energy Performance Contracts in 2018, which defines the conditions for possible off-balance (debt-deconsolidated) financing in the public sector. Some private actors and BELESCO are working today, in collaboration, with the Walloon CIF unit (Cellule d'Informations Financières) on its practical implementation in Belgium. This includes a model for "partial" off-balance EPC financing.

Regulation on Integration of Energy Services and Non-Energy Services in Belgium is limited to EPB (Energy Performance Building) regulations, under the umbrella of the national/regional transpositions of the EPB Directive.

The two aspects that are relevant are « Energy Performance » and « Indoor Climate » (mainly through Ventilation, as part of broader Comfort as a Non-Energy Service and multiple benefit, and Excessive heat).

Specific regulation differs between the 3 regions (Flanders, Wallonia and Brussels). Only the most recent regulations and criteria (i.e. for 2020 or 2021) are mentioned.

ENERGY PERFORMANCE

1. Flanders

EPB regulation in Flanders on the Energy Services related part focuses on energy performance, defined as an E-level to be reach after construction or deep energy retrofit. It is calculated using a dedicated EPB software.

It is important to note that this relates to energy performance "as built" and not energy performance "in use", which is more were EPC focuses on. Indeed, a building may have a good E-level after construction or after an energetic renovation, but it may still performance poorly once in operation and not meet its continuous and long-term energy performance guarantees under the EPC-contract.

There are no energy performance requirements for "shallow" energy retrofits, which are still a significant part of the EPC market.

Since 2017 there is an EPB regulation for Non-residential buildings, called EPN.

It is required

- For new buildings and deep energy retrofit.
- For each part or unit of a new building that is used separately (e.g. an apartment) and for each part that has a different destination (e.g. housing unit, office, school, restaurant)

For buildings that do not meet the minimum renewable energy percentage requirement, the maximum E-level is decreased by 10%.

By 2021 the purpose is that all new buildings are Near Zero-Energy Buildings (NZEB).

The E-level requirements for non-residential buildings, for different functions are summarized in the following table.

Function	**E-level requirements for building permits since 2018 and up to 31/12/2020**
Housing	70
Office	55
Education	55
Healthcare with housing	70
Healthcare without housing	65
Healthcare operation rooms	50
Gathering high occupation	65
Gathering low occupation	65
Gathering cafeteria/catering	60
Kitchen	55
Trade	60
Sports: sports hall, sports center	50
Sports: fitness, dance	40
Sports: sauna, swimming pool	50
Technical spaces	45
Common areas	55
Other	80
Unknown	80

Industrial buildings and certain agriculture buildings are not submitted to EPN regulations.

In case a unit contains several functional parts, the E-level is calculated as a weighted average using the gross surface as weighing parameter.

Public buildings with a building permit from 2018 onwards must meet stronger E-level requirements than non-public buildings, for some functions (see table below).

Function	E-level requirements for building permits since 2018 and up to 31/12/20
Office	50
Gatherings high occupation	65
Gatherings cafetaria/catering	60
Kitchen	55
Technical spaces	45
Common areas	50

For the other functions the E-level requirements from the first table apply.

Energy performance requirements for Residential buildings, so-called EPW, are also based on E-levels (and S-levels and other criteria) but the requirements are depending on several parameters and are hard to summarize in one table. Typically, from 2021 onwards they are maximum E30 for new buildings and maximum E70 for deep energy retrofits.

2. Wallonia

In Wallonia, from 2021 onwards, PEB regulations distinguish between systems and buildings.

For systems, specific requirements are defined on efficiency, energy monitoring, etc. to heating, hot and cold water, air conditioning and ventilation, either installed, replaced or modernised.

All new buildings need to follow the NZEB standard. For renovations, the requirements defined from 1/1/2017 have not changed and are the following:

For works, 4 cased are distinguished:

- New or assimilated building (i.e. volume > 800m^2; doubling volume; change installations and > 75% of the envelope)
- Comprehensive renovation (works on at least 25% of the envelope)
- Simple renovation, including the change of destination HEATED to HEATED
- Change of destination NON-HEATED to HEATED

Simple or comprehensive renovation of industrial buildings is not submitted to PEB regulations, unless it is destined to become a building for housing, offices, services or education, in which the 4th case applies.

Requirements are defined as PER (residential housing) and PEN (non-residential and collective housing).

For new and assimilated residential homes, the E-level requirement is 45. The specific energy consumption needs to be < 85 kWh/m^2.year.

For new and assimilated non-residential buildings, the required E-level is also calculated by weighting by type according to the surface and is either 45 or 90.

Function	E-level requirements for building permits from 01/01/21 onwards
Housing	90
Office	45
Education	45
Healthcare with housing	90
Healthcare without housing	90
Healthcare operation rooms	90
Gathering high occupation	90
Gathering low occupation	90
Gathering cafeteria/catering	90
Kitchen	90
Trade	90
Sports: sports hall, sports center	90
Sports: fitness, dance	90
Sports: sauna, swimming pool	90
Technical spaces	90
Common areas	90
Other	90
Unknown	90

3. Brussels

In the Brussels Capital Region, the EPB regulation focuses on 2 areas

1. EPB requirements for new and existing Heating and Climatisation installations
2. EPB Works, in the case of renovation works or new construction

Only the Works area is directly related to Energy Performance.

The regulation distinguishes between 4 types of works:

- New units (= newly built or rebuilt)
- Units assimilated with new units (= (re)construction works > 75% of wall/roof/floor surface and (re)placement of all technical installations)
- Units that undergo a comprehensive renovation (deep energy retrofit = works on > 50% of wall/roof/floor surface and (re)placement of all technical installations)
- Units that undergo a shallow renovation (= affecting energy performance but does not meet the definition of comprehensive refurbishment)

Criteria are different according to the type of building

- Individual housing unit
- Non-residential building
- Other building
- Common areas

Requirements are based on Net Demand for Heating (NDH) and Primary Energy Consumption (PEC), somewhat comparable to the E-level in Flanders).

For non-residential buildings requirements are summarized in the table below:

Function	**E-level requirements for building permits from 01/01/2021 onwards**
Housing	80
Office	45
Education	45
Healthcare with housing	80
Healthcare without housing	80
Healthcare operation rooms	60
Gathering high occupation	80
Gathering low occupation	80
Gathering cafeteria/catering	70
Kitchen	70
Trade	70
Sports: sports hall, sports center	65
Sports: fitness, dance	65
Sports: sauna, swimming pool	65
Technical spaces	45
Common areas	45
Other	85
Unknown	85

For individual houses the requirements are more complex, but can be summarized around two main parameters:

- Net energy Demand for Heating (NDH): < 15 kWh/m^2.year
- Primary Energy Consumption (PEC), following a more complex formula but typically between 45 and 90 kWh/m^2.year

This provides less flexibility for the use of renewable energy for heating, as is the case in Flanders.

Comfort – Ventilation – Non-energy services

With regard to comfort, Belgium already has since October 1991 a regulation on ventilation in residential buildings (NBN D 50-001). The different Belgian regions (Flanders, Walloon and Brussels) base themselves largely on this regulation.

- For Flanders, the EPB regulation states that the presence of ventilation system facilities for the supply and removal of air is required. The requirements for the facilities and with regard to the flow rates, differ between the destinations of the buildings. There is a difference between residential buildings compared to non-residential buildings and industry, and there is a difference for new construction and major energy renovation compared to renovation. Specifically, for new residential buildings, there is a requirement to limit the risk on overheating (in case of heat periods). This is embedded in the "energiebesluit", energy decree, in article 9.1.12 . More details on ventilation requirements in Flanders can be found in the EPB requirement tables [106].
- For Brussels, EPB regulation (réglementation climatisation PEB) about climatization regulates all climate appliances of more than 12 kW (cooling power). They regulate the minimal maintenance, the EPB-requirements and the EPB-diagnose for climate control. Since January 2019, there is an increased linkage within EPB in respect of heating and cooling; and some technical requirements are changed in light of the techno-economic feasibility. More information can be found in the EPB-regulation for ventilation regulation the Brussels environment [107]. Specific requirements can be found in the regulation of the Brussels Environment regarding EPB (PEB) [108].
- For the Walloon area, the EPB regulation also set out requirements for climatization (heating, cooling, ventilation…). Here as well, a difference is made between large and small renovations, and new and existing buildings. More information can be found through the Walloon Energy Portal [109].

6.3. PORTUGAL

6.3.1. CURRENT STATUS OF EPC IN PORTUGAL

Overview of the EPC status in the country	Buildings represent the third major energy consumption sector with a share of 29% in Portugal. Despite the increase of the final energy share in national energy consumption balance, the energy consumption trend of this sector has decreased about 15.9% in the last 11 years, with a relevant contribution of the residential sector [110]. The Household sector in Portugal had one of the largest evolution in energy efficiency gains while the services sector followed a relatively inefficient trend. However, the trend on increasing the energy efficiency measures in buildings in general is growing. The new decree-law establishes several requirements for new and buildings undergoing renovations or major renovations, as well as for building components and technical systems. Some of these requirements are already expected to evolve by certain dates that are already stated in the legislation. This situation allows for the market to prepare itself and adapt to future requirements. The table below presents a brief resume of the requirements in place for technical systems.

Building type	Technical system		Requirement evolution: Before 2013	Requirement evolution: 2013-2015	Requirement evolution: After 2016	Standard
Residential and non residential buildings	Heat pumps	cooling	None	Eurovent Label C (Example: Chiller COP ≥ 2.8; EER ≥ 2,7)	Eurovent Label B (Example: Chiller COP ≥ 3.0; EER ≥ 2,9)	EN 14511
		heating				EN 14825
		DHW		COP ≥ 2.3		EN 16147
	Boilers			Minimum nominal efficiency 86%	Minimum nominal efficiency 92%	-
	DHW Gas heater	Power ≤ 10kW		Efficiency ≥ 82 %		
		Power > 10kW		Efficiency ≥ 84 %		
Residential	Domestic Electric Storage Water Heaters			Maximum stand-by heat loss		EN 60379
Non residential	Air handling unit			Eurovent Label D Efficiency ≥ 47% Velocity ≤ 2.5 m/s Δp ≥ 125 Pa	Eurovent Label C Efficiency ≥ 57% Velocity ≤ 2.2 m/s Δp ≥ 170 Pa	EN 13053
	Pumps		Minimum EFF2 label	Minimum IE2 or IE3 class		IEC60034-30
	FANs			Minimum IE2 or IE3 class Minimum SFP 4 or 5 (W/m^3/s)		IEC60034-30 EN 13779
	Lighting		None	Maximum power (W/m^2)/100lux Example: Offices 2.5 (W/m^2)/100lux for 500lux		EN 12464-1 EN 15193
	Lifts			Minimum C	Minimum B	VDI 4707
	Central building management system		Mandatory if HVAC thermal power > 250 kW			EN15232

Moreover, the energy performance indicators in the buildings according to types of buildings and their useful and primary energy

	consumption has evolved specifically after the new Energy Performance of Building Directive (EPBD) in 2013. The Energy Performance Certificate is the most visible aspect and one of the requirements implemented after the transposition of the EPBD. According to the legislation the Energy Performance Certificate is required in the following situations: - New buildings, in the design phase and before the use permit concession; - Buildings that undergo a major renovation, in the design phase and before the use permit concession and; - Existing buildings before they’re rented or sold, including the moment they’re advertised for that purpose where the energy label has to be shown. Despite all these initiatives and changes, the Energy Performance Contracting is not yet a fully implemented model in Portugal [111]. Although it is gaining popularity because of an increase in demand for energy efficiency, EPCs are still not very common.
EPC-related regulations, directives and policies in the country	The main EPC-related regulations, directives and policies in Portugal are discussed below: **National Energy Efficiency Action Plan (NEEAP):** Decree-Law n.º 50/2010 of 20 May creates the Energy Efficiency Fund (EEF) aimed to fund programs and activities to finance the implementation of measures included in the NEEAP. This Decree-Law establishes the creation of a management structure, already foreseen in the NEEAP, to support and promote the implementation of its programs and measures, including the technical management of the Fund. Following the previously mentioned legislation, Ordinance n.º 1316/2010 of 28 December was published to regulate and set NEEAP’s management structure, and later Ordinance n. 26/2011, of January 10th, whose aim was to establish the financial support scheme for eligible FEE’s project aiming at implementation of programs and measures under PNAEE purpose. **Energy Efficiency Fund (EEF):** Decree-Law n.º 50/2010 of 20 May creates the EEF, aiming to fund programs and activities that support the measures included in the NEEAP. Under this legislative act, Ordinance n.º 26/2011 was published on January 10, defining the financial support system for measures and programs eligible for the Fund. This regulation is intended to coordinate the funding and support process for projects aiming the implementation of programs and measures that lead to reduction of the final energy demand contributing to the compliance of national targets on energy efficiency. **Energy Efficiency Programs in Public Administration (ECO.AP):** The Energy Efficiency Program in Public Administration "ECO.AP", launched through Resolution of the Council of Ministers no. 2/2011, of January 12, aims to achieve a 30% energy efficiency level in the Energy Efficiency Trends and Policies in Portugal 32 agencies and services of the Public Administration by 2020. This efficiency level should be being achieved without increasing public expenditure while allowing the economy to stimulate the energy services sector. The objective of this program is to enable the State to reduce energy consumption in services and bodies, reduce the emission of greenhouse gases and contribute to an enhanced stimulus of the economy thus contributing to the achievement of the objectives of the

NEEP and the NREAP.

In order to achieve the objectives proposed by ECO.AP, the Energy Efficiency Barometer was launched with the objective of characterizing, comparing and disseminating the energy performance of the different entities of the Public Administration. The Energy Efficiency Barometer plays a central role in the strategy of promoting energy efficiency in the public sector, allowing a detailed knowledge of the energy consumption structure of the public sector, and thus support the definition of policies and measures aimed at promoting the efficient use of energy resources in the public sector.

Public Contract Regime with the Energy Service Companies (ESE): Under the National Energy Strategy 2020, Decree-Law n.º 29/2011, of 28 February, was published aiming to establish a role for the public sector in the promotion and development of an energy services market, as well as the adoption of measures to improve end-use energy efficiency. This legislation regulates the use of ESE (ESCOs), through a competitive tender process, allowing these companies to identify potential energy savings in buildings and public facilities and to implement procedures for enhancing energy efficiency, reflected in the final energy bill. Decree-Law n.º 29/2011 also establishes the procedures for the establishment and conclusion of contracts between public administration bodies and energy service companies, with a clear commitment on simplified and objective models for the evaluation of proposals.

Plan for Promoting Efficiency in Electricity Consumption, (PPEC): Under the National Programme for Climate Change (PNAC) that evolved to NEEAP were assigned to the Energy Services Regulatory Authority (ERSE) specific responsibilities in the definition of mechanisms to promote energy efficiency on the demand, aiming the electric consumption reduction by 2010 compared to a reference scenario.

The 6th edition of PPEC (PPEC 2017-2018) is now in force, whose main objective is to finance support initiatives that promote the efficiency and reduction of electricity consumption in the different consumer segments. This edition approved 75 measures that will be implemented by 33 promotors. Both, ERSE and the DGEG, evaluated the candidate measures, and the final decision of the PPEC 2017- 2018 measures was published in Order no. 15355/2016, of 21 December 2016. The social benefits to be achieved with the implementation of the approved measures (around EUR 111 million) are much higher than the costs (EUR 23 million). The beneficial effects of the measures Energy Efficiency Trends and Policies in Portugal 33 will remain until 2037, representing about 1470 GWh of cumulative avoided consumption.

Energy Performance of Buildings: Main recent energy efficiency policies in buildings sector focus on the publication of Energy Certification of Buildings, Decree-Law 118/2013, August 20th that transposes to the Portuguese Legislation the European Directive n 2010/31/UE, regarding the recast of the energy performance of buildings directive and thus promoting the continuation of the energy certification of buildings, the improvement of requirements, among other issues. This Decree-law is supported through the publication of 6 ordinances and 14 orders that includes the specific calculation methodology, renewable energy account, energy performance certificates (EPC) lay-out, climate data, primary energy conversion factors and others. The Decree-law 118/2013 was published in a different configuration when compared to the previous legislation dated from 2006, which was built on three decree-laws. This new regulation revised and updated the three previous decree-laws (Decree-law 78/2006, Decree-law 79/2006 and Decree-law 80/2006, all from 4th April) and aggregated it one unique decree-law. The overall decrees-law, law, ordinances and orders which define specific issues that support this new building regulation are listed as follows:

- Decree-law 118/2013, of August 20th (SCE – Buildings Energy Certification System);
- Law n.º 58/2013, of August 20th (Professional qualifications of SCE technicians);
- Ordinance n.º 349-A/2013 of, November 29th (Establishes the buildings category of energy certification (CE) as well as the types of certificate model, the taxes of CE register in the SCE internet platform and the criteria for quality verification of energy certification process.
- Ordinance n. 349-B/2013 of November 29th (REH solutions requirements for residential buildings);
- Ordinance n.º 349-C/2013 of December 2nd (Establishes the required documents for the construction and use permit);
- Ordinance n. 349-D/2013 of December 2nd (RECS requirements for non-residential buildings); -
- Ordinance n.º 353-A/2013 of December 4th (Indoor air quality requirements for nonresidential buildings);
- Ordinance n.º 353/2013 of December 4th (Establishes the building cost per square meter)
- Order n.º 15793-C/2013 of December 3rd (Publishes the energy certificate layout for residential and non-residential buildings);
- Order n.º 15793-D/2013 of December 3rd (Publishes the final energy conversion factors to primary energy and CO2 emission system under energy certificate process);
- Order n. 15793-E/2013 of December 3rd (Establishes the rules of simplified calculations methods to be applied in existing buildings);
- Order n.º 15793-F/2013 of December 3rd (Publishes the climate data);
- Order n. º 15793-G/2013 of December 3rd (Establishes the proceedings for testing and acceptance of facilities as well as the guidance of minimum information required to be included in the Maintenance Plan)
- Order n.º 15793-H/2013 of August 20th (Establishes the rules for the accounting of renewable energy under energy certificate process); Energy Efficiency Trends and Policies in Portugal 56
- Order n.º 15793-I/2013 of December 3rd (Publishes the methodology of nominal energy household demands); - Order n.º 15793-k/2013 of December 3rd (Publishes the thermal parameters of constructions solutions);
- Order n.º 15793-L/2013 of August 20th (Defines economic viability methodology to support the energetic rational plan under RECS buildings);
- Order 8892/2015, of August 11st, (Defines the classification methodology to adopt for lifts, conveyors and escalators to be installed in commercial buildings and services in order to assess compliance with the minimum energy efficiency requirements according to VDI 4707 standard)
- Order 7113/2015, of June 29st, (Responsible for publishing quality verification of the selection criteria of the processes and methods of checking the quality of the certification processes carried out by the technicians of the Building Energy Certification System (SCE), particularly the Qualified Experts)
- Order 14985/2015, of December 17th, (Defines the methodology to be used for determining the values (Qusable) and Seasonal

	Performance Factor used in the calculation methodology of the renewable energy contribution from heat pumps). • Order 3156/2016, of March 1st, (Replaces the calculation program of the determination of the energy produced by the solar thermal system and solar photovoltaic system, under the Building Energy Certification System). • - Order 6470/2016, of May 17th, (Defines the requirements associated to the elaboration of energy rationalization plans).
Main types of EPC implemented	EPC is increasing only lately in Portugal due to various barriers including lack of trust in service providers, lack of liquidity for financial support of the contracts and services, etc. Although the existing models for the EPC types are Guaranteed Savings model and Shared Savings model, the majority of existing contracts (67%) [112] follow the shared saving model. This indicates again the fact that the EPC market in Portugal is still on early stages and this approach can be considered a good model while still the market is developing for such contracts.
Main actors involved in current EPC	The main EPC market actors in Portugal are ESCOs, facilitators, clients, financial actors and regulatory stakeholders. **ESCO:** an ESCO is a natural or legal person who delivers energy services in the form of EPC in a final customer's facility or premises. The ESCO delivers all the services required to design and implement a comprehensive energy saving project and assumes the contractually agreed performance risks of the project. An ESCO guarantees the achievement of the contractually agreed level of savings and is obliged to compensate savings shortfalls. **EPC facilitators:** an EPC facilitator will usually provide the customer with the necessary knowledge and experience as well as guidance to successfully implement an EPC project which will usually carry on throughout its complete duration. They act as intermediaries between the customer and ESCOs to build up a sustainable relationship. Their duties include the identification of opportunities, the assessment of suitability for the customer of the EPC, the valuation of savings expected from the EPC, as well as likely investments and support throughout the process. **National associations:** ESCOs and facilitators tend to create organizations with the goal of establishing lobbies that allow them to be in contact with all the updates that occur in the sector. One of the most important associations in Portugal is *APESEnergia* (Portuguese Association of Energy Service Companies). Their mission is to promote the development of the EES industry in Portugal through technological, regulatory and good practices, contributing to the increase of Portugal's increase in competitiveness in efficient energy use. **Clients:** The clients for the EPC market in Portugal varies from a range of public to private sectors covering the offices, industry (includes any type of factory where manufacturing processes are carried out), residential, as well as municipalities, health and education sectors. **Financial actors:** All who have a role in supporting the finances of the EPC which could be a bank or other sources. **Regulatory stakeholders:** In Portugal, the entities on the public sector that has a higher level in the EPC market and can take regulatory actions on EPC include the Portuguese Government, ADENE (Agência para a Energia) or the DGEG (Direção-Geral de Energia e Geologia) which oversees energy efficiency in Portugal.

ESCO market overview in the country	The Portuguese EES market was dominated by about 12-15 providers for some years, including private ESCOs with financial capacity, private small ESCOs, joint ventures and large energy companies through their commercial divisions. In recent years, an emerging market of energy services has developed mostly due to an increase in demand of energy efficiency and energy services driven by the EC legislation. This led the Portuguese Government to implement several energy policies focused on energy efficiency and although expectations were high, energy efficiency services are still not common in Portugal. According to the official database established by DGEG, there are over 100 companies registered as certified auditing companies in Portugal. However, according to the National EPC market insight report published by Trust EPC South in January of 2016 [4], no more than ten companies are EPC facilitators and three or four are EPC providers. Energy Performance Contracting is still a market in development in Portugal. Although it is gaining popularity it is experiencing a slow increase and can therefore be considered a new business product meaning that players involved are still going through a learning process. As of 2016 the number of ESCOs that can - and will - supply EPCs was unknown but interest was high, according to a JRC report. Around five to ten projects are implemented in a year with a value between EUR 100,000 and EUR 500,000, however they are usually pilot projects. Most projects are implemented in hotels, hospitals, leisure centre sports, schools and public buildings. There is no market size available, but estimations carried out by Trust EPC South [4] estimated investment costs at EUR 215 million and the EPC market potential in the sector reaches EUR 630 million. The JRC's report, however, place the investment outlay roughly between EUR 10 and EUR 30 million based on the Transparense project's survey in 2013.

6.3.2. CURRENT STATUS OF DEMAND RESPONSE AND OTHER FACTORS ENABLING THE ACTIVE EPC IN PORTUGAL

Overview of DR status in the country	Demand Response still has a long way to go to be active market in Portugal [113]. In terms of implicit demand response, there are already some offers, like the implicit demand response available from the retailers, but in a limited range. Regarding explicit demand response, there is no market and viable offers of services. In terms of products and market access, there exists a pilot testing the access to market of demand-side flexibility, led by ERSE, but no solid scheme of market access is available yet. The products available, like the demand response service available from EDP Comercial, are all in their infancy and the most mature, the interruptibility product, one has significant barriers to entry for consumers due to high minimum requirements of power capacity (5 MW). In the table below, an overview of the available products in Portugal is rendered:

ENTSO-E's terminology	TSO's terminology	Tot. Capacity Contracted[288]	Demand Response Access & Participation	Aggregated Demand Response Accepted
FCR	Primary Control	Not applicable	×	×
FRR	Secondary Control	2.559 GWh	×	×
RR	Tertiary Control	4.753 GWh	×	×
RR	Deviation Management	2.763 GWh	×	×
	Guarantee of Supply Constraints	4.085 GWh	×	×
	Technical Constraints (PDBF)	≈6.500 GWh	×	×
	Real-Time Constraints	≈1.800 GWh	×	×
RR	Power Reserve	2.109 GWh	×	×
	Secondary Regulation Band	1.197 GWh	×	×
	Interruptible Mainland[289,290] – 5MW blocks	1.430-1.970 MW	1.430-1.970 MW	×
	Interruptible Mainland[289,290] – 90MW blocks	630-1.170 MW	630-1.170 MW	×
	Interruptible Islands	≈50 MW	≈50 MW	×
	Capacity Mechanism	≈2.500 MW	×	×

From the table it can be concluded that only the interruptible demand can be identified as a demand response market product. The remaining markets have contracted capacity but have no Demand Response offer available.

Current status of implicit DR in the country

Implicit demand response refers to specific consumers choosing to be exposed to *time-varying electricity prices* or *time-varying network tariffs* that partly reflect the value or cost of electricity and/ or transportation in different time periods and react to those price differences depending on their own possibilities. The prices are always part of the supply contract which excludes the consumers' participation alongside generation in a market.

Within implicit demand response schemes, the consumer reacts to price signals that are set for pre-defined intervals such as night/day, hourly, half or quarter-hourly. To exploit this functionality, the consumer must be equipped with a smart meter with registration of the consumption with the appropriate resolution.

In Portugal, the obligatory provisions of the relevant EU Directives (**Art. 15 of COM/2016/0864 final**) have not been defined in Portuguese law. In particular, Portugal has not yet adjusted its regulatory structures to enable demand side resources to participate in the markets by defining the role of the independent aggregator and demand response service provider or adjusting critical technical modalities. These structural shortcomings entail several issues that need to be addressed by the regulatory authority to enable demand response programs including:

1. No definition of means for aggregators to offer demand side resources;

2. No definition of measurement baselines or remuneration for consumption shifts;
3. Non-existence of markets in which consumers or aggregators can sell the resources.

Currently, ERSE, the Portuguese regulator, is aware of the insufficient regulatory structures for demand response market participation, but indicates that as to date no requests for this have come from the market.

In general, demand response schemes can be distinguished by incentive-based demand response such as *direct load control (DLC),* time-based demand response and market-based and/or physical-based demand response .

Since 1997, consumers have access to a dynamic or time-of-use tariffs ranging between 3-4 price bands per day facilitating a time-based incentive to consume electricity in times of low demand (night/ day). The electricity price in Portugal is comprised of two parts:

- **Variable/ volumetric:** this part of the electricity price directly depends on the amount of electricity consumed (€/kWh);
- **Fixed:** this part of the electricity price is independent of the amount of consumed electricity but determined by contracted power of the consumer (€/kVA or €/kW).

The different time-based incentive schemes and their applicability in Portugal are summarized in the table below.

Scheme	Specifications	Implementation in Portugal	Application in Portugal
Time-of-Use pricing	A static price schedule is applied.	Household: Only applicable to the variable part of the electricity price Industrial: Pilot project for ToU tariff for both parts of the electricity price (variable and fixed)	x
Critical peak pricing	A less predetermined variant of ToU	-	-
Real-time pricing	Wholesale market prices are forwarded to end customers	-	-

Time-of-use tariffs are specific tariffs that attach fixed price rates to specific times of the day. However, most consumers have decided to remain on the flat controlled tariff scheme.

Critical peak pricing is a top-up rate in which electricity prices substantially increase for a few days of the year when wholesale prices are highest.

Real-time pricing are tariffs that directly forward wholesale electricity prices to the consumers and the electricity bills are determined

	based on at least hourly metering of consumption, or even higher granularity. Hereby, the price is composed of the wholesale electricity price and a supplier margin. The implemented time-of-use scheme of Portugal's largest retailer, EDP Comercial, is designed upon different influence categories that enable consumers to choose between various tariff options including seasonality, the differences between working days and weekends, flat-, bi- and tri-phased time-based tariffs (see Figure below).

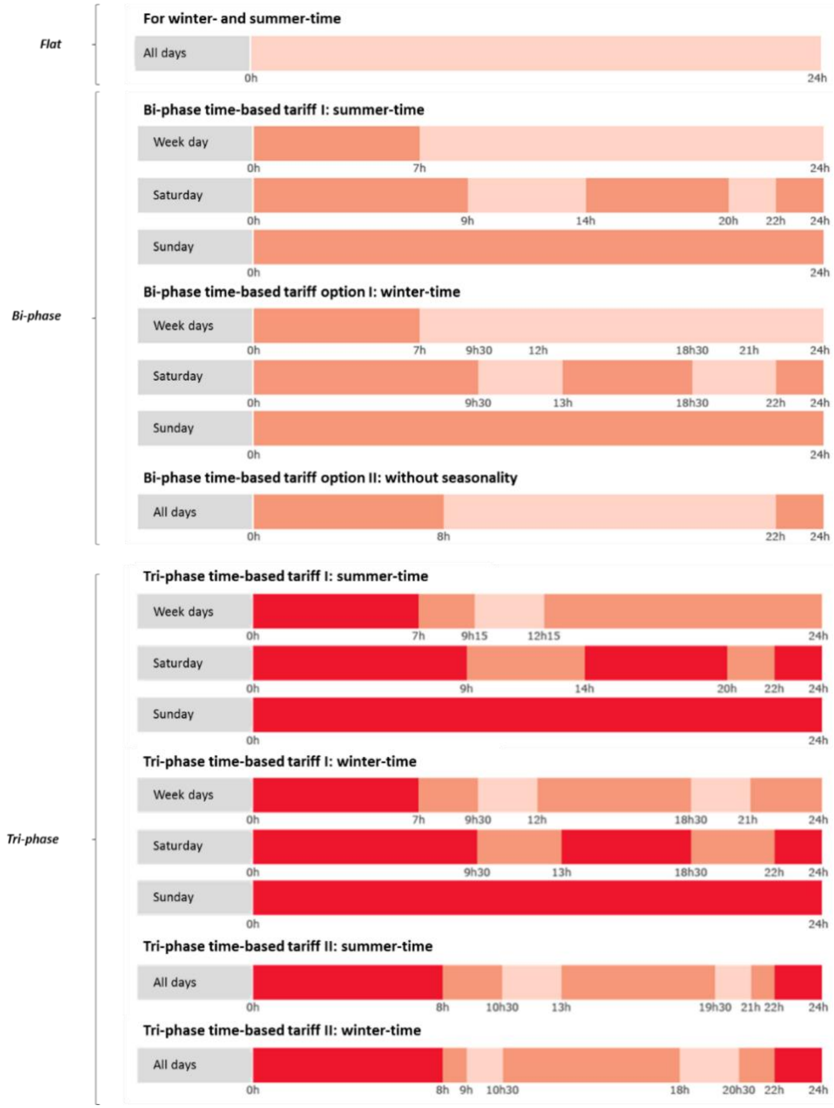
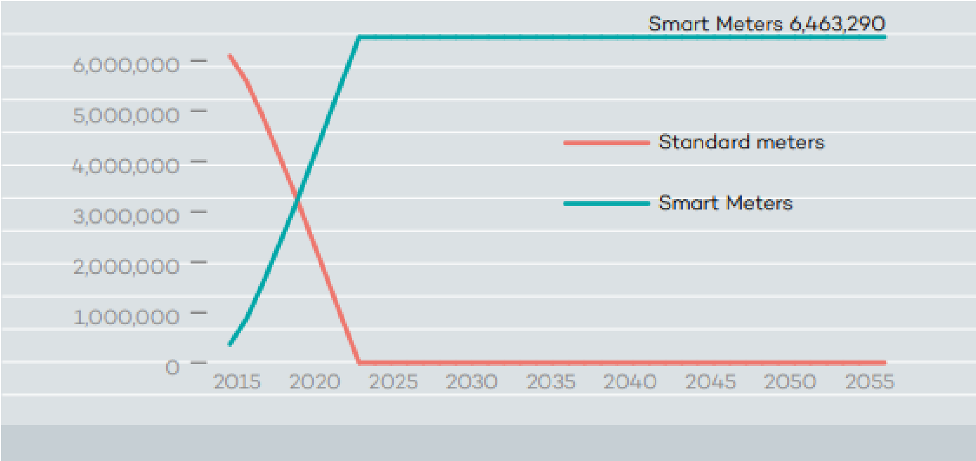


FIGURE 12 TOU TARIFF SCHEME IMPLEMENTED BY EDP COMERCIAL

Current status of explicit DR in the country	Today, explicit Demand Response has not been defined in the Portuguese law in terms of energy markets participation [6]. The accessibility for Demand Response to the balancing market and to the ancillary services is not given. Moreover, only generators with a production unit of at least 50 MW are accredited to participate as a seller in the wholesale market. Flexibility resources can be offered on the spot market through demand bids with the indication of price. Also, pumped hydro can participate in the Ancillary Services market. The role of independent Demand Response Providers is not yet defined in Portugal and there is no regulatory framework specifying roles and responsibilities, thus there has been little interest from the retailers present in the market to issue request. It is intended to address this issue once there is a push from the market participants. Until now, EDP Produção is able to participate in the ancillary services market by incorporating large capacities of storage from hydro power plants in the balancing market as a measure to prepare for potential demand reductions.
Current status of DR access to the market in the country	The status of the market is in an inactive state in what concerns demand response products trade [114]. The same market structure is shared between Portugal and Spain in the wholesale and balancing markets. The access to market is not illegal, but there isn't a defined way to aggregate the consumer loads, though there is for distributed generation for both wholesale and ancillary services. The market is essentially closed for DR products because there are no regulatory measures or entities in place to mediate the interaction between the markets and the users. There exists a pilot from Energy Services Regulatory Authority (ERSE) which promotes the aggregation of demand participation as a balancing product [115]. It is required for this pilot that the participating sites have at least 1 MW flexibility-based bids. There is an interruptible contracts programme, with a total agreed capacity with consumers of about 2200 MW, but puts the lower power threshold for participation at 4 MW which limits the market actors who could be interested to big industrial players.
Current status of DR product definitions in the country	We can divide the product offering in a set of sub-categories, will it refer to implicit or explicit demand response. In implicit we have: • Time of use (commercially available); • Real time pricing; • Critical peak pricing; In explicit we have: • Direct load control; • Interruptible services (commercially available); • Demand Bidding; • Emergency Demand Response; Regarding the Portuguese scenario, there aren't a lot of products defined. There is a product for time of use which is defined by the Energy Services Regulatory Authority (ERSE). This product divides the consumption tariff in several periods and creates a time-based product for energy billing. Besides this, there is a trial at EDP Comercial to create an Ancillary Services product, where the user gives access to capacity

	on the basis of a fee and the retailer can use it to balance the market when is needed. There exist some interruptible services on the market, also. The market operator asks the user to lower its load and he should do so on the basis that he will suffer penalties if he doesn't. The cost the market operator had to incur in was 0.176 €/MWh for activated consumers' flexibility. These services appear as part of a bigger plan to achieve energy efficiency goals. The targets are: • 32.5% as energy efficiency; • 32% of the countries' consumption should be renewables; • 14% of renewable energy on transportation;
Current status of DER flexibility assessment and exploitation in the country	There are several policies that encourage the use of DER. The Directive 2009/28/EC promotes the use of renewables by setting a target of 20%, for renewable energy use, of energy consumption until 2020. In terms of programs, there is the National Plan of Action for Renewable Energies 2013-2020 that stimulates the adoption of DER and, consequentially, flexibility. It is now simpler to install a self-consumption site. It was necessary to get a license from DGEG (Direção-Geral de Energia e Geologia) with a site power superior to 1.5 kW, now the license is only necessary after the 100 kW. The same regulation allows for the creation of local energy communities, by defining its concept, which facilitates the task of energy aggregation. Moreover, the decree-law 76/2019 eases the creation of generation units with a capacity below 1 MW.
Current status of independent aggregators in the country	For the moment there is not a defined independent aggregator in Portugal. The regulatory framework regulating this activity is the article 15.8 from Energy Efficiency Directive. The regulation defines that all member states that want to participate in demand response activities should include an aggregator as part of the market structure. An aggregator would be useful to aggregate the whole flexibility of the market, provide peak reduction services and respond to market necessities faster than a traditional generation plant. A non-official independent aggregator is created when local communities appear. Although they are not a standard aggregator, they can fulfil the role locally. These local communities are already part of the system. There are already, in the market, some companies that address the role of middleman for communities. Coopérnico makes an investment in specific communities so that they can build their solar system and create a local community of renewable powered installations.
Current status of regulations/policies supporting aggregation of resources in the country	The large scale aggregation of resources in Portugal is not yet defined. The resource aggregation is limited to local communities and small players. It is possible to create local communities of renewable energy and aggregate the energy from several sources through this mechanism. Nonetheless, without the figure of the independent market aggregator the retailers cannot participate in the market. The surge of local energy communities, Coopérnico is an illustrative case, is one step towards the building of an aggregation market, since small communities can be seen as mini markets that appear through the willingness of a group of people. The step forward would be to build specific legislation for other orders of magnitude of capacity in the national electricity system.

Current status of transparent measurement and verification standards in the country	The current status of measurement and verification status for the Portuguese demand response market is inexistent. The status is justifiable by the market itself, since the market doesn't exist, and the measurement and verification of energy aggregation is also inexistent.
Current status of regulations/policies and best practices supporting demand-side flexibility on building-level, for instance in the context of Energy Communities or in other situations if applicable	Energy Communities are an emergent collective entity in Portugal. This is a phenomenon backed by legislation, since the decree-law 162/2019 opened the doors for the legalization, with a specific law mechanism, of these communities. This way, market participants can establish a bilateral contract between them, so that exists a law instrument that regulates the buying and selling transactions of energy they will establish. Setting the regulatory scene for the spread of this communities throughout the country will ease the appearance of flexibility services. These will facilitate the interaction between different communities and enable demand side management to optimize the consumption of individual users, as well as groups of people sharing energy.
Status of real-time monitoring of energy consumption and generation in	For the real-time monitoring of energy generation and consumption we have to look at two distinct markets: B2B and B2C. For each one of these markets there is a set of platforms that measure generation and consumption in real time [116]. Starting with B2C energy consumption, the pre-defined status of metering is composed by smart meters countrywide. The main energy provider in this market, EDP with approximately 85% of market share, is replacing the legacy meters by smart meters that transmit data in real-time [117]. On the generation side the trend is different because the systems tend to be equipped with smart meters by definition, so that the energy production can be monitored in real time to identify eventual system problems or local defects that need to be corrected. As an example, there is a smart meter, ready from EDP, that can be contracted as a service for granular metering.

the country	In the B2B market, the transition is not as relevant due to the common presence of energy management services at companies. An energy management system typically makes energy measurements in real-time, typically with several meters for higher granularity, and this attenuates the relevance of having generic smart meters [118]. The figure below shows the general tendency of smart meter replacement of standard meters with time. It is clear that standard meters will eventually be irrelevant while smart meters tend to dominate the metering approach, bringing real time measurements with them.  **FIGURE 13 PORTUGAL'S SMART METER COUNT**
Status of integrations of Energy and Non-Energy services in the country	The integration of energy services and non-energy services exists. As a matter of example, EDP Comercial has the service *Funciona* [119]which is an energy service with a fixed monthly fee that guarantees that appliances in the house are fixed in case of damage. This enters the area of a comfort-related in an integrated way with an energy supply service. ERSE keeps an eye on the market for these kinds of services. The growth of the additional services is about 50% year on year, since 2016. The regulation tries to keep pace with the services growth and according to the Commercial relations regulation, the services have to follow the rules defined by ERSE [120]: 1. Non-discrimination; 2. Cost transparency; 3. Keep proportion between costs and benefits for the company and discounts and prices available for services; 4. Information dissemination adequate to information level and means available for it; 5. Guaranteed unique identification of services and their prices relatively to regulated services and their prices;

	6. Guaranteed requirement of availability of regulated services. Although the additional services do not meet the requirements for an activity subject to direct regulation and supervision embarked by ERSE [121], they can be included in existing legislation like the consumer protection rules. Therefore the legislation to regulate the additional services activity: • Law number 47/2014 the establishes the legal regime for consumer protection; • Decree-Law number 24/2014 relative to signed contracts at distance and out of the commercial establishment.
Relevant legislation and policies supporting implementation of the Active EPC	The main legislation supporting active EPC are: • The Decree-law 118/2013 establishes that a provisional Energy Performance Certificate is mandatory for buildings under construction or renovation. Once the building is completed a final EPC has to be emitted and will be valid for 10 years; • The Directive 2012/27/EU on energy efficiency. It is a set of measures promoting energy efficiency in the European Union with the goal of achieving the target of 20% in energy efficiency. It comprises mandatory energy-saving measures, renovating public buildings, energy-saving schemes and energy audits.

6.4. SPAIN

6.4.1. CURRENT STATUS OF EPC IN SPAIN

Overview of the EPC status in the country	The primary legislation addressing energy service market matters in Spain was the “Sustainable Economy Law”, Royal Decree Law 6/2010 [122], which included a section dedicated to the promotion of the ESCO market, which outlined measures consistent with the Energy Service Directive, ESD, 2006/32/EC. With the approval of the 2008–2012 Energy Saving and Efficiency Action Plan, governmental support measures to energy efficiency have included energy service companies as potential beneficiaries, with the aim of encouraging this type of procurement. Nowadays, no specific regulation in the Spanish legal framework on Energy Performance Contracting exists. No precise information was found about the extent to which EPC is used in Spain. Regarding EPC market sectors, although most of the ESCOs in Spain have clients from the private sector, the demand from the public sector is expected to grow in the coming years. Regarding the type of contract, the shared savings model is preferred to the guaranteed savings one. As for the EPC market, there are several important actors in Spain who can be assembled in 4 main groups: EPC providers (ESCOs) and facilitators, clients, financial institutions and decision makers. In Spain there are 1,238 companies registered as ESCOs (Energy Service Companies) [123]. The Spanish EPC Market is presented as a divided one. On the one hand, 7% of enterprises are considered large companies and they have had approximately 50% of market share in recent years. The remaining quota is very fragmented. 93% of the companies -around 1,150- are SMEs registered as ESCOs
EPC-related regulations, directives and policies in the country	The primary legislation addressing energy service market matters in Spain was the “Sustainable Economy Law”, Royal Decree Law 6/2010, which included a section dedicated to the promotion of the ESCO market, which outlined measures consistent with the Energy Service Directive, ESD, 2006/32/EC [17]. With the approval of the 2008–2012 Energy Saving and Efficiency Action Plan, governmental support measures to energy efficiency have included energy service companies as potential beneficiaries, with the aim of encouraging this type of procurement. Nowadays, no specific regulation in the Spanish legal framework on Energy Performance Contracting exists. Nevertheless, plenty of laws related to the energy efficiency field can be found. Noteworthy is the Royal Decree 56/2016 of 12 February [124] that partially transposes the 2012/27/EU directive, mainly in relation to energy audits, accreditation systems for energy service providers (ESCOs) and energy auditors and the promotion of energy efficiency in the production processes and use of heat and cold. In addition, it incorporates a specific definition for EPC art.1. f.: “Any contractual agreement between the beneficiary and the supplier of an energy efficiency improvement measure, verified and supervised during the term of the contract, in which the investments (works, supplies or services) in said measure are paid as a result of a level for contractually agreed energy efficiency improvement or other agreed energy efficiency criteria, such as financial savings or

	contractual savings guarantees”. On September 19, 2017, a Eurostat Guidance Note [125] which shall be also considered in the regulatory framework, was published. Eurostat released this guidance note to ensure an adequate accounting treatment of EPCs in the national account. Criteria to define whether an EPC should be considered as public debt or not were established. However, the new Guidance Note has not yet had a real impact due to the political instability that has influenced the slowdown in the decision-making processes of public bodies in Spain. The new Directive 944/2019 [8] concerning common rules for the internal market in electricity and the new Regulation 943/2019 [126] concerning the internal market in electricity will enable active customers, energy communities, aggregators and independent aggregators to play a decisive role in the electricity market. With this new regulation, the principles of a new configuration of the electricity market are established, which will provide incentives for flexibility services and appropriate price signals for the energy transition. Specifically, the active customer, demand response and storage become key elements in the new regulatory framework. Spain has a period of 18 months from the entry into force to adapt the Spanish national regulation to the European standard, which will be an important boost for the development of business in the sector.
Main types of EPC implemented	No precise information was found about the extent to which EPC is used in Spain. Regarding EPC market sectors, although most of the ESCOs in Spain have clients from the private sector, the demand from the public sector is expected to grow in the coming years. Regarding the type of contract, the shared savings model is preferred to the guaranteed savings one (IDAE 2011; EC JRC 2012). In recent years, more ESCO projects offer EPCs based on the shared guarantees model in most of the new public contracts with the local authorities. ▪ **Guaranteed Savings:** Under a guaranteed savings EPC-based project, the ESCO designs and implements the project and guarantees the energy savings, thus shielding the client from any performance risk (including technical and implementation risks). If the savings are less than the guaranteed level, the ESCO covers the shortfall. If the savings exceed the guaranteed level, the additional savings are shared between the ESCO and client. ○ Typically used if customer provides upfront investment through financial tools offered by a third part different from ESCO (for example undersigning a loan with financial institutions). ESCO can help customer in funding process; ○ ESCO is appointed by customer for plant management and maintenance operations. Customer pays a fee for these services; ○ A minimum target for energy saving is agreed between customer and ESCO; ○ ESCO assumes performance risk since if threshold target is not reached a compensation is due by ESCO to customer. Loan instalments may optionally (even if it is very uncommon) be indexed to effective energy-savings (pay from saving option). ▪ **Shared Savings:** Under a shared savings EPC-based project, the savings are split in accordance with a pre-arranged percentage: there is no ‘standard’ split as this depends on the cost of the project, the length of the contract and the risks taken by the ESCO and the consumer. The differences

	between the two approaches relate also to the payment arrangements, the primary technical focus, and the allocation and apportionment of energy savings. ○ Customer and ESCO agree to share investment cost and/or energy savings. Many options in this sense are possible but usually ESCO bears the whole investment cost (or the main part) with its own resources or through third part financial tools. Benefits of energy savings are shared between customer and the ESCO itself; ○ Contractual clause about minimum threshold for annual plant operating hours can be included for protection of ESCO; Contractual clause about guaranteed minimum threshold efficiency of the plant can be included for protection of the customer.
Main actors involved in current EPC	There are several important actors in the EPC market in Spain. They can be assembled in 4 main groups: EPC providers and facilitators, clients, financial institutions and decision makers. ▪ **EPC providers and facilitators** This group includes any agent working on the energy efficiency field. ▪ EPC providers: they are ESCOs who deliver energy services in the form of EPC. The EPC provider bears the commercial and technical implementation and operation risks and guarantees the outcome and all-inclusive cost of services for the duration of the contract. It is important to create long-term partnership between the provider and the customer based on their common goals. Providers should also offer training on the new measures implemented for the customer's operational staff. ▪ EPC facilitators: they are usually consulting companies that assist the client on the preparation. Traditionally organizations start by engaging an energy consultant to identify opportunities for energy savings, ranging from operating practices, to maintenance, control and equipment investment. National Associations: EPC providers and/or facilitators usually create these associations with the aim of creating lobbies and keeping up to date with all the news of the sector. Among them all, ANESE [127], the National Association of Energy Services Companies, benchmark for investment in energy saving and efficiency. Specifically, ANESE is a non-profit business platform that aims to structure the Energy Services market, a novel business model with great business opportunity. ▪ **Clients** Those who are interested in developing EE measures, usually owners or tenants of facilities/premises. ▪ **Financial institutions** A third party that finances the EPC provider, the customer, or a combination of both. ▪ **Decision makers** In this group, all public bodies that make decisions and contribute to the adoption of laws and policies related to the energy efficiency field

	are included. Some of these public bodies are the Government, IDAE or regional energy agencies, among others.
ESCO market overview in the country	The Energy Efficiency services market in general, and particularly the EPC market, are both growing. Thus, there is an important number of specialized companies within the sector. According to IDEA (El Instituto para la Diversificación y Ahorro de la Energía, The Institute for Energy Diversification and Saving) [128] there are 1,238 companies registered as ESCOs (Energy Service Companies). The Spanish EPC Market is presented as a divided one. On the one hand, 7% of enterprises are considered large companies and they have had approximately 50% of market share in recent years. The remaining quota is very fragmented. 93% of the companies -around 1,150- are SMEs registered as ESCOs The JRC's report [4] states that the most common types of ESCO projects in Spain include public lighting, public buildings (municipal offices and health care facilities) and water supply renovations. ESCO projects in the private sector have been carried out in hotels, corporate buildings, sports facilities, heating systems in apartment buildings, and big industries. The JRC's report states that it is generally known that EPC-based projects are mainly used in the private sector and that the shared savings model is preferred to the guaranteed savings one (IDAE 2011; EC JRC 2012). In recent years, more ESCO projects offer EPCs based on the shared guarantees model in most of the new public contracts with the local authorities. Regarding the demand of EPC projects, the JRC's report states that offices, hospitality, commercial and residential buildings are the main targets for EPC within the private sector, while in the public, the EPC solution has been broadly used in the management of municipal lighting systems. **Standardisation for energy efficiency services** Energy efficiency services are not widely standardised in Spain. No project implementation guidelines have been approved by any official body, so private entities execute projects under their own criterion. A model document to be adopted exists, but in this aspect public and private sectors need to be studied separately: If the EE service client is a public body, then it is quite common to use the model contract designed by IDAE in cooperation with the Spanish Federation of Municipalities and Provinces (FEMP). Although it is not mandatory, the Public Administration usually asks for this contract model [129]. On the other hand, if the EE service client is a private entity, there is no contract model established. In this case, both parties negotiate and agree on terms and clauses to include in the contract. Nonetheless, ESCOs generally have their own contract model. **ESCOs Certification Schemes** In Spain, an ESCO registration system and several ESCO certification schemes have been implemented to date. The latest certification scheme for ESCOs is defined under a new standard (UNE 216701) [130] and is the only ESCO certification scheme in Spain which applies

certification according to international standards. 9.14.1 ESCO registration

In order to increase awareness about energy service companies, the IDEA has created a database of ESCOs based on the information they have submitted to their regional authorities. This information is sent to the Ministry of Industry, Energy and Tourism (MINETAD), in accordance with Royal Decree 56/2016. All companies operating in the energy sector are required to be registered. To be registered, a declaration must be issued in which the owner of the company or its legal representative demonstrates that the enterprise meets a set of mandatory requirements.

Certification of EES providers according to the UNE 216701 standard

Currently the most widely used system of certification for ESCOs is the system established by Association for Standardization and Certification (AENOR) in 2016 and subsequently became standard UNE 216701 – "Classification of energy services providers" published in May 2018 by UNE (Spanish Association for Standardization). UNE was created by the separation of two parts of AENOR into UNE, which is the only Standardization Body in Spain and AENOR [131], which has now become a solely independent certification body. UNE represents Spain in the international (ISO / IEC) and in the European (CEN / CENELEC) standardisation organisations.

In the original standard, ESCOs were divided into the following categories; auditing/consulting, exploiting and/or investment ESCOs. The criteria also consider the previous experience and capabilities of the company such as turnover, number of technicians, total amount of contracts and regions of Spain where the company operates.

In 2018, a new category was added for new ESCOs that have no previous experience but want to be classified.

To date, 64 certifications have been issued to 32 ESCO companies. This is the most widely used certification in Spain, and it is getting increasing recognition among clients as well financial institutions.

The classification of ESCOs establishes clarity and confidence in the market regarding the different types of ESCOs that exist based on their service offerings. Moreover, it defines the parameters within each category that allow them to be objectively compared.

The new standard has been promoted by some of the most important associations of the sector: ATECYR, AMI, A3e and ADHAC.

This certification, according to the Spanish Procurement Law, can be required in Public Procurement.

Certification of EES providers by ANESE [132]

In 2015, the ANESE launched the first certification for ESCOs. ANESE offers two types of certification: ESE certificate for companies that have not yet implemented any project following the ESCO model but are established to do so. ESE PLUS certificate for companies that can prove with evidence that they have worked following the ESCO model.

Currently, 13 companies are certified as ESE PLUS.

Certification of energy efficiency services

	There is no official certification of energy efficiency services in Spain however, a few companies are developing their own certificates, especially under projects within the European Union's Horizon 2020 research and innovation programme framework

6.4.2. CURRENT STATUS OF DEMAND RESPONSE AND OTHER FACTORS ENABLING THE ACTIVE EPC IN SPAIN

Overview of DR status in the country	Today, Spain relies mostly on hydro and gas for its flexibility needs. As Spain is evolving towards more distributed energy generation, the need for flexibility is expected to increase in the coming years. While Spain is the first country in the world where the default price for households is based hourly spot prices and could thus drive important progress for Implicit Demand Response, and even though some smart grid pilot projects are in place, the development of Explicit Demand Response is limited to industrial consumers. Aggregation is still not legal in the Spanish electricity system and currently there is only one scheme allowing Explicit Demand Response: The Interruptible Load programme. The scheme, which is reserved only for large consumers, is managed by Red Eléctrica de España (REE) the sole TSO of the Spanish electricity system. The programme acts as an emergency action, in case the system is lacking generation and there are insufficient balancing resources. Although annual tests are conducted, this programme has not been called on for several years. Regarding distributors system operators DSO, there are 5 large DSO (operated by Endesa, Iberdrola, Union Fenosa, Hidrocantábrico and E.ON) that cover >90% of the system revenues. Even though aggregators are not recognised in Spain, the role of “representatives” exists, which sell energy in the name of their “representees” and build balancing perimeters, thus minimising deviations from programme and resulting penalties. It is, however, believed that the TSO and relevant stakeholders have started conversations for the future opening of these services to flexible demand. The new Directive 944/2019 concerning common rules for the internal market in electricity and the new Regulation 943/2019 concerning the internal market in electricity will enable active customers, energy communities, aggregators and independent aggregators to play a decisive role in the electricity market. With this new regulation, the principles of a new configuration of the electricity market are established, which will provide incentives for flexibility services and appropriate price signals for the energy transition. Spain has a period of 18 months from the entry into force to adapt the Spanish national regulation to the European standard, which will be an important boost for the development of business in the sector.
Current status of implicit DR in the country	Implicit demand response refers to consumers who choose to be exposed to tariffs in which the electricity price varies reflecting the value and cost of electricity in different periods. Example: PVPC/VPSC in Spain. The VPSC or Voluntary Price for Small Customer, is the system for establishing the price of electricity introduced by the government for customers in the regulated market with a contracted power that does not exceed 10kW. On 28 March 2014 (Royal Decree [133]) the VPSC tariff replaced the Last Resort Tariff (LRT). When the TUR system existed, the price of electricity was set at quarterly auctions between power generators and electricity suppliers.

<table>
<tr><td></td><td>This disappeared with the PVPC system, and new market conditions were introduced by which prices vary every hour of the day depending on supply and demand. Different factors influence the rise and fall of the price of the kWh in the VPSC regulated tariff system.

There are 3 options within the VPSC:

• General tariff: Prices vary little throughout the day, being slightly cheaper at night.
• Nocturnal tariff: Two time periods are established, an On-peak period (daytime) and an Off-peak period (nighttime) offering very different electricity prices.
  ○ On-peak period:
    ▪ Winter: From 12:00 a 22:00 h.
    ▪ Summer: From 13:00 a 23:00 h.
  ○ Off-peak period:
    ▪ Winter: From 22:00 a 12:00 h.
    ▪ Summer: From 23:00 a 13:00 h.
• Super Off-peak Tariff Is a tariff that splits the day into three periods. The Super Off-peak period is from 01:00 h to 07:00 h designed to make charging electric vehicles more economical.

All households should have a smart meter connected to the remote management system.</td></tr>
<tr><td>Current status of explicit DR and demand access to the market in the country</td><td>Although some of the markets are open for Demand Response in principle, in practice this applies only for large industrial consumers. Aggregated Demand Response is allowed only for Tertiary Control

Balancing market & Ancillary Services. Currently, aggregated Demand Response does not have access to the balancing market, nor to ancillary services. However, in 2015 a new regulation allowing the participation of generation-based renewables in balancing markets was approved. As such, since 2016, decentralized and renewable energy resources (in particular wind generators) have been able to prequalify and participate in the tertiary reserve which is an important development in paving the way for aggregated Demand Response to participate in this market.

Interruptible Contracts. There is an available capacity of 2,000 MW of demand reduction in peak hours. In 2015 3,020 MW of interruptible load was assigned; while in the auction for 2016, 2,890 MW of interruptible demand was assigned, with a total cost of €503 million. The requirements to take part in the interruptible demand service are defined by the Ministry of Energy. The National Regulatory Authority reports on the relevant legal disposition and overviews the related auction.

Depending on the notification time (from zero to two hours) and duration of the interruption (from one to twelve hours), there are five different types of contract. Interruptions can take place for up to 240 hours a year, with a maximum of one interruption per day and five per week.</td></tr>
</table>

	Wholesale market. Only generators, with a production unit of at least 50 MW, can participate as a seller in the wholesale market. Flexibility resources can participate in the spot market, through demand bids with indication of price. Regarding the total market size, in 2015, around 175.97 TWh was traded in the day-ahead market, and around 28.32 TWh in the intraday market. Capacity Mechanism. The capacity mechanism allows for the participation of generation units only, providing both availability and utilisation payments. In 2013, the availability payment was reduced, and the programme duration extended. **Distribution network services.** Demand-side flexibility could represent an important tool for local congestion management. If needed, DSOs have the possibility to request from the TSO to call the use of the interruptibility service or as for redispatching and curtailmaint of generators. Furthermore, at DSO level, some pilot projects are on-going at city level, such as "Smart City Project" in Malaga, and the "Barcelona Smart City".
Current status of DR product definitions in the country	Interruptible Load Programme: This programme does not allow aggregated demand- side resources to participate. In mainland Spain, the scheme was introduced in 2008, with a threshold of 5MW to participate. In 2014, different conditions were introduced for interruptible loads bigger than 90MW. In 2015, it was made possible to bid with blocks of curtailable load: 5 MW blocks, or 90 MW blocks. For the 5 MW-block product, it is required to have a minimum hourly consumption of the assigned resource (i.e. 5 MW for one 5 MW block), while for the 90 MW-blocks product it is required to have at least the 91% of the assigned resource (i.e. 81 MW for one 90 MW block). In the Canaries and Baleares, the old framework still applies, with a minimum size of 0.8 MW to participate.

Current status of independent aggregators in the country	Overall, there is no possibility for aggregated demand-side resources to take part in the Spanish electricity market. There are no standards at the moment defining their relationship with the BRP and the TSO. Aggregators are not accepted in the market. Only consumers with contracted power above 5 MW have access to interruptible demand service managed by the TSO. The concept of aggregator for Demand Response does not exist in the Spanish regulation, however, individual customers can directly participate in the wholesale market. There is no involvement of aggregation in the interruptible contracts programme, it is limited to large industrial consumers, connected to the HV grid. Industrial energy consumers involved in this scheme come from the construction industries (steel, concrete, glass, etc.), or other material factories (paper, chemicals, etc.) and desalinisation plants (in the Canarias Islands). The participants must have an ICT system, which links them directly to the TSO and not to the DSO where they may be connected. If, however they are connected to the DSO's network, the DSO does not participate, and it is not even able to forecast it in advance. The retailer's imbalance is directly corrected by the TSO, taking into account its reduction order. The baseline is set individually, and the available capacity is tested around twice a year. Lastly participants have to send the forecast to the TSO monthly for the following two months. In 2011, there were 152 interruptible customers in Spain, offering reductions of about 2,200 MW. In 2014, the assigning of interruptible capacity and the linked payments was done by the TSO through public auction, where customers satisfying the requirements for the service could participate. The load curve was registered during the whole interruption event in order to verify the fulfilment of the order, and penalties were applied when customers did not reduce their power by the agreed amount. Imbalance settlement after load management. Participants in the interruptible load programme are directly in contact with the TSO via their ICT system. The retailer's imbalance is directly corrected by the TSO, which takes into account its reduction order, although as the programme has not been activated within the last decade, this provision is symbolic.
Current status of regulations/policies supporting aggregation of resources in the country	The figure of the aggregator that is not currently recognised in Spanish legislation while the European Union has included it in the Directive 944/2019 concerning common rules for the internal market in electricity, that Spain will have to transpose by the beginning of 2021. The energy communities are a legal entity with voluntary and open participation controlled by shareholders or members who are individuals, local authorities or companies, whose main objective is to offer economic benefits to its members or to the locality in which it carries out its activity. The idea considered by the Government was to adopt a regulation this year 2019 that would allow local markets to be organized to facilitate the management of distributed resources. The objective was that traditionally passive consumers, thanks to the incorporation of "resources" of local electricity production, such as the installation of batteries or demand management, could become active producer-consumer behaviour "prosumers". However, political instability brings this planning to a halt.
Current status of	Ministerial Order ITC/3860/2007, of 28 December [134], stipulated that "All meters in electricity provisions with a contracted power of up to 15 kW must be replaced by new equipment that provide an hourly breakdown and remote management before 31 December

transparent measurement and verification standards in the country	2018". Due to this order, Spain has been the first in Europe to fit 'smart' electricity meters in 100 % of homes and businesses". Meter readings are sole responsibility of the Distribution Company for the zone where the point of supplies located (Royal Decree 1718/2012). If the meter is not accessible then customers themselves must provide the readings to the zonal Distribution Company periodically, in order to allow the reseller to be informed of the correct consumption to be invoiced. For all of these advantages and qualities, the remote management meters are considered as a key element of the new energy model, based on efficiency and sustainability, they allow developing smart grids, integrating renewable energy and making the demand more flexible. The IEC 60870-5-104 standard, also known as IEC 104, is an industrial protocol, extension of IEC 60870-5-101, for short IEC 101, which deals exclusively with telecontrol, monitoring and communications related to the SCADA system. In general, it is used in the electrical sector for the automation of substations and generation plants. The IEC 104 protocol improves the IEC 101 version in the services provided in the network, transport, physical and link layer of the OSI model, since it allows connectivity or total access to the network via TCP/IP. The IEC 104 protocol is responsible for transporting information from the RTU (Remote Terminal Unit), IED (Intelligent Electronic Devices), Gateway or communications servers to the SCADA system.
Current status of regulations/ policies and best practices supporting demand-side flexibility on building-level, for instance in the context of Energy Communities or in other situations if	Spain does not yet have specific regulations on local energy communities. Royal Decree-Law 15/2018, of 5 October 2018 [135], on urgent measures for the energy transition and consumer protection, is a first step in the political will towards the positive legal development of renewable energies, which is an open door to speeding up the transposition of these European Directives in Spain. Instead, the Royal Decree 244/2019, of 5 April [136] completes the regulatory framework on self-consumption, promoted by Royal Decree-Law 15/2018, which repealed the so-called sun tax, providing certainty and security to users. In particular, it develops: • the administrative, technical and economic conditions of self-consumption of electric energy, • defines the installations close to self-consumption purposes, • develops individual and collective self-consumption, • provides for a simplified system of compensation between consumers' deficits and the surpluses of their own consumption facilities, and • organises the administrative register of self-consumption of electricity as well as its registration procedure which will not impose an administrative burden on consumers. The Royal Decree enables various possible configurations for generation facilities that may be: • individual, when there is only one consumer associated with the installation or • collective, where there are several consumers associated with the same generation facility. The figure of collective self-

applicable	consumption allows, therefore, self-consumption facilities in communities of owners or industrial estates. Generation installations can be connected in different ways, so they will be: • nearby installations in an internal network, when they are connected to the consumers' internal network, or • installations close to the grid, when they are connected to low voltage networks that depend on the same transformation centre, or are connected less than 500m from the consumer, or are located in the same cadastral reference as the consumer. In addition, it introduces a simplified compensation mechanism that will allow consumers to reduce their electricity bill, compensating for their surplus energy produced and not consumed by themselves. **Modalities of self-consumption:** • WITHOUT surpluses. When antivertide systems exist that prevent the injection of excess energy into the transport or distribution network. In these facilities, technological development is combined with the commercial progress of storage with batteries, which allows better management of peak demand while reducing pressure on the distribution networks. In this case there is only one type of subject: the consumer. • WITH surpluses. When generation facilities can, in addition to supplying energy for self-consumption, inject surplus energy into the transport and distribution networks. In these cases, there are two types of subjects: consumer and producer. Installations with surpluses may be: • WITH surpluses WELCOME to compensation In this mode, energy that is not consumed by itself instantly is dumped into the grid so that at the end of the billing period (a maximum of one month) the value of that excess energy will be compensated in the consumer's bill. Individual and collective installations connected to an internal network that meet the conditions described in the Royal Decree may opt for this modality. • WITH surpluses NOT WELCOME to compensation In this mode, energy that is not consumed by itself instantly is dumped into the grid and sold, obtaining for it the price of the electricity market.
Status of real-time monitoring of energy consumption and generation in	Red Eléctrica, the sole TSO of the Spanish electricity system, provides graphs that show, in real-time, the electricity demand on the Spanish peninsula. The graphs include data, updated every ten minutes, of the actual demand, the forecasted demand and the scheduled demand, as well as the maximum and minimum values of the daily demand.

the country	

FIGURE 14: ELECTRICITY DEMAND TRACKING IN REAL TIME, ASSOCIATED GENERATION MIX AND CO_2 EMISSIONS [137]

Along with the graphs, information is shown regarding the different production technologies or generation mix necessary to meet the demand, including the energy to be exported and that corresponding to pumped storage consumption.

In addition, it also shows the CO_2 emissions associated to the complete set of power generation facilities on the Spanish peninsula, which represents approximately 28% of the total emissions.

Along with the generation mix, the total CO_2 emissions produced by the complete set of power generation facilities on the Spanish peninsula are presented and detailed by energy sources.

Such emissions are calculated by associating to each technology the emission factor established in the Spanish Renewable Energy Plan 2005-2010, in line with the Decision of the European Commission 2007/589/CE.

The actual demand (yellow curve) shows the instantaneous value of electricity demand.

The demand forecast (green curve) is drawn up by Red Eléctrica based on historical electricity consumption data from similar periods, adjusting it by using a series of factors which influence consumption, such as working and seasonal patterns, and economic activity.

The hourly operating schedule (stepped red line) shows the scheduled production of the generating units which have been allocated the responsibility of supplying the electricity required to meet the forecasted demand. The schedule and allocation is established through

	the matching of the day-ahead and intraday markets, as well as the deviation management and tertiary control markets. Red Eléctrica, based on the evolution of the electricity demand, manages the latter two markets. The interval-based electricity demand graph also enables the peninsular demand to be analysed during different periods of time and helps check uniform behaviour in the daily demand
Status of integrations of Energy and Non-Energy services in the country	Royal Decree 107/2007 of 20 July [138] approved the RITE, the Regulation of Thermal Installations in Buildings, (RITE) that establishes the conditions that must be fulfilled by heating, air conditioning and hot water installations designed to meet the demand for thermal wellbeing and hygiene, in order to achieve the rational use of energy. In Spain, the RITE, in its 2009 update (RD1826), specified the ideal temperature in the environment in both summer and winter: <table><tr><th>Season</th><th>Temperature</th><th>Relative humidity</th></tr><tr><td>Winter</td><td>21-23°C</td><td>40-50%</td></tr><tr><td>Summer</td><td>23-25°C</td><td>45-60%</td></tr></table>At this time, the Ministry for the Ecological Transition has opened the public information period of the Royal Decree Project amending Royal Decree 1027/2007, of 20 July, approving the RITE. The recent adoption of Directive (EU) 2018/844 of the European Parliament and of the Council, amending Directive 2010/31/EU on the energy performance of buildings, makes it necessary to transpose the amendments introduced by this directive into the legal system, especially with regard to the introduction of new definitions and modification of existing ones, such as technical installation. Also, in this new version of RITE, new obligations are established regarding the automation and control systems of these technical installations, when technically and economically feasible, to monitor and adapt the energy consumption of the building on a continuous basis. In addition, the measurement and assessment of the overall energy performance of these installations and the modification of the inspection regime are established. The text of the proposed Royal Decree also indicates that with the approval of Directive (EU) 2018/2002 of the European Parliament and of the Council, amending Directive 2012/27/EU relating to energy efficiency, it is necessary to transpose additional modifications, as well as new provisions relating to energy efficiency in buildings and their installations. In this way, the obligations related to the accounting of heating, cooling and hot water consumption are modified, as well as the need to have a remote reading of these and the rights related to billing and information on billing or consumption. In addition, this modification of RITE adapts various aspects within its scope of Directive (EU) 2018/2001 of the European Parliament and of the Council on the promotion of the use of energy from renewable sources, as well as European regulations on eco-design and labelling of energy-related products. Other innovations include passive systems that allow buildings to be air-conditioned without the

	use of additional energy.
Relevant legislation and policies supporting implementation of the Active EPC	The technical and economic conditions for self-consumption are regulated by the Royal Decree 900/2015 of 10th October 2015 [139]. According to this regulation, two modalities for self-consumption are contemplated: i) consumers with on-site RES generation capacity < 100 kWp for self-consumption (excess energy fed into the grid is not remunerated) and ii) consumers with officially registered generation facilities for self-consumption, who could optionally perceive economic remuneration for the energy injections to the grid, according to the specific regulation in place for the generation technology in question. In any case, installed generation capacity must be below the consumption contracted capacity. Under both modalities, the consumer with self-consumption must pay for a series of regulated charges to contribute to economically sustain the electricity system costs under the following conditions: • Network access tariffs, including a volumetric charge and a capacity charge, applied respectively on the hourly net demand supplied from the grid and on the contracted capacity, controlled in the connection point to the grid (net capacity). • Charges associated to the electricity system regulated costs, aimed at recovering regulated costs such as renewable energy subsidies, the budget deficit annuity and the extra costs from non-peninsular systems. This charge would be applied on total hourly consumption, i.e. the electricity withdrawn from the grid plus the self-consumed energy. • Charges for other services of the system, or “support charge”, which is a specific charge determined by the Ministry of Industry and energy aimed at recovering the costs incurred by the system to support the connection of self-consumption, which would not be necessary if the prosumer were not connected to the grid. This charge would be applied on hourly self-consumed energy. During a transitional period during which the charges associated to the electricity system regulated costs are to be defined, the contribution to grid and system costs will temporarily be done through a capacity charge (€/kW) and a volumetric charge (€/kWh), applied on self-consumed energy and the capacity actually required for self-consumption, i.e. the difference between the total contracted capacity for consumption and the capacity actually measured in the connection point to the grid (net capacity). During this transitional period, consumers that are connected to the LV network with installed capacity below 10 kW, consumers living in extra-peninsular systems, and consumers with cogeneration (until December 2019) will be exempted from paying this contribution to grid and system costs.

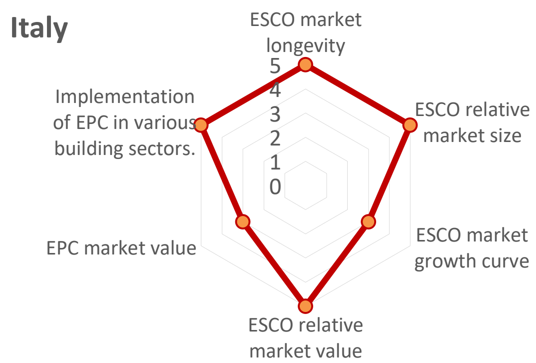
7. CRITICAL ASSESSMENT OF KEY FINDINGS IN THE ANALYSIS AT A COUNTRY LEVEL

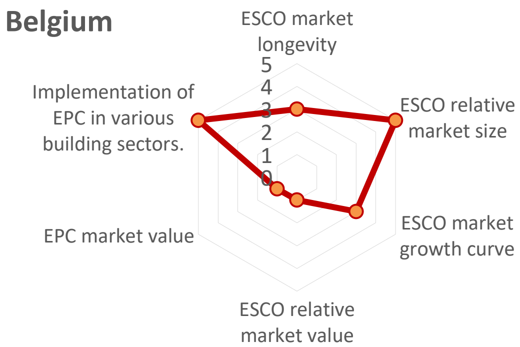
7.1. ASSESSMENT OF EPC/ESCO STATUS

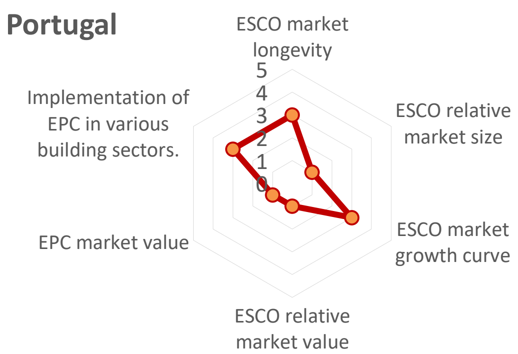
As described in Section 4, six key areas are identified for the critical assessment of the status of EPC/ESCO development, which are:

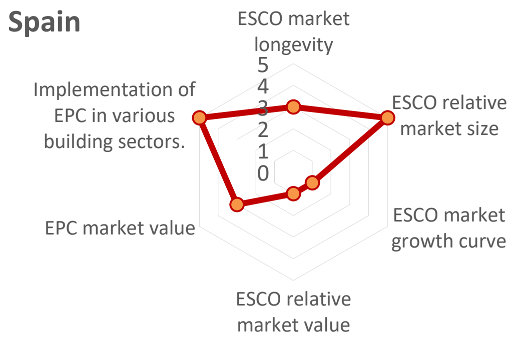
1. ESCO market longevity;
2. ESCO relative market size;
3. ESCO market growth curve;
4. ESCO relative market value;
5. EPC market value;
6. Implementation of EPC in various building sectors.

According to the scoring matrices established, the radar diagrams for Italy, Belgium, Portugal and Spain are presented below.









Moreover, an overall grade is also assigned to each country represented in the consortium with reference to the general status of EPC/ESCO development, based on the scoring matrix established. The map of ESCO/EPC development status is presented in Figure 15 for Italy, Belgium, Portugal and Spain.

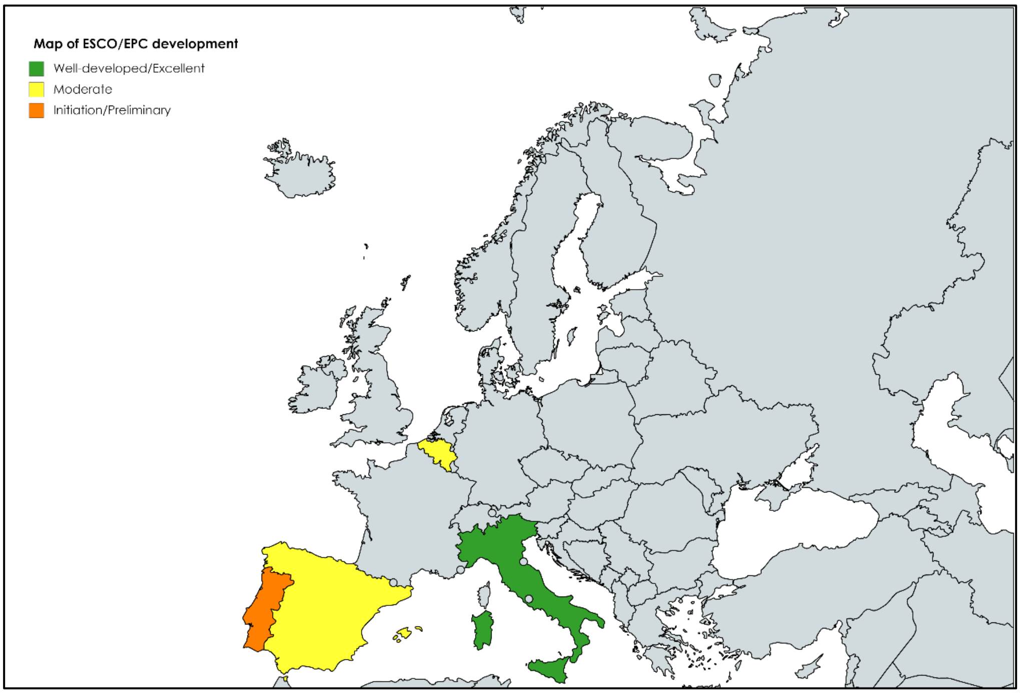


FIGURE 15: MAP OF ESCO/EPC DEVELOPMENT STATUS FOR THE COUNTRIES REPRESENTED IN THE CONSORTIUM

It can be noted that **Italy** is the most advanced country in the consortium, with the highest scores achieved for all the key areas investigated. Overall, the ESCO market in Italy is still considered to be among the biggest and most developed ones in Europe [4]. This is mainly due to the strong legislative background and standards established in Italy for energy efficiency in buildings. ESCO projects, including EPC, have been present in the country for decades. In detail, ESCO market development started with the Ministerial Decree of 20 July 2004, where a first definition of "ESCO Company" was introduced. Since then, the market has grown steadily, also thanks to the mechanism of energy efficiency certificates that represent an important source of income for these companies. There are many associations and industry groups that serve the ESCO market in different ways. These include independent associations, such as AssoEsco and FederEsco, and representatives of utility suppliers and technology providers. In Italy, there are about 1045 Companies certified according to the UNI CEI 11352 Standard, which requires companies to have carried out at least one EPC project to be defined as an ESCO [24]. In the last 5 years, the total turnover of the ESCOs has grown from EUR 1.3 billion in 2014 to EUR 3.7 billion in 2018 [19], [25]. The growth rate in the last 5 years has not been constant. In fact, in 2016 there was a doubling of turnover, followed by a constant growth of around 10% per year. In 2018, the ESCO turnover from EPC has amounted to 35% of the total revenues [25]. EPCs are implemented in all the building sectors, even if their penetration is still low in some market areas, as discussed below.

In the industrial sector, the big companies realised 72% of total investments in energy efficiency for industrial processes, while the remaining part has been carried out by SMEs focusing on both industrial processes and buildings. In both cases a small part of investment (about 12% in average) has been done through the ESCO Companies and using EPC. In 2018, the Home & Building sector including both offices, commercial and residential buildings, has been involved in energy efficiency investments for euro 4.6 billion: most of these investments involved the residential sector (82%), whereas the remaining part is divided between commercial buildings (4%) and private offices (14%). The EPC contracts are mostly used in commercial and offices sector, while their penetration level is low in the residential one. With reference to the Public Administration, the EPC contracts interested about the 35% of their investments in energy efficiency.Italy is followed by Belgium and Spain, which have been characterized by a moderate development of ESCOs/EPC in the last decades.

With reference to **Belgium**, the energy service market is considered stable and moderately sized, although young. Notwithstanding some early trials with ESCO models in the public sector and in the private sector (with a focus on optimizing building controls) in the ‘90s, the real market development started in 2006 with the creation of Fedesco, the Federal Energy Services Company, and its Knowledge center by Fedesco in 2011. Fedesco did not start using EPC until 2011. The Belgian ESCO Association (BELESCO) was created in 2010. The development of the first “new generation” Maintenance and Energy Performance Contract (M-EPC) was initiated in 2011, but the first ESCO contracts in Belgium were only signed in 2016 and 2017. Since then the market grew steadily, in particular since 2016, but still at a moderate rate. It has to be noted that for Belgium, the ESCO market definition is limited to the narrow definition of an ESCO, i.e., a provider of EPC projects. In accordance with this premise, the assessment has been performed with specific reference to EPC projects, and this also explains the different scoring matrices used for this country as specified in Section 4. In the last 5 years, the total number of ESCOs offering EPC has increased from 5 to 205, the number of private EPC facilitators has increased from 2 to 4, and the number of public facilitators or One-stop-shops has increased from 1 to 5. Moreover, in the last 5 years, the number of EPC projects has grown from 3 to over 35, whereas the number of buildings under contract has increased from 20 to over 350. There are no exact numbers on annual turnover for the Belgian market, given the fact that is difficult to determine what can be considered an ESCO contract and what cannot. However, the growth of turnover of EPC contracts can be estimated from a few million in 2014 to roughly 50 million euro in 2018. The annual growth rate is estimated at 50%. Total revenues reached during 2018 are estimated amounting to 50 million euro. As the EPC market corresponds to the ESCO market for Belgium, the size is also estimated at 50 million euro. In Belgium EPCs are implemented in many building sectors. The public building sector is most developed and includes federal and regional government buildings (administrative and office buildings), provincial buildings (schools, cultural centres, etc.) and municipal buildings (town halls, elementary schools, swimming pools, libraries, sports facilities, etc.), secondary schools (both public and subsidized catholic), universities and public hospitals. The private tertiary sector is less developed but includes private elderly homes and some office buildings. There are little to no examples of retail, hotels and private hospitals although there is no reason why they should not see development in the coming years. Some ESCOs focus on small or medium sized companies, often in the industrial sector. In this case, energy conservation measures are mainly focused on the building (heating, cooling, lighting, etc.) and not on the processes. There are a few projects in social housing, multi-apartment buildings, but not on individual houses. Similarly, there are some projects on private co-owned, multi-apartment buildings. However, they are often focused on boilers and combined heat and power (CHP) systems. Some pilot projects are providing a one-stop-shop solution for deep renovation of such co-owned private apartment buildings. There is also a pilot project on the deep renovation of multiple individual social housing units. In detail, large ESCOs focus on public buildings and large tertiary or industrial buildings, whereas smaller ESCOs focus on buildings of (industrial) SMEs. Pooling multiple buildings (typically between 5 and 40) is very common in the public sector, much less in the private sector. Ambition levels are relatively low, with typically 20 to 35 % guaranteed savings, with some exceptions of deeper renovation of some buildings in a pool. Comprehensive Refurbishment (CR-EPC) or Deep Energy Retrofit (DER) with EPC is not very common yet, although it is expected to grow.

With reference to **Spain**, the Spanish energy services market has been dormant for a long time, based on the previously introduced, later stopped complex set of governmental support measures. The primary legislation addressing energy service market matters in Spain was the “Sustainable Economy Law”, Royal Decree Law 6/2010, which included a section dedicated to the promotion of the ESCO market, while also outlining measures consistent with the Energy Service Directive, ESD, 2006/32/EC. In Spain there are 1238 companies registered as ESCOs. In the last 5 years EPC total turnover in Spain grew from euro 0.85 billion in 2014 to euro 1.2 billion in 2018 (according to data from the Observatorio Sectorial DBK de INFORMA [140]). In 2016, there was stagnation in the market growth, which recovered in 2017 and 2018 with growth rates around 8% and 9%, respectively. With specific reference to the EPC market, in 2018, it was estimated at around euro 1 billion per year according to [123]. More than 60% of the ESCOs worked with energy efficiency products different than the EPC business model. Regarding the demand of EPC projects, according to [4], offices, hospitality, commercial and residential buildings are the main targets for EPC. In detail, in 2018 the main segment for this type of contract was characterized by offices [123]. It is striking that the weight of the public sector in the client portfolio of Spanish ESCOs is significantly lower than for companies in the sector in other European countries. However, demand from the sector is expected to grow. Another business opportunity for the coming years is the signing of energy supply contracts associated with investment in energy efficiency for industry. Less than 20% of the ESCOs surveyed stated that their clients included companies in the industrial sector, a figure far removed from the European average. In summary, the predominant sectors are offices, retail and leisure, industrial and public buildings.

Compared to the other countries analysed by the consortium, **Portugal** has the lowest scores for the key areas investigated. Indeed, the ESCO sector in Portugal is still underdeveloped and small. The market started to gain traction in 2010 when the Portuguese Government looked at ESCO structures and concluded that it could be a major tool to help the public sector improving its energy efficiency and save on energy budgets. As a result of this, the government created the regulatory framework to facilitate the growth of ESCO’s and their financing mechanisms. In

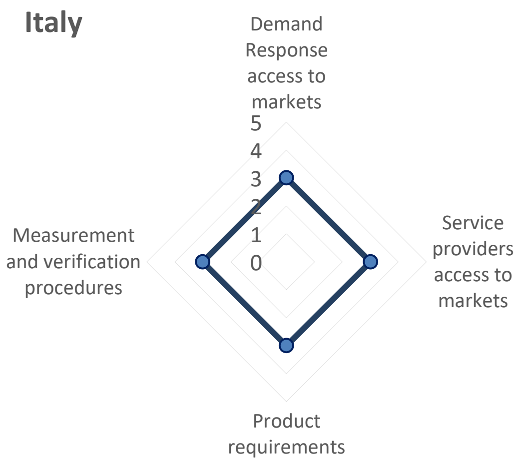
Portugal, 30 companies are registered as ESCOs, and the total market size is estimated to be close to euro 75 million in 2018, with an annual growth rate of about 20% starting from 2014. With specific reference to the EPC market, it hasn't developed at the same speed during the past several years, with a turnover of about euro 30 million in 2018. The number of companies registered as EPC facilitators or EPC providers are no more than 10, so the capability to develop numerous EPC projects in several fields is quite limited. Nonetheless, the projects are spread by different buildings segments, and they are mainly implemented in hotels, hospitals, leisure center sports, schools and public buildings.

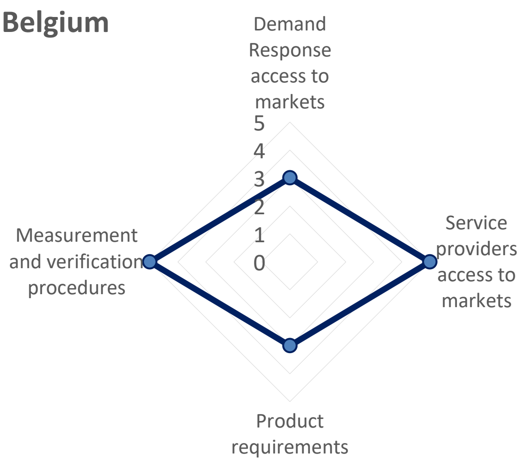
7.2. ASSESSMENT OF DEMAND RESPONSE SERVICES OFFERED BY (CLUSTERS OF) BUILDINGS

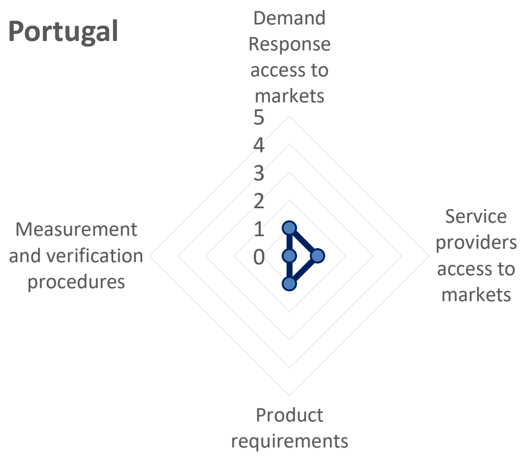
As described in Section 4, four key areas are identified for the critical assessment of the status of DR serviced offered by clusters of buildings, which are:

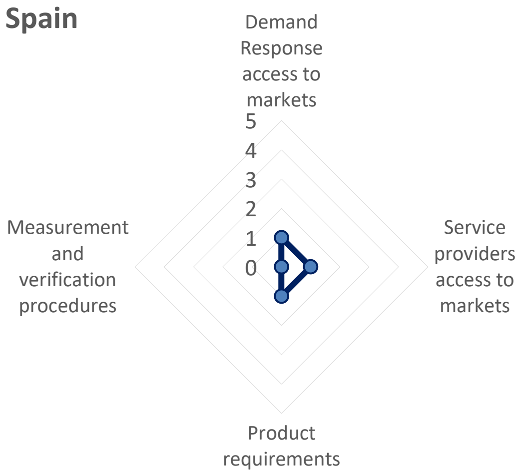
1. DR access to markets;
2. Service providers access to markets;
3. Product requirements;
4. Measurement and verification procedures.

According to the scoring matrices established, the radar diagrams for Italy, Belgium, Portugal and Spain are presented below.









An overall grade is also assigned to each country represented in the consortium with reference to the general status of buildings' flexibility aspects for DR services, based on the scoring matrix established in Section 4. The map of the status of DR serviced offered by clusters of buildings is presented in Figure 16 for Italy, Belgium, Portugal and Spain.

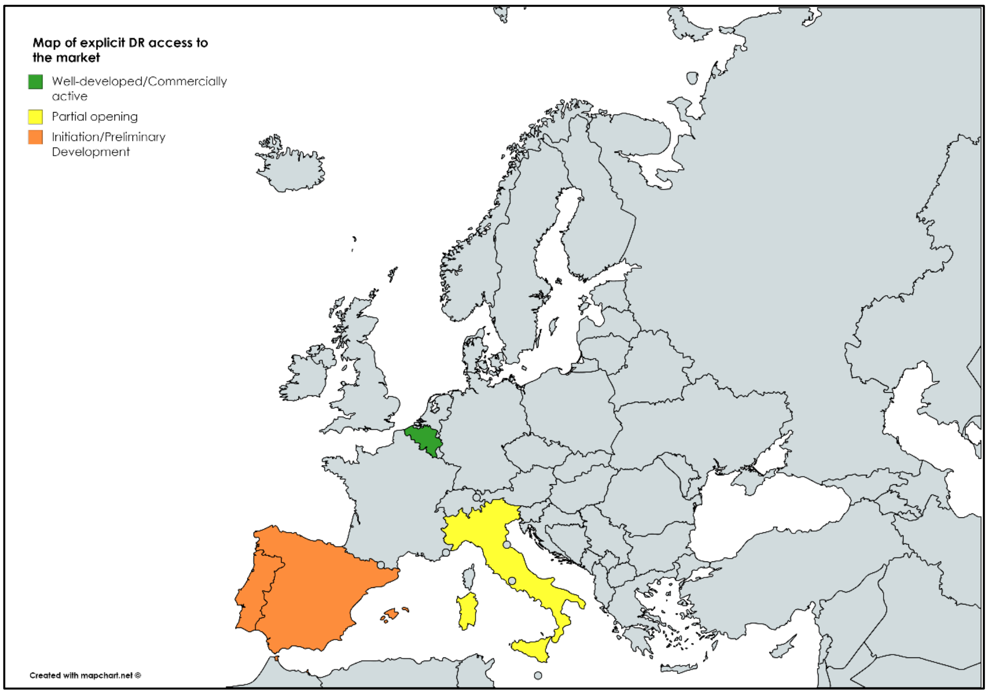


FIGURE 16: MAP OF THE STATUS OF BUILDINGS' FLEXIBILITY ASPECTS FOR DR SERVICES FOR THE COUNTRIES REPRESENTED IN THE CONSORTIUM

It can be noted that **Belgium** is the most advanced country in the consortium, with the highest scores achieved for all the key areas investigated. In fact, over the last years, ELIA created a new framework to enable participation of new energy sources (such as demand flexibility) with new types of market players (such as aggregators). While the implementation of this framework is still ongoing, the end-goal is to “open up the different products and services to all technologies (demand side management, storage), independent to the type of connection (TSO/DSO) and the type of provider (incl. Non BRPs)”. This means that in the near future, all products will be adapted to become accessible to new future market parties. Moreover, independent aggregators are fully accepted in Belgium, referring to the case in which the activation of flexibility involves a supplier and a provider of flexibility services with a separate BRP and/or a provider of flexibility services that is not the appointed supplier. In Belgium independent aggregation is facilitated and no preconditions or contractual relationships between the BRP of the electricity supplier and the flexibility service provider are prescribed by regulation. As for the product requirements, the goal is to have a market in which all products and services, independent of the technology, the type of connection and the type of provider, can access the market. Currently, there are still minor barriers as the implementation of the new, technology-neutral framework is still ongoing. For all market players, apart from consumers who do not yet have a digital meter, measurement and verification is clearly defined and standardized. However, by 2034, all Flemish households will have a digital meter, and the roll-out started in July 2019.

Belgium is followed by **Italy**, for which the relevant regulatory framework has been subject to substantial changes starting from 2017. The Authority ARERA, through the path started with Resolution 300/2017, undertook a complete review process of the MSD towards an opening to the participation of new subjects, with the aim to increase the supply of network services necessary for the national electricity system while also integrating these new subjects more and more into the electricity system. Pending the definition of the new integrated text of the electrical dispatching (TIDE) in consistence with the European Balancing Code, this Resolution has envisaged the launch of pilot projects to test a first opening of the MSD also for flexible electricity demand. Moreover, through this Resolution, for the first time in Italy, the figure of aggregator has been introduced. In detail, it corresponds to the BSP, i.e., the party managing the virtually aggregated units (UVA) and responsible for provision of services traded on the MSD, which does not necessarily have to correspond to the BRP. Indeed, the BSP does not have a contractual relationship with the BRP, by directly providing services to the grid operator, whereas the BRP is responsible for payment of the imbalancing fees. As for the product requirements, similar to Belgium, Italy is experimenting with new forms of participation in the MSD according to the criteria of “technological neutrality” in order to guarantee the supply of network services and improve integration of new subjects in the system.

Therefore, in Italy, after completion of pilot projects of TERNA (UVAC, UVAP, UVAM), it will be necessary to complete the opening, when fully operational, of the MSD to all resources including flexible demand. The assigned scores are thus expected to increase in the near future.

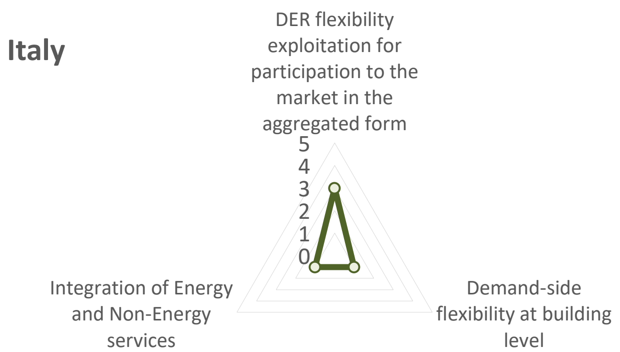
The situation is totally different for **Spain** and **Portugal** which are left behind the other countries, with the lowest scores for all the key areas investigated. Overall, it is found that there is no possibility for aggregated demand-side resources to take part in the electricity markets for these countries. Aggregation is still not legal and currently there is only one scheme allowing Explicit Demand Response, which is the Interruptible Load programme. These countries are indeed characterized by the poorest regulatory regimes regarding DR and asset aggregation, and thus significant barriers still exist.

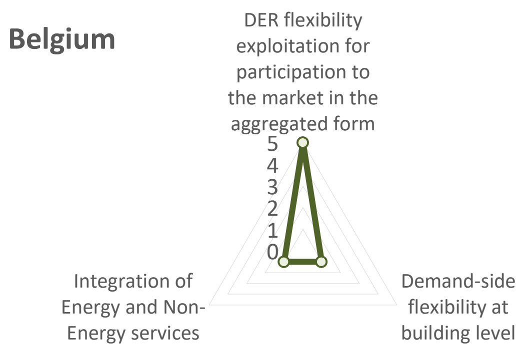
7.3. ASSESSMENT OF OTHER FACTORS ENABLING THE ACTIVE EPC

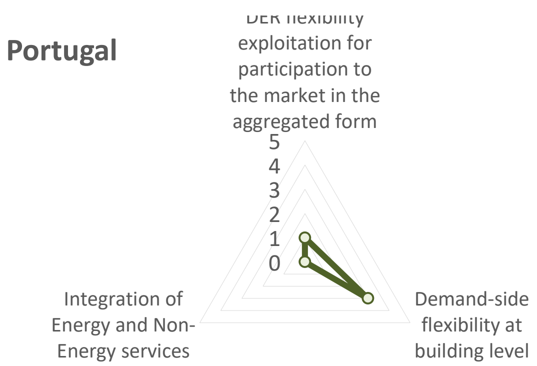
As described in Section 4, three key areas are identified for the critical assessment of the status of other factors enabling the Active EPC, which are:

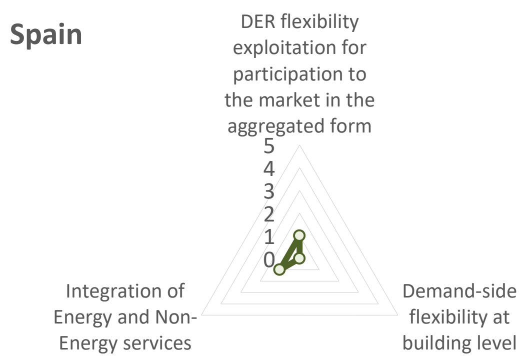
1. DER flexibility exploitation for participation to the market in the aggregated form
2. Demand-side flexibility at building level
3. Integration of Energy and Non-Energy services

According to the scoring matrices established, the radar diagrams for Italy, Belgium, Portugal and Spain are presented below.









In **Italy**, aggregation of DER for participation to the market is currently allowed only within pilot projects, although the revision of the TIDE is currently ongoing in view of the full opening of a range of resources to AS market as demonstrated by the consultation document 322/2019/R/eel launched by ARERA in July 2019. According to the Resolution 300/2017, the forms of aggregation of DER include: UVAC characterized by the presence of only consumption units; UVAP characterized by the presence of only non-relevant production units (programmable and non-programmable resources) including storage systems; and UVAM characterized by the presence of both non relevant production units (programmable and non-programmable resources) including storage systems and electric vehicles when they offer services to the grid in vehicle-to-grid mode, and consumption units. With reference to the exploitation of demand-side flexibility on building level, the policy framework is currently under development as demonstrated by the PNIEC through the measures established towards the exemption of charges on self-consumption for small plants, the simplification of authorizations for self-consumers and renewable energy communities, and the reorganization and rationalization of configurations with self-consumption. However, significant barriers already exist for active engagement of individual consumers or on building level. With reference to the integration of Energy and Non-Energy services, the regulatory framework assesses two Non-Energy services, which are comfort & health and building condition. The D.P.R. 16 April 2013, n. 74 sets the maximum values of room temperature so as to improve the energy savings of buildings while guaranteeing a high level of thermo-hygrometric comfort of indoor environments. Moreover, the Ministerial Decree of 11 October 2017 sets criteria on internal environmental quality for public buildings. With the aim to increase the energy efficiency of new buildings, and so the building condition, the Ministerial Decree 26 June 2015 sets that from 31 December 2018, new buildings or existing buildings undergoing renovation, occupied and owned by Public Administrations have to be nZEB; and that, from 1 January 2021, all new buildings or existing buildings undergoing renovation, both public and private, will have to be nZEBs.

In **Belgium**, independent aggregation of DER is facilitated and no preconditions or contractual relationships between the BRP of the electricity supplier and the flexibility service provider are prescribed by regulation. With reference to the exploitation of demand-side flexibility on building level, in theory, the framework to engage individuals more actively is present. However, in practice, more encouragements and facilitating tools are needed before individual buildings will offer their flexibility. In the short run, some pilot projects will be set up to examine this issue. The integration of Energy and Non-Energy services is only regulated through EPB regulations, by linking E-levels (and specific energy consumption) to ventilation requirements as is described in the table in Section 6.2.2.

DER flexibility is not exploited for participation to the market in the aggregated form both in **Portugal** and **Spain**. Regarding the exploitation of demand-side flexibility on building level for instance in Energy Communities, in **Portugal**, there exist some pilot projects which have started to aggregate energy at demand side, whereas in **Spain**, there is no any policy fostering demand-side flexibility on building level in the near future. Finally, with reference to the integration of Energy and Non-Energy services, in **Portugal**, the relevant regulatory framework is totally absent, whereas in **Spain**, the situation is more advanced, as demonstrated by the Royal Decree 107/2007 of 20

July approved the RITE, the Regulation of Thermal Installations in Buildings, that establishes the conditions that must be fulfilled by heating, air conditioning and hot water installations designed to meet the demand for thermal wellbeing and hygiene, in order to achieve the rational use of energy. It was updated in 2009, and now is under review to include last directives amendments and recommendations.

7.4. EXTENSION OF THE ANALYSIS TO COVER THE OTHER EU MEMBER STATES

In order to provide a complete overview of on the status of ESCO/EPC and of DR serviced offered by clusters of buildings in Europe, the analysis is extended to cover most EU Member States.

With reference to the EPC/ESCO status in Europe, reference is made to [4]. The map of ESCO/EPC development status for the other EU countries is shown in Figure 17.

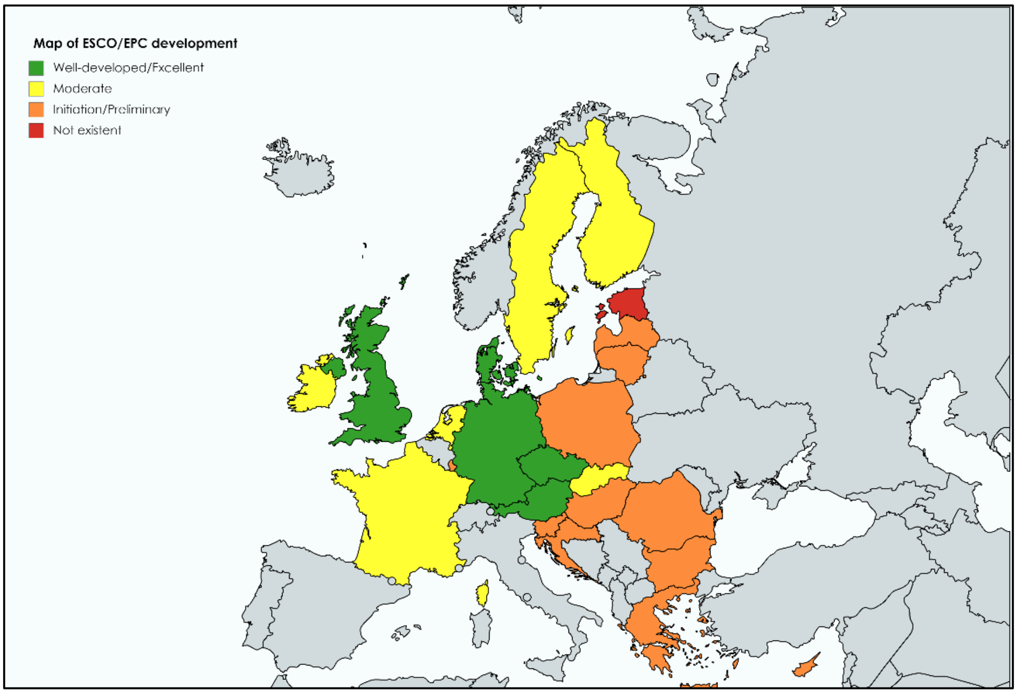


FIGURE 17: MAP OF EPC/ESCO DEVELOPMENT STATUS FOR THE OTHER EU COUNTRIES

Germany, Austria, the Czech Republic and the UK were most recently considered the most active markets. Germany is one of the most established markets, with strong institutional and legal frameworks, whereas Estonia and Malta do not still have an ESCO/EPC market.
The defining characteristics of this market are summarized in Table 3.

TABLE 3: COUNTRY SNAP SHOT ON THE ESCO/EPC DEVELOPMENT STATUS

Well-developed/Excellent	Moderate	Initiation/Preliminary	Not existent
• Austria • Czech Republic • Denmark • Germany • United Kingdom	• Finland • France • Ireland • The Netherlands • Slovakia • Sweden	• Bulgaria • Croatia • Greece • Cyprus • Hungary • Latvia • Lithuania • Luxembourg • Poland • Romania • Slovenia	• Estonia • Malta
Defining characteristics • Well-established institutional context (national ESCO association, etc) • Developed legal framework addressing EPC contracting • More mature market • Wider variety of EPC offerings and project facilitators		**Defining characteristics** • Lack of dissemination of project outcomes • Policy instability and divergent political priorities • Lack of legal framework regarding EPCs and EPC models	

With reference to the buildings' flexibility aspects for DR services, a specific questionnaire has been prepared by the consortium and shared with members of EERA JP SG. In detail, Greece, Cyprus, Norway, UK, Finland and France responded to the survey, whereas for the other countries, the related status of the DR services offered by buildings cluster, has been constructed based on [6].

Similarly to the approach established for the countries represented in the consortium, also for the other EU Member States, four key areas have been investigated, which are:

1. DR access to markets;
2. Service providers access to markets;
3. Product requirements;
4. Measurement and verification procedures.

The related scores assigned to the other EU Member States for the key areas investigated are shown in the figures 18-21.

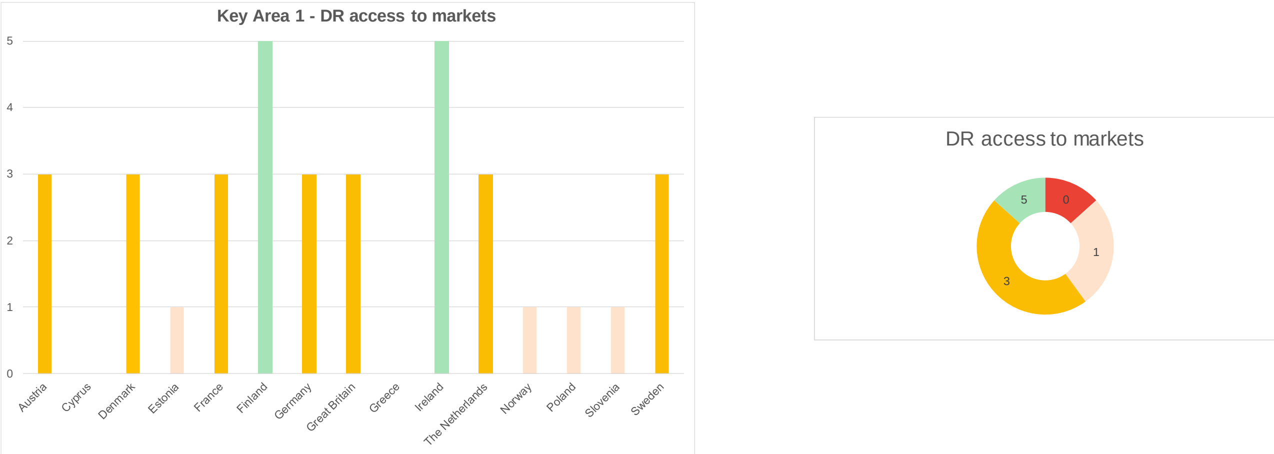


FIGURE 18: SCORES OF THE OTHER EU COUNTRIES UNDER KEY AREA 1 “DR ACCESS TO MARKETS”.

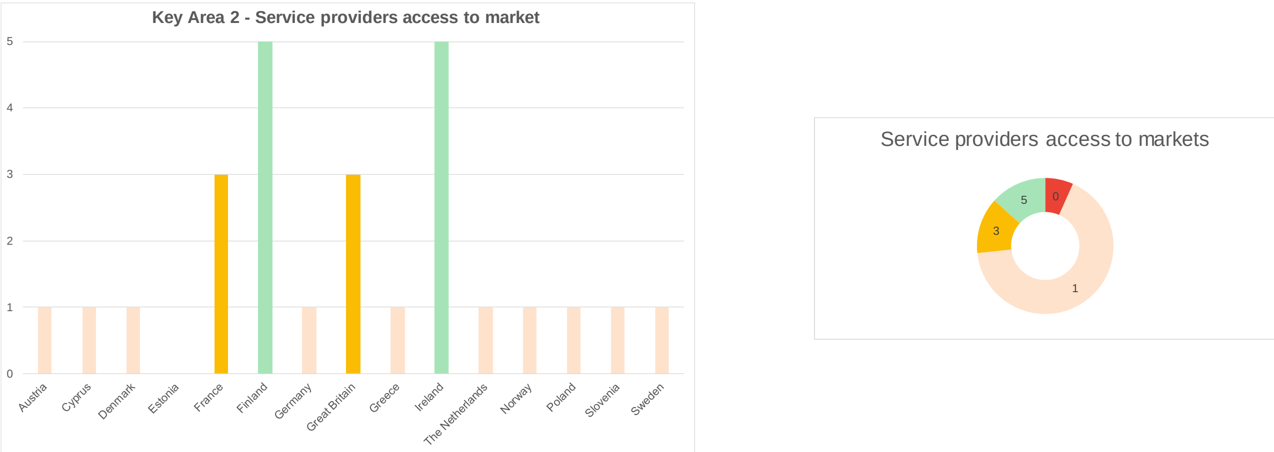


FIGURE 19: SCORES OF THE OTHER EU COUNTRIES UNDER KEY AREA 2 “SERVICE PROVIDERS ACCESS TO MARKETS”.

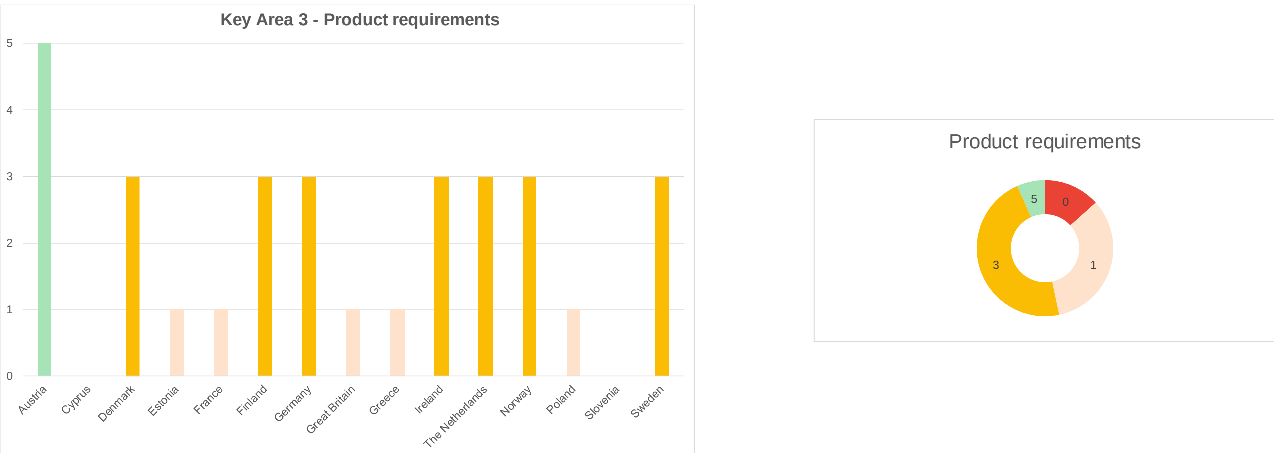
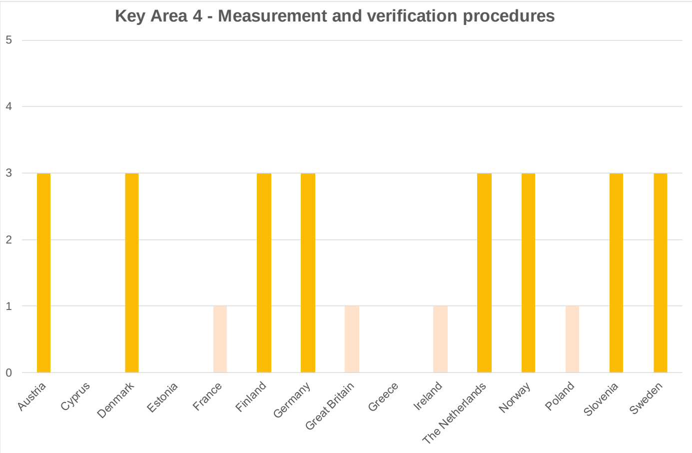


FIGURE 20: SCORES OF THE OTHER EU COUNTRIES UNDER KEY AREA 3 “PRODUCT REQUIREMENTS”.



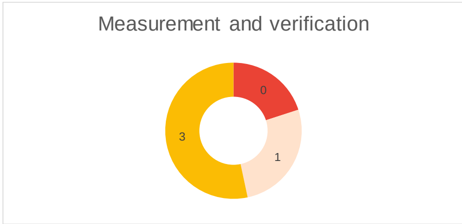


FIGURE 21: SCORES OF THE OTHER EU COUNTRIES UNDER KEY AREA 4 "MEASUREMENT AND VERIFICATION PROCEDURES".

An overall grade is also assigned to the other EU Member States with reference to the general status of buildings' flexibility aspects for DR services, based on the scoring matrix established in Section 4. The related map is shown in Figure 22, whereas the defining characteristics are summarized in Table 4 below. It can be noted that Ireland and Finland are considered the most advanced ones in Europe, whereas Cyprus and Estonia are left behind the other EU countries, since they are characterized by a complete absence of a regulatory framework allowing DR access to the market.

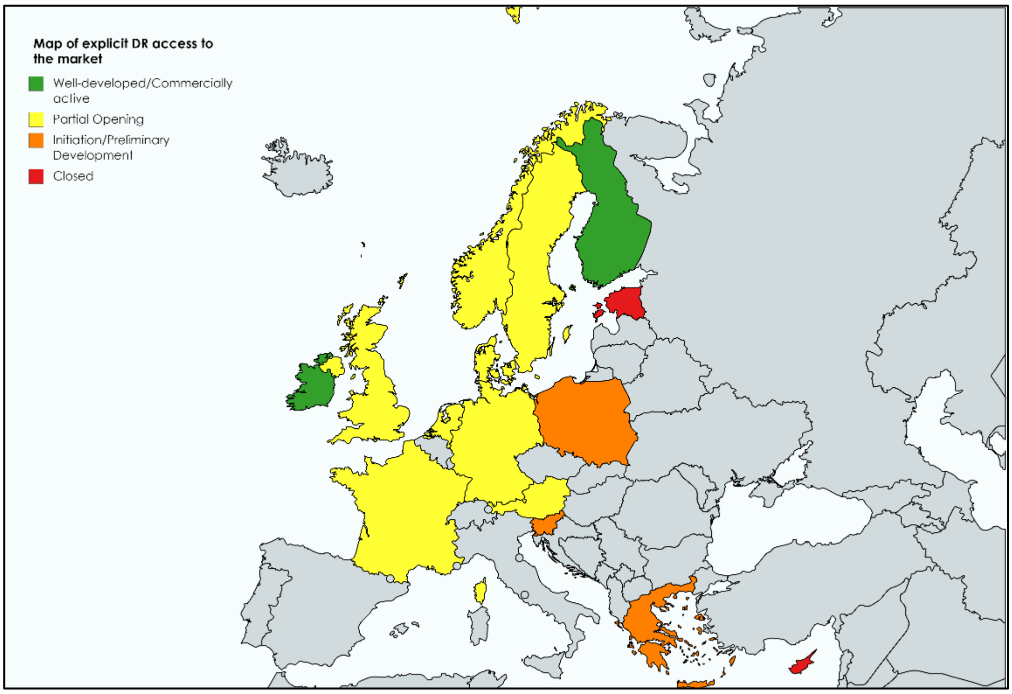


FIGURE 22: MAP OF THE DEVELOPMENT OF BUILDINGS' FLEXIBILITY FOR DR SERVICES FOR THE OTHER EU COUNTRIES

TABLE 4: COUNTRY SNAP SHOT ON THE DEVELOPMENT STATUS OF DR SERVICED OFFERED BY CLUSTERS OF BUILDINGS

<table>
<tr><th>Well-developed/Commercially Active</th><th>Partial Opening</th><th>Initiation/Preliminary Development</th><th>Closed</th></tr>
<tr><td>• Finland
• Ireland</td><td>• United Kingdom
• France
• Norway
• Sweden
• Germany
• The Netherlands
• Austria
• Denmark</td><td>• Greece
• Slovenia
• Poland</td><td>• Cyprus
• Estonia</td></tr>
<tr><td colspan="2">Defining characteristics
• DR participation allowed in multiple electricity markets;
• Product requirements well established according to the criteria of “technological neutrality”;
• Positive cooperation between stakeholders (new market actors, regulators and retailers).
• Benefits for small customer still rather small: revision of requirements ongoing to reduce minimum bid sizes.</td><td colspan="2">Defining characteristics
• Regulation is slow to appear, it needs a faster adoption to enable DR services.
• Insufficient market players (aggregators)
• No dedicated flexibility market;
• High minimum bid size on the existing market (AS market);
• The huge energy-saving potential of building stock has not been realized;
• Lack of economic and contractual incentives;
• Privacy issues for data to be solved;
• High cost for the qualification and M&V equipment to create flexibility from demand side;
• DR participation mainly reflected at the level of research programs.</td></tr>
</table>

8. OVERVIEW OF MAIN ENABLERS AND BARRIERS

Based on the critical analysis performed across EU Member States, the main enablers and barriers for the implementation of the Active Building EPC are derived. In detail, these are identified for each group of key areas which in turn will define the components of the new concept and business model proposed in AmBIENCe.

The main enablers correspond to the ones found in the most advanced countries, and they are summarized in the tables below for each group of key areas investigated.

EPC/ESCO ENABLERS	
Italy	**High competence of the ESCO**: thanks to the introduction of the UNI 11352 certification and to the presence in the company structure of an expert in energy management such as the EGE, the ESCO is perceived by the Customer as a subject with high technical and design skills
	Outsourcing Intervention management: through an EPC contract, in general all the bureaucratic, administrative and management duties connected to the energy efficiency interventions, are borne by the ESCO and this is appreciated by the Customers
	Normative obligations: the preparation of audits and energy audits which are mandatory for energy-intensive Companies, has led them to carry out the planned interventions, in many cases by addressing to the ESCOs
	Incentives management: the ESCO normally manages incentives / deductions granted by law on behalf of the Customer which receives indirect economic benefits. The news about the possibility to transfer the tax credit also to the ESCO subjects, may constitute a driving force for investments also in the residential sector
Belgium	**Existence of a national ESCO association (BELESCO).** Besides a limited budget it has played a key role in creating awareness, promoting best practices, supporting policy makers developing content, organizing networking and customer events, supporting pilot projects, supporting EU and regional innovation projects and participating in the development of tools (e.g. Eurostat compatible models and tender documents/contracts).
	Creation of several so-called public One-stop-shops or facilitators (VEB, Renowatt, etc.). Some of them have chosen EPC as one of the main delivery and financing mechanisms for energy efficiency and building retrofit projects.
	Growing of the know-how about and availability of Eurostat-compatible ESCO financing solutions. This is considered a strong leverage for more EPC projects as no other delivery mechanism (besides the more complex Public-Private Partnerships (PPP)), provides the capacity to deconsolidate investments either totally or at least partially. A lot of work is going on, among others within BELESCO, on partial deconsolidation which will add flexibility which is also a strong enabler.

ENABLERS FOR DR SERVICES OFFERED BY (CLUSTERS OF) BUILDINGS	
Belgium, Italy	**Ongoing revision of the regulatory framework according to the concept of "technology-neutrality"** to guarantee the supply of network services from demand side and improve integration of flexible demand in the market.

	Well-established (or under revision) regulatory framework for accepting independent aggregators with no preconditions or contractual relationships between the BRP of the electricity supplier and the flexibility service provider**.**
	Ongoing revision of minimum performance requirements for the enabling to each ancillary service set in such a way as to maximize the number of units eligible to provide the service so as to promote competition in its supply.
	Standardized and clear measurement and verification procedures for all market players with a digital meter (valid for Belgium).
	Consumers' data availability in real time made possible through the plan established for the roll out of 2G smart meters, which represent an essential element towards the full opening of the markets to new resources (valid for Italy). In such a context, Italy is among the most advanced countries in Europe. The availability of consumer data in real time represents an enabling technological element for the evolution of electricity market by considering demand side response.

OTHER ENABLERS	
Belgium, Italy	**Ongoing revision of the regulatory framework according to the concept of "technology-neutrality"** to guarantee the supply of network services from DER and improve integration of new subjects in the market.
	Policy framework under development envisaging measures towards the **exemption of charges on self-consumption for small plants, the simplification of authorizations for self-consumers and renewable energy communities, and the reorganization and rationalization of configurations with self-consumption** (valid for Italy).
	Comfort & health and **building condition** integrated with energy savings assessments in regulation (valid for Italy).
	EPCs in Belgium include Non-Energy Services (maintenance, comfort and related improved Health benefits and improved productivity, increased asset value, financing), although it differs from contract to contract (e.g. EPC vs. M-EPC) or sector (e.g. public buildings vs. SME buildings) (valid for Belgium).
	Strong legislative background and standards established for energy efficiency in buildings

As for the barriers, they are found for all the countries under investigation, and they are summarized in the tables below for each group of key areas investigated.

EPC/ESCO BARRIERS	
Italy	**Contractual Complexity:** EPC contracts are not standard energy supply contracts, but are characterized by many technical and economic clauses regulating the remuneration and activities of the ESCO (for example the scheduled maintenance). Therefore these contracts cannot be easily interpreted by people with low technical and legal skill.
	Lasting commitment with the ESCO: EPC contracts normally have a medium-long duration (over 5 years) to allow the return of the initial investment through energy savings. This sometimes discourages customers, especially in the industrial sector, due to market uncertainties over a long

	time horizon
	Complex calculation method for savings: EPCs provide formulas and methods for calculating savings that are difficult to understand for the decision makers which do not have sufficient technical skill
	Financial Constraints: some customers are discouraged from signing multi-annual payment obligations with the ESCOs foreseen in the EPC contracts
	Uncertainty of the regulatory framework: the laws regulating the obligations and the economic and fiscal incentive schemes change too frequently not allowing the customer to make long-term projects. As example, in some cases customers decide to postpone the interventions hoping for more favourable future laws, or they prefer not to do more important works, whose realization should involve two consecutive fiscal years, not being sure that the laws of the following year will guarantee the same benefits as those of the current year.
	Critical interaction with the production process: especially in the industrial sector, important energy efficiency interventions could interfere with the customer production process causing problems to the production continuity and therefore economic damages to the customer.
	Difficulty in accessing to the credit both for the ESCOs and for the end customers (in the event that the intervention is done in self-financing).
	Poor technical preparation of the top management: in some cases the decision makers of the companies and the public administration do not have the necessary technical preparation to understand the profit opportunities offered by energy saving interventions.
	Uncertainty about the type of EPC contract to be applied in the public administration: it is not still clear whether the PA can manage an EPC as a service contract, or as a PPP. The difference is not only formal, but substantial because in the case of PPP the contracting station does not have to carry out the executive design (which is instead mandatory in the case of service contract) and it is possible to proceed with an integrated contract (which is prohibited in the case of service contract). The choice depends on the cases and in particular an accurate risk analysis is required from the contracting station to correctly address the EPC to a service contract or to a PPP. Public administrations often renounce to proceed in this field both for economic raisons that prevent the drafting of adequate projects, and for lack of adequate skill of the technical office employees which are not able to define the right administrative procedure for the EPC.
	Absence of historical monitoring data: in many companies, but also in the residential buildings and the public administration, there is no culture of monitoring the overall and partial energy consumptions: this makes difficult to carry out a correct energy audit mandatory for the stipulation of a well calibrated EPC.
	Uncertainty in the evaluation of results: in EPC contracts, clear and precise contractual conditions must be defined, standardized tools are also needed in order to facilitate the unequivocal evaluation of the project and it is also important to use validated monitoring procedures. The lack of these conditions reduces trust in the Customer and represents a barrier to the EPC diffusion.
Belgium	**Complexity of the political system** created a situation in which it is very hard to get coherent and ambitious climate policies in place across the 3 regions and at federal level. Current and recent blockades of the process of creating a strong new federal government and fundamental differences in approaches and priorities in the 3 regions, make it difficult for EPC market stakeholders to engage

	with policy makers to define consistent regulation and policy measures across the country.
	Low energy prices are still a substantial barrier to energy efficiency in general and to EPC specifically. Pressure to lower them even more by taking out of the energy bill non direct energy-related costs (e.g. the cost of green certificates for PV) may make things even worse**.**
	Fundamental and culturally driven conservatism with many decision makers in Belgium, combined with the lack of awareness about the benefits of EPC is still hindering more rapid deployment of EPC
	Subsidy conditions not well adopted to EPC, but focused on input-driven methods using technical specifications, rather than functional and performance-based specifications in tenders**.**
Portugal, Spain	**Administrative barriers:** the public procurement process is lengthy and inefficient and administrative accounting systems are not set up to efficiently realize energy cost savings.
	Lack of knowledge and trust both towards the EPC business model and its providers, and a lack of familiarity of EPC projects from the final users. These barriers are perceived by providers as a main issue to develop the tertiary sector potential.
	Lack of standard and enforced M&V protocols and lack of a neutral third-party institution that certifies the accountability of a particular ESCO. It has been perceived by EPC providers that final users are not 'comfortable' with the current evaluation and measurement of savings methodology.
	Duration of contracts: While EPC providers need such durations, they also see this as a major roadblock, as the level of risk involved in the project may be perceived as too high by the prospect clients due to the long duration of the contracts.
	Financial barriers: There are no suitable financing schemes for the development of ESCOs and ESCO projects. Before the economic crisis, most ESCOs dealt with commercial banks for financing. However, now this source of financing has virtually disappeared. Currently, many ESCOs are financing projects with their own money, which is unsustainable. High transaction costs decrease interest for both the client and the ESCO. ESCOs cannot justify the administrative costs to carry out small projects.

BARRIERS FOR DR SERVICES OFFERED BY (CLUSTERS OF) BUILDINGS	
Portugal, Spain	**Legal barriers:** Lack of regulations flexibility to enable innovation and demand participation to the market
	Market barriers: Limited access to the various market options for demand and DER; Market concentration with high entrance costs; Absence of a clear support schemes for fostering DER penetration in the markets; No market entity, known as independent aggregator, responsible for aggregation;
	Technical barriers: Interoperability of hardware (to allow future aggregation of DER); Cybersecurity issues; Reliability issues (lack of Operational Procedures); DER Data access to third parties not possible
	Social barriers: Lack of knowledge for changing the end-user behaviour in order to provide flexibility services; Opacity of energy market and lack of confidence; Demand anaesthesia – reactive consumer.

Some of the social and technical barriers presented above for Spain and Portugal are also found for

Italy and Belgium, although these latter countries are much more advanced with reference to the opening of DR to the electricity markets.

OTHER BARRIERS	
Italy, Belgium, Portugal, Spain	**Absence of a policy framework fostering demand-side flexibility on building level (energy communities) in the near future** (valid for Spain).
	Absence of a regulatory framework related to the integration of Energy and Non-Energy services (valid for Portugal)
	Historical restriction which characterises the national building stock (valid for Italy): for historical buildings, improving the energy performance could imply intervention on the building envelope that, if not carefully assessed by means of a proper energy audit, could affect the monumental value of the building. In general, the restrictions highly limit the possibility to operate on the building envelope, and for this reason, very often the upgrade interventions are mainly focused on cooling devices and even more on systems for the regulation, control and management of the building.
	Regulation on **Integration of Energy Services and Non-Energy Services is limited to EPB** (Energy Performance Building) (Valid for Belgium).

9. CONCLUSIONS AND KEY FINDINGS

The deliverable presents the current directives, policies and measures already adopted, as well as those under consideration, at EU level and across the EU Member States, in support of the Active Building Energy Performance Contracting concepts and business models.

In the analysis carried out at EU level, it is found that Europe is on a good track towards the empowerment of the end user to foster energy transition, by putting this latter at the center of the energy system. According to the **ETIP SNET Vision 2050**, European citizens will be the main actors in the transition from existing fossil fuel-based energy systems to an integrated, low-carbon, safe, reliable, resilient, affordable and cost-effective energy system. By 2050, demand flexibility will play a key role as product and service in energy markets, and the active role of consumers and prosumers will be fully implemented in the mechanisms of demand response (DR), through which the user is made an active participant in the management of network contingencies, as well as in reducing energy consumption through applications such as zero energy buildings or energy communities. It is found that **DR and consumer empowerment are integral parts of the Energy Union and the Clean Energy Package for all Europeans** because they help to reach a competitive, secure, and sustainable economy. In detail, the **Directive 2019/944** aims to construct a true internal market governed by common rules that can guarantee a wide range of electricity accessible to all. In relation to consumers, this directive provides an important paradigm shift, aimed at qualifying the consumers as “active”, who can operate directly or in an aggregate manner, sell self-produced electricity, including through agreements for the purchase of electricity and participate in flexibility and energy efficiency mechanisms. In such a context, the directive states that all consumers should be able to take advantage of direct participation in the market, in particular by adjusting consumption based on market signals while benefiting from lower electricity prices or other incentives. Another important innovation envisaged by the directive concerns the introduction of the concept of “**Citizen Energy Community (CEC)**”, that must be able to operate on the market on equal and non-discriminatory conditions with respect to the other subjects, being able to freely assume the roles of final customer, producer, supplier or manager of distribution systems. The **RED II Directive** also pays particular attention to the role of consumers that are allowed to become consumers of renewable energy, and also to be able to produce, store and sell the electricity produced in surplus, both individually and through aggregators, while guaranteeing the consumer’s rights. RED II in fact introduces the concept of "**Renewable Energy Community (REC)**”, which must have the right to produce, consume, store and sell renewable energy. They will also be able to exchange, within the same community, the renewable energy produced by them and access all the appropriate electricity markets, directly or through aggregation, in a non-discriminatory way. The **new EED Directive** also extends the consumer rights and improves access to smart metering tools, smart billing and consumption information, whereas the **new EPBD Directive** contains provisions concerning, among other things, energy efficiency targets for buildings, energy certification, verification methods, monitoring and control of energy use and the establishment of obligations relating to the installation of electricity recharging points.

At Member States level, a detailed country analysis has been developed for Italy, Belgium, Portugal and Spain, by analyzing the following three groups of key areas:

1. **Current status of EPC/ESCOs,** through the analysis of main regulations, directives and policies on EPC, main types of EPC implemented and main actors involved in current EPC, and ESCO market.
2. **Current status of DR services**, through the analysis of the implicit DR and main type of schemes implemented, explicit DR and demand access to the market to understand to which extent demand is allowed as a resource within the different national electricity markets, independent aggregators, regulations/policies supporting aggregation of distributed energy resources, etc.
3. **Current status of other factors enabling the Active Building EPC**, through the analysis of regulations/policies and best practices supporting demand-side flexibility at building-level, integrations of Energy and Non-Energy services in regulations/policies, and other relevant legislation and policies supporting implementation of the Active EPC, for example those supporting incentives in the field of energy efficiency and RES integration.

This in-depth analysis at country level has allowed to identify which are the countries offering the best chances for AmBIENCe concepts and business models to succeed, what are the current gaps in legislation and market awareness that might have a significant impact in the successful deployment of the new concepts and business models, and what are the best practices in legislation and practices fostering the deployment of the proposed concepts and business models.

In detail, with reference to the first group of key areas for the assessment of the **status of EPC/ESCO development**, it is found that **Italy** is the most advanced country in the consortium. Indeed, the ESCO market in Italy is still considered to be among the biggest and most developed ones in Europe, and this is mainly due to the strong legislative background and standards established in Italy for energy efficiency in buildings. Italy is followed by **Belgium,** where the energy service market is considered stable and moderately-sized, and by **Spain**, where the energy service market has been long awaited to boom, based on the complex set of governmental support measures. Instead, **Portugal** is left behind the other countries represented in the consortium, with the lowest scores for the key areas investigated. Indeed, the ESCO sector in Portugal can be currently considered still underdeveloped and small.

With reference to the second group of key areas for assessment of the **status of DR serviced offered by clusters of buildings**, it is found that **Belgium** is the most advanced country in the consortium. In fact, over the last years, the Belgian transmission grid operator created a new framework to enable participation of new energy sources (such as demand flexibility) with new types of market players (such as aggregators). While the implementation of this framework is still ongoing, the end-goal is to “open up the different products and services to all technologies (demand side management, storage), independently to the type of connection (TSO/DSO) and the type of provider (incl. Non BRPs)”. This means that in the near future, all products will be adapted to become accessible to new future market parties. Belgium is followed by **Italy**, for which the relevant regulatory framework has been subject to substantial changes starting from 2017. In fact, the Italian Regulatory Authority for Electricity, Gas and Water undertook a complete review process of the ancillary service market towards an opening to the participation of new subjects by introducing the figure of aggregator, with the aim to increase the supply of network services necessary for the national electricity system while also integrating these new subjects more and more into the electricity system. Instead, a totally different situation is found for **Spain** and **Portugal** which are left behind the other countries. These countries are indeed characterized by the poorest regulatory regimes regarding DR and asset aggregation, and thus significant barriers still exist.

Finally, with reference to the third group of key areas for the assessment of the status of **other factors enabling the Active EPC**, **Italy and Belgium** are well positioned, thanks to the very new regulatory framework established to allow **aggregation of Distributed Energy Resources (DER) for participation to the market** (note that in Italy this is valid only in the context of pilot projects), instead DER flexibility is not exploited for participation to the market in the aggregated form both in **Portugal** and **Spain.** With reference to the **exploitation of demand-side flexibility on building level for instance in Energy Communities**, **Belgium and Portugal** look quite advanced, since the framework to engage individuals more actively is present and there are some pilot projects that are already running or will be set up in the near future to examine this issue. In **Italy**, the policy framework is currently under development and there are some existing measures established towards the exemption of charges on self-consumption for small plants, the simplification of authorizations for self-consumers and renewable energy communities, and the reorganization and rationalization of configurations with self-consumption. However, significant barriers already exist for the active engagement of individual consumers or on building level. In **Spain**, there is no any policy fostering demand-side flexibility on building level also in the near future. Finally, with reference to the **integration of Energy and Non-Energy services**, in **Italy**, the regulatory framework assesses two of them, which are comfort & health and building conditions, whereas in **Belgium**, the integration of Energy and Non-Energy services is only regulated through EPB regulations, by linking E-levels (and specific energy consumption) to ventilation requirements. The situation is quite advanced in **Spain**, where the conditions that must be fulfilled by heating, air conditioning and hot water installations designed to meet the demand for thermal wellbeing and hygiene, are established in order to achieve the rational use of energy. The relevant regulatory framework is instead totally absent in **Portugal**.

In order to provide a complete overview of the status of ESCO/EPC and of DR serviced offered by clusters of buildings in Europe, the analysis has been extended to cover most EU Member States. With reference to the **ESCO/EPC development status, the most advanced countries in Europe are Austria, Czech Republic, Denmark, Germany and United Kingdom**, which are characterized by a more mature market fostered by a well-developed legal framework addressing EPC contracting and a wider variety of EPC offerings and project facilitators. **The list of the countries with an ESCO/EPC market still in an initiation phase is much longer and in general it is found that these countries belong to the Eastern Europe**, characterized by the lack of legal framework regarding EPCs and EPC models mainly due to policy instability and divergent political priorities. With reference to the **development status of DR serviced offered by clusters of buildings**, most of the outcomes presented in the deliverable have been achieved through a survey replied by representatives of **the European Energy Research Alliance – Joint Programme on Smart Grids**

(EERA JP SG), which is involved in the Advisory Board of AmBIENCe project. In detail, it is found that **the most advanced countries in Europe are Finland and Ireland** where DR participation is allowed in multiple electricity markets thanks to the well-established regulatory framework and the positive cooperation between stakeholders (new market actors, regulators and retailers). Also in this case, the **list of the countries with a development status still in an initiation phase is longer and in general it is found that these countries belong to the Eastern Europe**. These countries are indeed characterized by significant barriers such as the absence of regulation allowing the adoption of DR services, insufficient market players, the lack of economic and contractual incentives, etc.

Finally, the critical analysis performed across EU Member States allowed identifying the main enablers and barriers for the implementation of the Active Building EPC. First of all, it can be concluded that **Belgium and Italy are in a good track for receiving this enhanced EPC**, being in a good position for all the key areas investigated. The main enablers found for the EPC/ESCO are the presence of a strong legislative background and standards established for energy efficiency in buildings, the very high competence of the ESCOs, the guarantee of the results making the customer reassured by the fact that the ESCO will earn only if the proposed interventions will be effective and will lead to an effective energy saving, the presence of national ESCO associations, the creation of several so-called public One-stop-shops or facilitators, etc. The main enablers for the DR services offered by (clusters of) buildings are the ongoing revision of the regulatory framework according to the concept of "technology-neutrality, the well-established (or under revision) regulatory framework for accepting independent aggregators and for revisions of the minimum performance requirements, the standardized and clear M&V procedures for all market players with a digital meter, and the possibility of consumers' data availability in real time. Of course there are still some barriers to demolish for these countries such as the contractual complexity of EPCs, the uncertainty about the type of EPC contract to be applied in the public administration, and the absence of historical monitoring data, etc.

On the other hand, **Spain and Portugal** need to overcome significant barriers to receive and implement the Active EPC. Beyond the typical administrative and financial barriers, the most important ones for EPC are the lack of knowledge and trust, and the lack of standard and enforced M&V protocols and lack of a neutral third-party institution that certifies the accountability of a particular ESCO. Regarding the DR services offered by (clusters of) buildings, the barriers are of legal, market, technical and social type.

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ABBREVIATIONS AND ACRONYMS

ACE	Energy Certification Certificate
ACER	Agency for Cooperation of Energy Regulators
ADENE	Agência para a Energia
AENOR	Spanish Association for Standardization and Certification
aFRR	Automatic Frequency Restoration Reserve
AmBIENCe	Active managed Buildings with Energy PerformaNce Contracting
AMM	Automated Meter Management
AMR	Automatic Meter Reading
ANESE	Spanish National Association of Energy Services Companies
APE	Energy Performance Certificate
APESEnergia	Portuguese Association of Energy Service Companies
ARERA	Italian Regulatory Authority (Autorità di Regolazione per Energia Reti e Ambiente)
ARP	Access Responsible Parties
AS	Ancillary Services
ASDC	Other Closed Distribution Systems
ASSPC	Other Simple Production and Consumption Systems
BELESCO	BElgian ESCO association
BREEAM	Building Research Establishment Environmental Assessment Method
BRP	Balancing Responsible Party
BSP	Balancing Service Provider
CAM	Italian Minimum Environmental Criteria
CEC	Citizen Energy Community
CHP	Combined Heat and Power
CIM	Continuous Intrady Market
CIPU	Contract for the Coordination of the Injection of Production Units
CREG	Commission for Electricity and Gas Regulation
CR-EPC	Comprehensive Refurbishment Energy Performance Contract
DAM	Day Ahead Market
DER	Distributed Energy Resources
DER	Deep Energy Retrofit

DG	Distributed Generation
DGEG	Direção-Geral de Energia e Geologia
DLC	Direct Load Control
DR	Demand Response
DSM	Demand Side Management
DSO	Distribution System Operator
EC	European Commission
ECO.AP	Energy Efficiency Programs in Public Administration
EE	Energy Efficiency
EED	Energy Efficiency Directive
EEF	Energy Efficiency Fund
EERA JP SG	European Energy Research Alliance-Joint Programme on Smart Grids
ELENA	European Local Energy Assistance
EMD	Electricity Market Directive
EPBD	Energy Performance of Building Directive
EPC	Energy Performance Contract
ERSE	Energy Services Regulatory Authority
ESC	Energy Supply Contracting
ESCO	Energy Services COmpany
ESD	Energy Service Directive
EU	European Union
EV	Electric Vehicle
FCR	Frequency Containment Reserve
FEDESCO	Federal Energy Services Company
FEMP	Spanish Federation of Municipalities and Provinces
FRR	Frequency Restoration Reserve
FSP	Flexibility Service Provider
HV	High Voltage
HVAC	Heating Ventilation and Air Conditioning
ICT	Information and Communication Technologies
IDEA	National Institute for Energy Diversification and Saving (Instituto para la Diversificación y Ahorro de la Energía)

IEA	International Energy Agency
IED	Intelligent Electronic Devices
IEM	Internal Electricity Market
IoT	Internet of Things
IPMVP	International Performance Measurement and Verification Protocol
JRC	Joint Research Centre
KPIs	Key Performance Indicators
LEMON	Less Energy, More OpportuNities
LRT	Last Resort Tariff
LV	Low Voltage
M&V	Measurement and Verification
MARTE	Marche Region Technical assistance for healthcare buildings Energy retrofit
M-EPC	Maintenance and Energy Performance Contracts
mFRR	Manual Frequency Restoration Reserve
MINETAD	Spanish Ministry of Industry, Energy and Tourism
MMR	Monthly Meter Reading
MSD	Italian Ancillary Service Market – Mercato dei Servizi di Dispacciamento
MV	Medium Voltage
NEEAP	National Energy Efficiency Action Plan
NEN	NEderlandse Norm
nZEB	nearly Zero Energy Buildings
PA	Public Administration
PANZEB	Action Plan for Almost Zero Energy Buildings
PMV	ParticipatieMaatschappij Vlaanderen
PNAC	National Programme for Climate Change
PNIEC	Italian National Integrated Plan for Energy and Climate
PPEC	Plan for Promoting Efficiency in Electricity Consumption
PPP	Public-Private Partnerships
PREPAC	Plan for the Energy Re-qualification of Central Public Administrations
PV	Photovoltaic
R&D	Research and Development
REC	Renewable Energy Community

RED	Renewable Energy Directive
REE	Red Eléctrica de España
RES	Renewable Energy Sources
RITE	Regulation of Thermal Installations in Buildings
RIU	Users' Inner Networks
RR	Replacement Reserve
RTU	Remote Terminal Unit
SCE	Building Energy Certification System
SDC	Closed Distribution Systems
SLA	Service Level Agreement
SME	Small and Medium sized Enterprise
SO	System Operator
SRI	Smart Readiness Indicator
SSPC	Simple Production and Consumption Systems
STREPIN	Strategy for Energy Redevelopment of the National Housing Stock
TEE	Italian energy efficiency certificates
TIDE	Italian Integrated Electricity Dispatching Text
ToU	Time-of-Use
TSO	Transmission System Operator
UCMC	Consumption units for the capacity market
UNE	Spanish Association for Standardization
UPMC	Peripheral Monitoring Consumption Unit
UPMDC	Peripheral Unit for Monitoring and Load Disconnection
UVA	Virtually Aggregated Units
UVAC	Virtually Aggregated Consumption Units
UVAM	Virtually Aggregated Mixed Units
UVAN	Virtually Aggregated Nodal Units
UVAP	Virtually Aggregated Production Units
VEB	Vlaams Energiebedrijf
VPSC	Voluntary Price for Small Customer
VREG	Flemish Regulator (Vlaamse Regulator voor de elektriciteits- en gasmarkt)
YMR	Yearly Meter Reading

11. ANNEX I: AMBIENCE GLOSSARY

Term	Definition
Use Case	The specification of a set of actions performed by a system, which yields an observable result that is, typically, of value for one or more actors or other stakeholders of the system.
Energy Performance Contract	A form of 'creative financing' for capital improvement which allows funding energy upgrades from cost reductions. Under an EPC arrangement, an external organisation (ESCO) implements a project to deliver energy efficiency, or a renewable energy project, and uses the stream of income from the cost savings, or the renewable energy produced, to repay the whole or part of the costs of the project, including the costs of the investment. Essentially the ESCO will not receive its payment unless the project delivers energy savings as expected. The approach is based on the transfer of technical risks from the client to the ESCO based on performance guarantees given by the ESCO. In EPC ESCO remuneration is based on demonstrated performance; a measure of performance is the level of energy savings or energy service.
Flexibility	Modification in generation and/or consumption patterns without violating comfort constraints or impacting the normal operations. Flexibility can be used/activated in reaction to an external signal (such as a change in price) to provide a service within the energy system'.
Demand side management	DSM includes everything that is done on the demand side of an energy system, ranging from exchanging old incandescent light bulbs to compact fluorescent lights (CFLs) (form of Energy Efficiency) up to installing a sophisticated dynamic load management system for demand response services.
Demand Response	Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized. According to the DR arrangements, three possible actions could be followed: demand shifting, demand reductions (or increase), self-consumption
Implicit Demand Response	Refers to consumers choosing to be exposed to time-varying electricity prices that reflect the value and cost of electricity in different time periods. Armed with this information, consumers can decide – or automate the decision – to shift their electricity consumption away from times of high prices and thereby reduce their energy bill. Time-varying prices are offered by electricity suppliers and can range from simple day and night prices to highly dynamic prices based on hourly wholesale prices. Examples include time-of-use pricing, critical peak pricing, and real-time pricing.
Explicit Demand Response	In explicit demand response schemes (sometimes called "incentive-based" or "volume-based") the result of demand response actions is sold upfront on electricity markets, sometimes directly for large industrial consumers or through demand response service providers. Consumers receive a specific reward to change their consumption upon request, triggered by high electricity prices, flexibility needs of balance responsible parties or a

	constraint on the network.
Active Building	Building equipped with active control option that can actively participate in demand response and energy efficiency programmes.
Active Building EPC	An Energy Performance Contract (EPC) which performance features and guarantees are extended with the concepts and services of an Active Building, in particular Demand Side Response and flexibility.
Business case	Is a value proposition intended to inform and convince a decision maker or a decision making unit to take some kind of action. It involves representation of the benefits or rewards but also the risks and downsides involved in taking action or not taking action. It includes different approaches to a given situation in order to allow for proper assessment of the different options considered.
Business model	The business model is the rationale of how an organization creates, delivers and captures value (Osterwalder and Pigneur, 2010) Business models are about: Value Proposition – what services are sold and to whom, Value Creation – how will the service be created and provided, Value Capture – how will the value be monetised. It is a rather conceptual structure defining how an organization fulfils its business objective. It discusses the elements that make this business objective work successfully.
Business Plan	Is a document, or a set of documents, featuring the financial and operational objectives of a business. It actually includes the budgets and the plans showing how the business objective (the prospective business) is going to be realised. It is pretty similar to a Business Model in content and structure though it differs from the Business Model in the sense that it specifies or shows in detail the elements needed to demonstrate the viability of the business objective.
Financial Model	Is the quantified summary (in monetary terms) of an organisation's operational performance (i.e. the probable financial result) or of an organisation's specific decision based on certain variables and assumptions. It is used to support the prediction of that organisation's prospective financial performance or the prospective financial outcome of the specific decision. It is also used to estimate the value of a business or compare businesses. It looks at income and expenses and may include discounted cash flow analysis and sensitivity analysis.
Non-energy related services	Non-energy related services refer to impacts often delivered by energy improvements beyond energy savings. Some examples include improved indoor air quality due to enhanced ventilation, comfort, increased asset value and productivity.
Hybrid energy systems	Hybrid energy systems are defined as the integration of several types of energy generation equipment such as electrical energy generators, electrical energy storage systems, and renewable energy sources. Hybrid energy systems may be utilized in grid-connected mode and islanded mode
Vehicle-to-building	A system in which electric vehicles can communicate with a building to sell demand response services by either delivering electricity into the building or by throttling their charging rate.
Vehicle-to-	A system in which plug-in electric vehicles communicate with the power grid to sell demand

grid	response services by either returning electricity to the grid or by throttling their charging rate.
Local energy community / Citizen energy community	An association, a cooperative, a partnership, a non-profit organisation or other legal entity which is effectively controlled by local shareholders or members, generally value rather than profit-driven, involved in distributed generation and in performing activities of a distribution system operator, supplier or aggregator at local level, including across borders. A local energy community can be engaged in electricity generation, distribution and supply, consumption, aggregation, storage or energy efficiency services, generation of renewable electricity, charging stations for electric vehicles or provide other energy services to its shareholders or members. It has for its primary purpose to provide environmental, economic or social community benefits to its members or shareholders or to the local areas where it operates rather than to generate financial profits.
Measurement & Verification	Measurement and Verification (M&V) is the term given to the process for quantifying savings delivered by one or more Energy Conservation Measures (ECMs). Measurement and Verification demonstrates how much energy the ECMs has avoided using, rather than the total cost saved. The latter can be affected by many factors, such as energy prices. The Measurement and Verification process enables the energy savings delivered by the ECM to be isolated and fairly evaluated, taking into account so-called routine and non-routine correction parameters, like weather conditions or building occupation. The most commonly used protocol for good practices in Measurement and Verification is the International Performance Measurement and Verification Protocol (IPMVP), which defines common terminology and the key steps in implementing a robust M&V process. A key part of the M&V process is the development of an 'M&V Plan', which defines how the savings analysis will be conducted before the ECMs are implemented. This provides a degree of objectivity that is absent if the savings are simply evaluated after implementation. M&V is common, if not essential, in any Energy Performance Contract (EPC) as the payments to the ESCO are directly related to the measured and verified energy savings.
Building energy management system	Building Energy Management Systems (BEMS) are integrated, computerised systems for monitoring and controlling energy-related building services plant and equipment such as heating, ventilation and air conditioning (HVAC) systems, lighting, power systems and so on.
Contracting phase	In the process of preparing an energy performance contract (EPC), the ESCO and the building owner/building energy manager would start the design and negotiating on the terms and conditions of the contract. This period where some data exchange and negotiation would happen is referred to as contracting phase.
Peak shaving	The process of reducing the amount of energy purchased from the utility company during peak demand hours. The goal is to avoid the installation of capacity to supply the peaks of a highly variable load. Peak shaving installations are often owned by the electricity consumer, rather than by the utility.

12. ANNEX II: AMBIENCE QUESTIONNAIRE FOR EERA JP SG MEMBERS

The aim of this questionnaire is to assess the status of Demand Response (DR) services offered by (clusters of) buildings for the countries represented in EERA JP SG.

This analysis and report represents a starting point for the consortium in exploring new concepts and business models for performance guarantees of Active Buildings, combining savings from energy efficiency measures and the active control of assets enabling the use of flexibility, so as to understand:

- Which countries offer the best chances for AmBIENCe concepts and business models to succeed
- What are the current gaps in legislation and market awareness that might have a significant impact in the successful deployment of the new concepts and business models proposed in AmBIENCe
- What are the best practices in legislation and market fostering the deployment of the concepts and business models proposed in AmBIENCe

The assessment for your country will be done to cover buildings' flexibility aspects for DR services. The development of DR market in your country will be assessed with reference to the following four key areas:

1. **Buildings' Demand Response access to markets**
2. **Service providers access to markets**
3. **Product requirements**
4. **Measurement and verification procedures**

Country assessed: [Indicate the name of the country]

Organization: [Indicate the name of the organization]

Area of expertise: [Indicate the area of expertise]

- **Area 1: Buildings' Demand Response access to markets**

This area includes to what extent demand from (clusters of) buildings is allowed as a resource within the different national electricity markets (i.e. wholesale, balancing, ancillary services, Capacity Mechanism, strategic reserves, etc.).

Assign a score to your country with reference to Area 1.

KEY AREA	Demand Response access to markets
5	Aggregated building load is accepted in a range of markets
3	Aggregated building load is limited to a number of markets
1	Aggregated building load is accepted only in one or two programmes
0	Building Load is not accepted as a resource in any market

Score assigned: [Indicate the score according to the table above]

Main barrier or best practice in your country: [According to the score assigned, indicate the main barriers in your country or the best practice worthy of investigation]

- **Area 2: Service providers access to markets**

This area involves the clarification of involved parties' roles and responsibilities, allowing for direct access of consumers to independent service providers, alongside the retailers. In particular, it focuses on progress towards fair and standardised arrangements between BRPs/retailers and aggregators.

Assign a score to your country with reference to Area 2.

KEY AREA	Service provider access
5	Standardised arrangements between involved parties are in place for all markets – aggregators do not depend on prior consent of the retailer/BRP
3	Independent third parties may access some parts of the market without consent of retailer/BRP
1	Lack of standardised arrangements between involved parties and aggregators must contract with retailer/BRP to access market.
0	No standardised arrangement between involved parties is in place and aggregation is illegal

Score assigned: [Indicate the score according to the table above]

Main barrier or best practice in your country: [According to the score assigned, indicate the main barriers in your country or the best practice worthy of investigation]

- **Area 3: Product requirements**

This area refers to the requirements of the different products/programmes (e.g. minimum bid limit, symmetric bid, maximum number of activations, notification time, duration, etc.), assessing whether these enable demand-side resources to participate.

Assign a score to your country with reference to Area 3.

KEY AREA	Program requirements
5	Programme requirements enable a range of building-level resources (supply and demand) to participate in multiple markets
3	Minor barriers to building-level demand-side participation in market remain, however participation is still possible
1	Significant barriers for building-level flexibility remain, creating major issues for building-level demand-side resource participation
0	Programme requirements block demand-side participation

Score assigned: [Indicate the score according to the table above]

Main barrier or best practice in your country: [According to the score assigned, indicate the main barriers in your country or the best practice worthy of investigation]

- **Area 4: Measurement and verification procedures**

This area refers to existing standardised and transparent regulation on how building-level Demand Response events are measured.

KEY AREA	Measurement and verification
5	Requirements are well defined, standardised, proportionate to customer capabilities and dealt with at the aggregated level
3	Requirements are under development, but do not act as a significant barrier.
1	Requirements act as a significant barrier to consumer participation.
0	There are no measurement and verification rules for Demand Response participation.

Score assigned: [Indicate the score according to the table above]

Main barrier or best practice in your country: [According to the score assigned, indicate the main barriers in your country or the best practice worthy of investigation]