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Deliverable D7.5

Report on future trends and market potential for frESCO solutions

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Main author	Andrea KOLLMANN (EI-JKU), Francisco VILLAGARCIA (EI-JKU), Benjamin KIRCHLER (EI-JKU)
Contributors	Giannis Georgopoulos (MOH), Juan Aranda (CIRCE)

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1 EXECUTIVE SUMMARY

This report presents a comprehensive analysis of the status and future prospects of frESCO Business Models (BMs) in the context of the European Union's residential energy sector, with a particular focus on the horizon up to 2030. The analysis is framed in the context of the EU's ambitious sustainability goals, the evolving policy landscape, technological advances and changing market dynamics. The report explores several scenarios that could shape the EU's residential energy sector by 2030. These include increased energy efficiency renovations driven by rising energy costs, accelerated deployment of renewable generation technologies and the growing importance of demand-side flexibility markets. In addition, we highlight the crucial role of digitalization in improving the operational efficiency and market reach of frESCO's solutions. In a risk assessment, we analyze the range of challenges for frESCO's BMs, from high risk factors such as regulatory change and consumer acceptance, to medium risks related to technology integration and market dynamics. The assessment highlights the importance of strategic planning and agile response mechanisms for frESCO to effectively manage these risks.

Our key findings are:

- **Regulatory and policy landscape:** frESCO BMs are significantly influenced by the EU's evolving energy policies, including the 'Fit for 55' package, the Renewable Energy Directive, the Energy Efficiency Directive and the Energy Performance of Buildings Directive. These policies present both opportunities and challenges for frESCO, requiring adaptability to regulatory changes and exploitation of emerging market opportunities. Crucial for frESCO BMs will be the development of a favorable regulatory environment in major European economies that allows for a fair access to the market and considers the impact of taxation and accounting rules.

- **Market and economic trends:** Overall market condition and future trends appear favorable for frESCO's solutions from this year's perspective. Nonetheless, in order to derive benefits from general market conditions, frESCO business developers will need to be vigilant against concrete developments at local level. The report identifies a medium risk of market and economic instability, driven by volatile energy prices and

wider economic uncertainties. frESCO's strategies will need to balance the drive for energy efficiency with market affordability and consumer investment capacity.

- **Technological advances:** Rapid technological innovation, especially in digitalization and renewable energy integration, presents both opportunities and challenges. frESCO must continually adapt its services to effectively incorporate these advances.
- **Consumer acceptance and awareness:** High risk areas for frESCO include consumer awareness and acceptance. The report highlights the need for frESCO to invest in consumer education and engagement initiatives to demonstrate the benefits of energy efficiency and renewable solutions.
- **Digitalization and data management:** The medium risk associated with digitalization and data management requires frESCO to focus on strengthening its digital infrastructure and investing in cybersecurity measures.
- **Competition and barriers to entry:** Although a low risk factor, competition in the energy services market requires frESCO to innovate and differentiate its services to maintain a competitive edge.

2 ABBREVIATIONS

Abbreviation	Name
BM	Business model
EPC	Energy Performance Contracting
ESCO	Energy Service Company
P4P	Pay for performance

3 OVERVIEW AND OBJECTIVES

In this report, we review frESCO's main business models (i.e., ESCO and Aggregator business models) with the aim of identifying the major factors that could influence—either positively or negatively—the growth and sustainability of businesses within a time frame extending up to 2030. Our analysis considers key influencing factors such as the development of energy prices, renewable energy prospects, carbon emission costs, local flexibility markets, as well as prospects related to the degree of digitalization of the residential building sector and the degree of standardization of data and protocols.

Furthermore, we conduct a landscape analysis focusing on influencing market trends to identify additional indicators that could be relevant for the evolution of frESCO's business models. This will encompass evaluations of existing scenarios by the European Commission and other trans- and supranational organizations like the International Energy Agency (IEA). These scenarios will be assessed to select those that reveal market trends associated with the factors and indicators we have identified.

3.1 frESCO business models for the future residential sector

This section synthesizes the two main ESCO and Aggregator business models (BMs), as detailed in Deliverable D3.3: "New business models for ESCOs/aggregator for energy services in the residential sector " (Georgopoulos 2021), with the goal of identifying the key business characteristics that are likely to be pivotal in shaping the future of the energy services market in the residential sector. A significant transformation in this sector is anticipated, particularly as Europe strives to meet its decarbonization targets in the coming years and decades.

Making the residential building sector appealing to private investors is crucial for realizing the ambitious energy efficiency goals set for the residential building sector. According to EU records (European Commission 2020b), the sector currently accounts for 40% of the EU's total energy consumption and 36% of its greenhouse gas emissions (GHG) originating from energy use. Addressing this challenge calls for innovative solutions that leverage both technological advancements and the readiness of end-users to contribute to sustainability. By doing so, we can foster a society that is not only sustainable but also conducive to enhanced living standards through increased efficiency.

The two main business models (BM) in the Energy Efficiency and Demand Response fields are the ESCO BM and the Aggregator BM. These models have been re-addressed in frESCO based on a Pay-for-Performance principle. Since the actors, markets and revenues are defined individually they are discussed as two separate BMs, but the key market proposition of frESCO is to follow a hybrid approach that combines both energy efficiency and demand response aggregation, simultaneously delivered by the same service provider.

The frESCO approach offers the flexibility required in the residential building sector to extend the current ESCO EPC models from retrofitting projects to advanced energy services for prosumers and grid operators, expanding the profitability and attractiveness for ESCOs and service providers. This is achieved by unlocking new revenue streams through participation in the electricity market and the intelligent use of generation and storage technologies, and the smart provision of demand response flexibility, as detailed in more depth in Deliverable D3.3 of the frESCO project (Georgopoulos 2021). The following section aims to summarize the main characteristics of the core BMs with the goal of identifying the most relevant market trends and determining the adaptive measures that should be considered in the future. The suite of energy services and energy service bundles developed within the frESCO project can be categorized into four main groups:

(i) **Smart Retrofitting Services,** that serve as the foundation for the other categories of services;

(ii) **Energy Efficiency Services,** that aim to generate savings by optimizing energy consumption. This is achieved either through providing personalized information to the end-users for making informed energy usage decisions, or through automation in a remote manner;

(iii) **Flexibility Services,** that enable end-users to participate in the demand flexibility market, generating revenue through reduced grid congestion and optimized grid capacity utilization by power grid operators;

(iv) **Non-Energy Services,** that improve the comfort levels of residential users but are not directly related to energy efficiency or flexibility services.

This suite of services can be accessed simultaneously by end-users through predefined service bundles. However, each of the main business models has a distinct focus, as will be summarized in the following subsections.

3.1.1 The ESCO business model

The ESCO BM focuses on generating revenue from energy efficiency upgrade projects in the residential sector, which are enabled by the introduction and optimization of either self-controlled or automated energy management processes across a diverse set of residential households. In essence, ESCOs —or, in certain instances, facility managers or even property owners— shoulder the upfront cost of an investment, develop and deploy an energy management system, and conduct the necessary audits to maximize the saving potential of the facilities under a Pay-for-Performance (P4P) contract. Utilizing real-time data collection and continuous energy metering from each controllable load, ESCOs monitor the overall energy consumption across multiple contracted facilities, offer consultations or suggestions

regarding the services provided, and ideally control loads or Distributed Energy Resources (DERs) automatically. This is done to optimize both savings and relevant revenue, from which end-users stand to benefit.

3.1.2 The Aggregator business model

The Aggregator BM is centered on managing flexibility services, through which residential prosumers are expected to profit directly. Aggregators represent small consumers in the electricity markets, aggregate the necessary flexibility, handle all transactions with the grid and market operators, and initially receive the majority of the compensation. Subsequently, they distribute these revenues to the prosumers based on contract stipulations. Small consumers—which include residential consumers and prosumers, as well as small businesses, commercial enterprises, agricultural companies, and manufacturers—are willing to adjust their energy consumption in response to somewhat unpredictable market demands. This is primarily managed automatically by the aggregator, who maintains a portfolio of end-users offering demand flexibility services.

Table 1. Key characteristics of frESCO's business models

ESCO business model	Aggregator business model
Main business actor addressed: • Energy Service Company (ESCO)	Main business actor addressed: • Aggregator/ESCO
Main service provided: • Energy Efficiency Services	Main service provided: • Demand Flexibility Services
Type of services offered: • **EE1**: Energy Management for Energy efficiency. Energy efficiency analytics awareness for EE management service. • **EE2**: Personalized Energy Analytics for Energy Behavior optimization. Implicit EE service. • **EE3**: Holistic self-consumption maximization service. For prosumers. • **EE4**: Automation and optimal device scheduling. Explicit automated dispatch of efficiency events.	Type of services offered: Explicit demand response schemes: • **FL1**: Flexibility analytics services. Information and analytics towards awareness and market participation. • **FL2**: Explicit automatic DR services. • **FL3**: Virtual Power Plant and Optimal Flexibility Activation Scheduling.
Identified stakeholders: • ESCO • Building/facility manager • End user	Identified stakeholders: • ESCO • Building/facility manager • End user

• Equipment suppliers/installers and technicians	• Equipment suppliers/installers and technicians • Aggregators • Network operator • Market operator • System operator

Revising the BMs developed within the frESCO project reveals that ESCO BMs rely on the development of energy management systems (EMS) and more particularly smart EMS or Building energy management systems (BEMS), which itself depends on the deployment of smart home services, Internet of Things solutions, as well as optimized data analytics based on ICT and Artificial Intelligence (Joy Kiruba et al. 2023). These BMs are equally dependent on the degree of development and quality of the smart grid and smart metering coverage, as well as profitable market prospects for renewable energy technologies, energy prices and a favorable regulatory framework supporting energy efficiency brought by ESCO solutions and clear taxation schemes (UNEP Copenhagen Climate Centre 2023). Consequently, the next section will focus on the future trends shaping the markets involved with retrofitting the residential sector by capitalizing on energy savings and participation on demand side flexibility markets.

3.2 Methodology and limitations

For the assessment of risks associated with the future deployment of frESCO business models, a combination of qualitative methods has been chosen as described by Abba et al. (2022). Quantitative and qualitative methods offer both advantages and disadvantages. However, influential for applying qualitative methodology have been the nature of the data regarding regulatory trends and lack of data availability for certain categories of general market trends as assessed by monitoring institutions (see in particular ECNO 2023; European Commission. Directorate General for Energy. 2023a). In the following, Section 4 covers the key market trends identified in a literature review addressing key factors with the potential to impact the European ESCO market in the coming years. In addition, a dedicated expert workshop was carried out on October 30th, 2023 as part of frESCO activities to survey potential trends and insights from the practice of energy service operations. Section 5 summarizes the key trends and influencing factors identified in Section 4 to finally assess the risk involved with frESCO operations to serve as a basis for the development of mitigation strategies to be defined in an independent deliverable (D7.6, see Kollmann, Villagarcia, and Kirchler 2023).

The focus of the following analysis was put on the prospects and influencing factors expected to have a significant impact on the residential building sector in the period until 2030. Furthermore, trends related to the regulatory frameworks influencing frESCO activities (Chapter 4.1) and general market trends expected for the defined time horizon (Chapter 4.3) are discussed.

4 FUTURE MARKET TRENDS

An overview of policies pertaining to the ESCO market is provided in this section, with a particular focus on the residential sector. Covered within this scope are key pieces of European legislation, such as the EU Energy Efficiency Directive and the Energy Performance of Buildings Directive, along with their respective amendments. Additionally, we discuss the Renovation Wave Strategy, which has been formulated within the framework of the European Green Deal. Finally, this section explores the calls for revisions to existing strategies and policy adjustments that are essential for accelerating the transition to low carbon heating systems and building renovations.

4.1 European policies shaping the ESCO market

The policy framework that will shape the future development of the European ESCO market must be considered in the context of the European Green Deal. Unveiled in 2019, the EU Green Deal serves as the guiding policy instrument for the current European Commission. It outlines a comprehensive action plan aiming at transitioning Europe's economy and society towards environmental sustainability by the mid-21st century. Conceived as a growth strategy, it aims to expedite Europe's evolution into a more modern, resource-efficient, and competitive economy with a carbon-neutral impact on both the environment and society. The action plan emphasizes efficient resource utilization by advocating for a clean, circular economy capable of restoring biodiversity and achieving zero-pollution objectives. In doing so, it aims to safeguard both citizens and the environment sustainably. The Green Deal also outlines the required investments and available financial tools, clarifying how these provisions will facilitate a socially just and inclusive transition. To realize its ambitious objectives, the European Green Deal addresses all relevant sectors and areas, spanning multiple layers of EU policy (see Figure 1). This includes a focus on the building sector, with the enhancement of its energy efficiency identified as a core pillar (European Commission 2019).

Figure 1: The European Green Deal, (European Commission 2019).

Achieving reductions in energy consumption and realizing energy savings is critical for the successful implementation of the European Green Deal. This underscores the importance of successful ESCO retrofitting projects and innovative business models in the residential building sector. In this context, the ESCO market intersects with two major areas of European policy action: *"Building and Renovating in an Energy and Resource-Efficient Way"* and *"Financing the Transition"* (European Commission 2019; 2020c). Together with other regulatory instruments, these policy mechanisms indicate how energy efficiency in the residential building sector will be prioritized at the European level and which business opportunities are likely to arise for ESCO business models in the coming decades.

Despite the fact that the EU has a strong commitment to achieve carbon neutrality by 2050 and the corresponding policy frameworks are progressive and continually assessed and sharpened, further political effort will need to take place during the current decade to accelerate the pace of transformation in the EU building sector. Two main objectives are regarded as crucial for the EU buildings sector: (i) a significant reduction of the GHG emissions caused by energy usage in buildings and (ii) limiting materials demand for construction purposes. For the *European Climate Neutrality Observatory* (ECNO 2023), corrective measures of significant impact can be expected for the next years in the building sector in order to meet overall carbon neutrality goals. Figure 2 and Figure 3 show the trend of transformation towards the EU's 2050 ambitions for the building sector. The latest data suggest that the

estimated 5 years trend - projecting an average from 2016 to 2021 values - for emissions reduction is still far to slow whereas the increasing demand for building blocks and bricks is currently even going in the wrong direction.

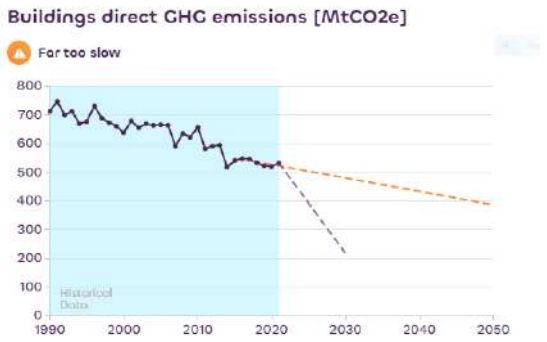

Figure 2: Projection of direct GHG emissions of buildings in MtCO2e, Source: ECNO (2023).

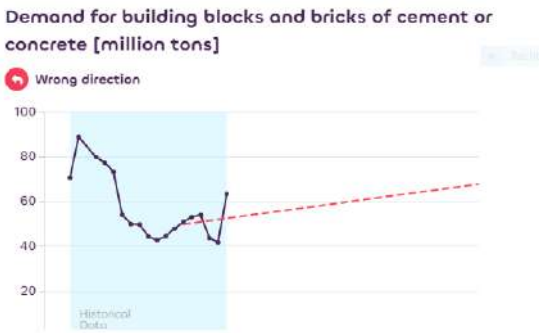

Figure 3: Projection of demand for construction materials, Source: ECNO (2023).

Among the principle enabling condition to achieve the aforementioned objectives, the ECNO keeps additionally track on three groups of indicators concerning (i) a reduction of demand for heating and cooling, which includes both limiting the increasing trend on average space per capita and reducing energy consumption for heating and cooling of living spaces, (ii) prompting the renovation of buildings, which includes increasing levels of investments as well as average and deep renovation rates, and (iii) advancing the technology switch towards renewables (see Figure 4, Figure 5 and Figure 6). Lack of data availability makes it difficult to monitor and evaluate all these action fields adequately (ECNO 2023; European Commission. Directorate General for Energy. 2023a).

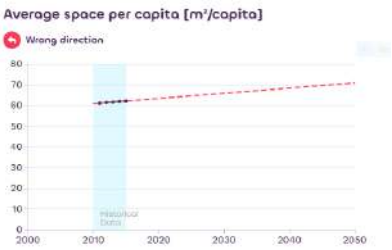

Figure 4: Average space per capita, Source: ECNO (2023).

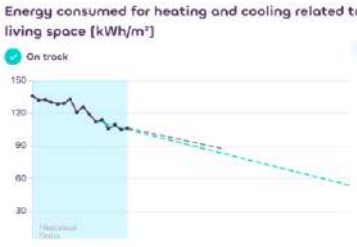

Figure 5: Energy consumption for heating and cooling of living spaces, Source: ECNO (2023).

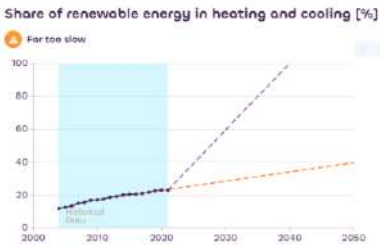

Figure 6: Share of renewables in heating and cooling, Source: ECNO (2023).

The three groups of enabling factors for carbon neutrality in the building sector by 2050 are projecting an unsatisfactory trend in this branch of industry. The slow-paced progress in the transition to sustainable buildings (assessed in terms of the two main objectives previously discussed) underscore the need for effective, corrective revision of EU strategies and their implementation Europewide. The latest EU progress report on the state of the Energy Union

regarding the building stock addresses the lack of data reporting (of voluntary character) from EU member states -regarding key topics like *energy use* of building, *GHG emission* related to buildings and *renovation rates*- as well as the diversity of definitions and indicators used. These issues are expected to be solved by harmonization efforts to be implemented by more evolved national Building Renovation Plans with a more profound mandatory reporting elements (European Commission. Directorate General for Energy. 2023a; European Commission 2023c).

In summary, the European Legislative Framework, encompassing the EU Energy Efficiency Directive, Energy Performance of Buildings Directive, and Renovation Wave Strategy, among other, plays a pivotal role in shaping market trends within the building sector. These legislative measures are key in dictating the direction and pace of development in the sector. In parallel, the European Green Deal, launched in 2019, represents a significant move towards environmental sustainability, with a particular focus on energy efficiency in the building sector. This initiative underscores the need for a clean, circular economy, advocating for biodiversity restoration and achieving zero-pollution objectives. These elements are critical in shaping practices and policies within the building sector. Building and renovating practices that prioritize energy and resource efficiency are central to the development of the Energy Service Company (ESCO) market. These practices open up new business opportunities, indicating a shift towards more sustainable construction and renovation methods. Financing these transitions is another crucial aspect. Policies that govern the financing of energy-efficient renovations are set to have a significant impact on the ESCO market. These financial mechanisms and policies will play a decisive role in determining the feasibility and attractiveness of such projects. The EU's commitment to achieving carbon neutrality by 2050 is a major driving force behind these changes. This goal necessitates substantial modifications in the building sector, primarily focusing on reducing greenhouse gas (GHG) emissions and limiting the demand for construction materials. These objectives align with broader environmental targets and are essential for achieving the long-term vision of a sustainable Europe. Lastly, the adoption of new technologies is crucial for the advancement of the building sector. A shift towards renewable energy technologies, coupled with the development and deployment of smart grids and smart metering systems, is key to this transformation. These technologies not only enhance energy efficiency but also pave the way for more innovative and sustainable building practices.

4.1.1 European Union strategies in the context of decarbonizing buildings

4.1.1.1 The Renovation Wave Strategy

The objective of the Renovation Wave strategy is to double the rate of renovation in the European building sector by 2030. This strategy engages multiple legal instruments and is set to influence the updating and revising of existing directives, such as the EED (Energy Efficiency Directive), the RED (Renewable Energy Directive), and the EPBD (Energy Performance of Buildings Directive). As it stands, approximately 11% of the EU's building stock undergoes some form of renovation annually; however, only 1% of buildings involves energy-efficient renovation within the same time frame (European Climate Foundation 2023; European Panel Federation 2018). Deep renovations, which reduce energy consumption by at least 60%, account for a mere 0.2% of the entire building stock (European Commission 2020b; Regan 2023; BPIE 2021). Consequently, the potential for increasing both energy efficiency and the consumption of renewable energy within the building sector is considerable.

The European Commission is focused on boosting renovation rates over this decade to ensure that building sector upgrades lead to enhanced energy and resource efficiency (Jack 2023). Accelerating the pace of building renovations is a high priority for the European Commission, as such efforts will concurrently improve people's quality of life, alleviate energy poverty, reduce GHG emissions across Europe, promote digitalization, and enhance the recycling and reuse of materials in an environmentally sustainable manner (AK Europa 2021; European Commission 2020b). According to Commission estimates, as many as 35 million buildings could be renovated, potentially creating up to 160,000 additional green jobs by 2030 (European Commission 2020b; FIEC 2022).

Although progress is being achieved for the environmental sustainability of buildings, analysts agree that the pace of this progress will not allow Europe objectives to be achieved timely. For instance, Oxford Economics (Regan 2023) evaluated the prospects for average growth in building renovation for different European countries and came to the conclusion that the current strategies allow for higher growth rates in every EU member state especially within the period between 2027 and 2030 (see Figure 7). According to their analysis, the countries participating in frESCO - Spain, France, Italy, Austria - can expect higher growth rates closer to the 3% average growth rate after 2027. The highest growth rates are however expected for countries like Denmark, Czechia, Slovakia and the UK, expecting to approximate an average growth rate of 4% yearly between 2027 and 2030.

The booming of building renovations is expected to start later in the second half of this decade once the current adverse economic situation is overcome. A shortage of labor force in the

construction sector together with the high cost of materials are seen as critical market factors holding back progress in energy efficient renovations. In addition, some measures are intended to be enforced not earlier than 2027 starting with the non-residential sector and expanding its application to residential building in a posterior stage (Regan 2023). Similarly, the introduction of minimum energy performance standards (MEPS) for the European building sector is also expected to take place in non-residential buildings earlier than in residential ones (BPIE 2023). Nevertheless, latest estimates forecast stronger policy interventions in the building sector, especially concerning renovation activity in residential buildings, if the net zero targets are to be achieved according to current European plans (ECEEE 2023; Regan 2023). These trends create favorable prospects for business models designed to exploit savings potential while capitalizing revenues opportunities from participating in an emerging market with positive growth capacity like in the case of frESCO solutions.

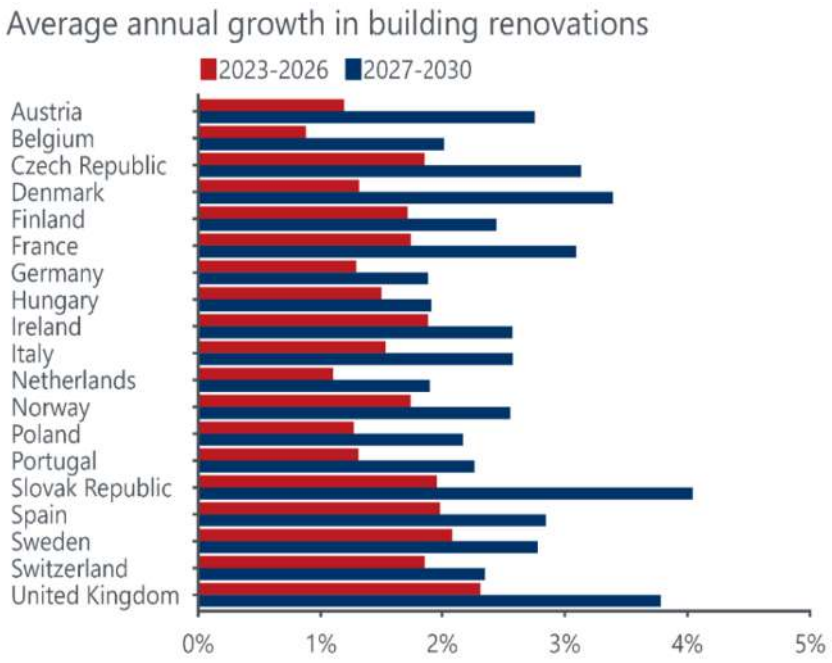

Figure 7: Forecasted Average Annual Growth in Buildings renovation from 2023 to 2026 and from 2027 to 2030, Source: Regan (2023).

Considering an average contract duration of 10 years for financing ESCO retrofitting projects in the building sector, market players are looking for strategies to secure their market position in this promising market. In this context, the market prospects for Energy Management Systems (EMS) project growth rates around the range of 12% to 18% Compound Annual Growth Rate (CAGR) towards 2030 in Europe - varying moderately depending on the forecast period and the particular market research institution- (see Inkwood Research 2022; Mordor Intelligence 2023). Energy Management Systems are computerized tools utilized for

measuring, monitoring and improving energy generation and transmission of energy grids or microgrids. They include infrastructure renovation activity aiming at enhancing energy efficiency, energy savings and energy performance. EMS find application also in entire residential buildings but also in independent dwellings. Building Energy Management Systems (BEMS) are similarly computerized energy management tools but applied for the improvement of energy management activities of buildings by building managers as well as optimization of energy usage at industrial or commercial sites. Home Energy Management Systems (HEMS) are energy management tools targeted for residential households that provide the benefits of optimizing energy consumption of homes using smart technologies, Internet of Things and data analytics. These systems can also allow participation in demand response markets aligning domestic energy consumption to grid requirements on the event of a peak on grid energy consumption. Market penetration of home energy management systems in Europe is estimated as under 1%. However, market growth for home solutions is expected to increase in the next years reaching a CAGR of 12.5% by 2028.

Consequently, EMS enhance opportunities to exploit the full energy saving potential locked in inefficient buildings and facilities. In this context, the European Commission (European Commission. Directorate General for Energy. 2023b) has assigned *ICF International Inc* with the assessment of the technical and economic savings potential for the residential, commercial, industrial sector and for road transportation in the EU-27 to project its future development in a business-as-usual (BAU) scenario towards 2030. The results of the assessment identify a technical saving potential of 77,113 ktoe (32.7% compared to BAU consumption) and an economic saving potential of 58,495 ktoe (24.8% compared with BAU scenario) within the residential sector by 2030, assuming a projected energy consumption of 236,129 ktoe for this specific sector in three projected BAU scenario. The assessment highlights that the economic saving potential had to be updated to reflect the considerable increases in fuel prices caused by the energy price crisis and the Russian-Ukraine conflict, which has resulted in much higher values compared to a previous release of the report in 2021. Latest data from Eurostat records was analyzed for the categories space heating, hot water heating, lighting, appliances, cooking, cooling, fans and pumps (see Table 2). The assessment highlights that the highest technical and economic saving potential can be expected for the categories *space heating* and *hot water heating.* These two categories alone account for nearly 94.3% and 92.5% respectively of the technical and economic saving potential of the residential sector by 2030.

Table 2: Technical and economic energy saving potential of EU-27 residential sector by end-use category

Residential end-use category	Technical saving potential [KTOE]	Economic saving potential [KTOE]	Updated economic saving potential [KTOE]
Space heating	40,187	26,698	31,816
Hot water heating	32,564	5,656	22,337
Lighting	2,645	2,645	2,645
Appliances	1,557	1,504	1,535
Cooking	81	81	81
Cooling	78	75	78
Funs and pumps	2	0	0.4

Source: European Commission DG Energy (2023b, 9).

Optimizing the energy consumption related with thermal comfort is one of the pillars of the frESCO solutions. The frESCO project has been exploring the importance of data-driven energy services for improved energy consumption in the heating a cooling of building of the future (García-Cuadrado et al. 2022). But not only cost-effective building renovation demanding considerable investments are important. The market is also looking at low-cost renovations that can bring energy savings and reduce energy bills accordingly. In this regard, in order to offer transparent information about the cost and benefits involved with a particular retrofitting approach, the EU-supported project ReCO2st (Horizon 2020 Grant agreement ID: 768576) has developed a Smart retrofitting toolbox that facilitates decision making about available technologies for building renovation. Smart appliances can be used to optimize energy usage of dwellings by installing smart thermostats, smart water heaters, smart windows or similar devices (Nita 2022).

In summary, the Renovation Wave strategy, which aims to double the renovation rate by 2030, presents significant opportunities for the ESCO market, particularly in the area of energy-efficient renovations. Given the current low percentage of energy-efficient renovations, there is a large potential for market growth. The strategy's push for deep renovations, aimed at reducing energy consumption by at least 60%, directly aligns with ESCO interests in energy savings and efficiency. A key element for ESCOs is the emerging market for energy management systems (EMS), particularly in the area of home energy management, which is expected to grow significantly. This growth is crucial for ESCOs as it provides a direct avenue for business expansion and the provision of energy efficiency services. The strategy's emphasis on the technical and economic potential for energy savings, particularly in the residential sector by 2030, is also in line with the objectives of ESCOs. This potential highlights opportunities for ESCOs to provide solutions that capitalize on this untapped market. In

addition, the focus on data-driven energy services, particularly in heating and cooling, is critical for ESCOs. It represents a shift towards more sophisticated, analytics-based approaches to energy management, which is a core area of ESCO expertise. Finally, the strategy's attention to low-cost retrofit solutions, including the use of smart appliances, offers ESCOs a broader market to serve, particularly in providing cost-effective energy optimization solutions for residential customers.

4.1.1.2 The Heating and Cooling strategy

The energy efficiency goals of the Renovation Wave strategy for the building sector are closely tied to the EU's heating and cooling strategy. Nearly half of the European Union's total gross final energy consumption is allocated to heating and cooling energy (Eurostat 2023). Recognizing the importance of these activities in achieving a clean and carbon-neutral economy, the EU introduced a Heating and Cooling Strategy in 2016 (European Commission 2016a). This strategy aimed to facilitate a transition towards renewable energy sources in the heating and cooling sector, with a focus on key end-user sectors like buildings and industry. The Heating and Cooling Strategy —along with its subsequent implementation through the 'Clean Energy for All Europeans' Package (European Commission 2016b)— has been pivotal in aligning the heating and cooling activities of the building and industry sectors with long-term carbon neutrality targets. Despite these initiatives, the transition towards renewable energy sources in the heating and cooling sector has been slow-paced. Nevertheless, the Horizon-2020 funded project HOTMAPS (Grant agreement #723677) has found that current European policies, encompassing the heating and cooling strategy and its implementation, have been effective for what concern a decreasing trend in energy demand related to heating and cooling in the building sector. According to the analysis and estimates performed by HOTMAPS, further investment will be relevant to fulfill the most ambitious goal set for the future renewable, sustainable heating and cooling needs of the European Union (Kranzl et al. 2021). Figure 8 displays the differences between the estimated total energy demand for heating and cooling in the EU (to the left of each milestone) applying no further changes to the *current* policy framework and (to the right of each milestone) assuming measures will be adopted to meet the most *ambitious* goals for 2030, 2040 and 2050 respectively.

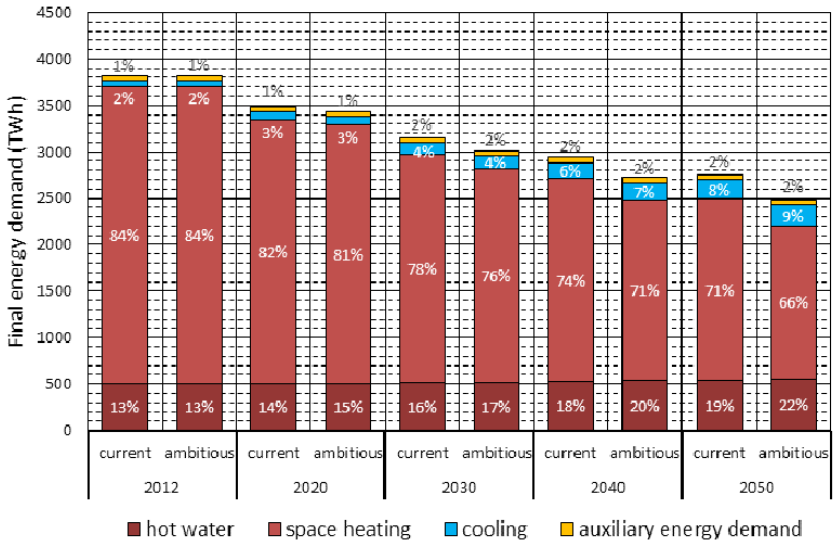

Figure 8: Prospected total final energy demand by end use types for current and ambitious policy scenario for heating and cooling in the EU28 in TWh till 2050. Source: Kranzl et al. (2021, 38).

In summary, the Heating and Cooling Strategy, which is an integral part of the EU's energy efficiency targets, is a cornerstone for the future development of the ESCO market. Accounting for almost half of the EU's gross final energy consumption, heating and cooling are central to the transition to a clean, carbon-neutral economy. The significance of this strategy for the ESCO market lies in the growing demand for renewable, sustainable heating and cooling solutions. Projects such as HOTMAPS, funded under Horizon-2020, highlight the need for further investment to meet ambitious future targets. For ESCOs, this means a growing market for innovative, energy-efficient heating and cooling solutions. As the sector evolves to meet these ambitious targets, ESCOs will find ample opportunities to develop and implement technologies and services that contribute to this essential energy transition.

4.1.1.3 The "Fit for 55" package and the building sector

In alignment with the objectives set forth in the Green Deal, the European Commission has formulated an additional action plan aimed at reducing GHG emissions to 55% by 2030. This comprehensive plan covers a range of urgent issues, including energy, land use, buildings, transportation, and taxation. The 'Fit for 55' package (European Commission 2021b) has initiated the revision of eight major directives and has also proposed five additional legislative instruments. A key proposal within this package is the introduction of a separate Emissions Trading System (ETS II), which would be dedicated specifically to the road transport and building sectors (potentially by 2027 at the earliest). This specialized ETS is designed to address more effectively the unique challenges these sectors pose, especially since carbon pricing has

a direct impact on vulnerable, low-income households. Consequently, the package also proposes the establishment of a Social Climate Fund, aimed at mitigating the financial impact on the most vulnerable populations as these sectors advance towards carbon neutrality. This is particularly beneficial for the residential building market, as supported households will find it easier to finance investments in energy-efficient renovations, as well as heating and cooling systems that employ clean technology. Additionally, the package strengthens the existing Renovation Wave Strategy and provides guidelines for the revision of current European legislation, notably the EED (Energy Efficiency Directive) and RED (Renewable Energy Directive). Dubbed 'Fit-for-55', this legislative initiative is set to adapt the regulatory framework to achieve the ambitious goal of doubling the annual renovation rate and decarbonizing the heating and cooling sectors, which together account for 80% of residential energy consumption.

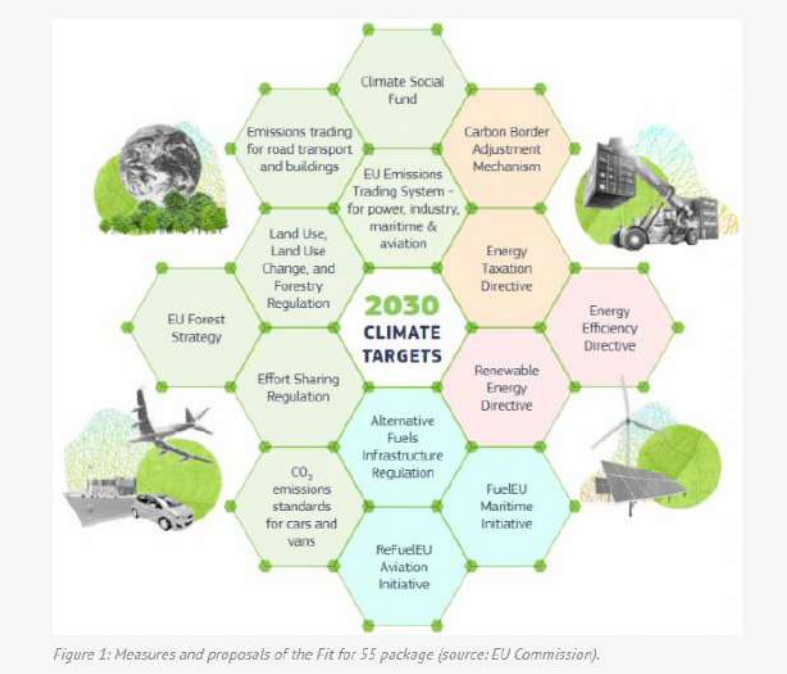

Figure 9: Regulatory frameworks, measures and proposals involved with the 'Fit for 55' package. Source: European Commission (2021a).

This package has set out a concrete timeline for decarbonizing the building sector. According to 'Fit-for-55', construction of new *public buildings* will not allow any GHG emissions from 2028 onwards, whereas *all new constructions* will not be allowed to cause any GHG emissions by 2030 at all. Existing *non-residential building* - i.e. buildings constructed before 2030 - will need to reduce their primary energy consumption and comply with a *maximum energy performance threshold* set by each member states based on the primary energy usage of the worst performing non-residential building. Maximum energy performance thresholds of 15%

and 25% are targeted for 2030 and 2034 respectively. Decarbonization of the remaining *residential building stock* follows gradually. Average energy consumption levels of existing residential building should at least comply with D *energy performance class* - i.e. energy performance is higher but no more than 35% of the requirement imposed for new buildings (Boverket 2023) - at latest by 2033. The next steps toward fully decarbonization of the residential stock are to be established by the corresponding national authorities, who will promote a timely decarbonization path towards 2050. The package will enforce the installation of cleaner energy generation technologies in all new public buildings with a floor area greater than 400m² by 2028 and all new residential buildings constructed by 2030. Exceptions to comply with energy efficiency standards can be defined by national authorities. This may be suitable for buildings of worship or facilities/buildings of temporary or seasonal use (BPIE 2023).

In summary, the 'Fit for 55' package is of particular importance to the ESCO market as it covers key sectors such as energy, land use, buildings, transport and taxation, initiating the revision of key directives and proposing new legislative instruments. A key aspect of this package is the Emissions Trading Scheme (ETS II), which specifically targets the road transport and buildings sectors. It is expected to come into force around 2027. The Social Climate Fund proposed alongside ETS II aims to reduce the financial burden on vulnerable groups, enabling more households to invest in energy-efficient renovations and clean heating and cooling systems. This will directly benefit the housing market and create new opportunities for ESCOs. The package reinforces the Renovation Wave Strategy and guides the revision of the EED and RED, focusing on doubling annual renovation rates and decarbonizing the heating and cooling sectors. As these sectors account for a large proportion of residential energy consumption, the 'Fit for 55' initiative offers significant opportunities for ESCOs to expand markets and provide services in these areas. Fit for 55 also sets a clear timetable for decarbonizing the buildings sector. It includes stringent measures for new public and residential buildings after 2028 and 2030 respectively, requiring zero greenhouse gas emissions. Existing non-residential buildings will also have to meet specific energy performance thresholds. This regulatory shift towards decarbonization and energy efficiency opens up a wide range of opportunities for ESCOs, particularly in implementing cleaner energy technologies and ensuring compliance with evolving energy standards.

4.1.2 European legislation and their implementation in the member states

The EU Energy Efficiency Directive and the Energy Performance of Buildings Directive are the key instruments setting provisions for the residential market and the building sector in general (more detailed insights can be found in Deliverable D2.2 of the frESCO project, see Aranda

2021). Key aspects for the progress on the EPBD are reported by member states addressing cost-optimal minimum energy performance requirements, Energy Performance Certificates (EPC), Nearly Zero-Energy Buildings (NZEB), financial incentives and market barriers, and Long-term Renovation Strategies (LTRS) (European Commission. Joint Research Centre. 2021; European Commission. Directorate General for Energy. 2023a).

By implementing the EPBD, member states are in charge of standardizing levels of energy demand for new residential buildings taking under consideration several categories like outdoor weather and indoor climate, envelope thermal characteristics, own-energy generation, and others. Figure 10 shows the current levels of primary energy demand in accordance with member states' requirements for new residential buildings.

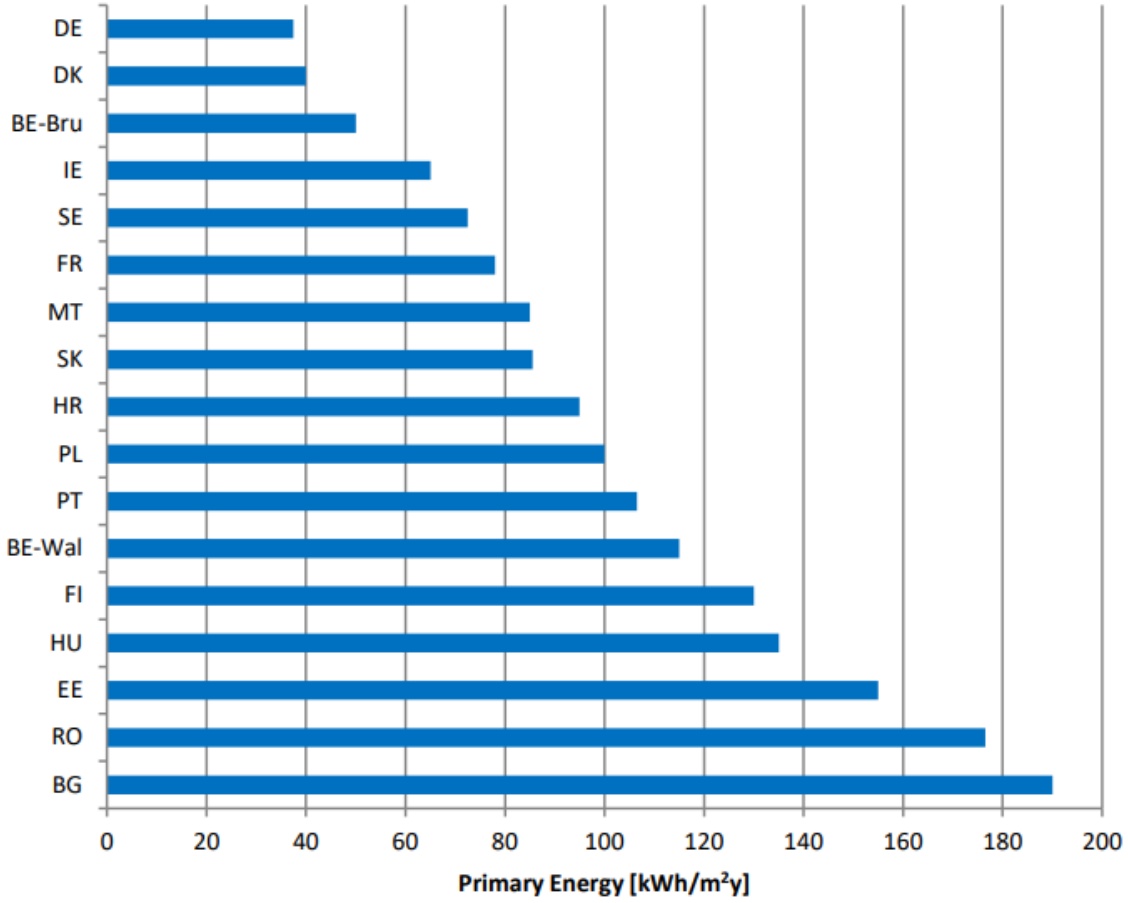

Figure 10: Energy requirements in force for new residential buildings in terms of primary energy in selected EU member states. Source: European Commission Joint Research Centre (2021, 17).

In order to enhance the quality of Energy Performance Certificates (EPC) that offer fair-pricing standards across Europe, the EPBD makes provisions for developing a rating tool for smart readiness of buildings called smart readiness indicator (SRI). Expected to be fully implemented

at EU level by 2040, the SRI could contribute to save annually around 160 TWh in primary energy consumption and 23 Mt of CO2 emissions annually as well as to reduce EUR 12.5 billion in consumer energy costs and EUR 1.4 billion in energy system costs (SRI 2022).

Nevertheless, according to the latest accounts from the National Energy and Climate Progress Reporting (NECPR) submitted by member states, while progress on decarbonizing EU building sector can be observed, several challenges remain for the harmonization of standards. Despite definitions and regulatory frameworks of the EPBD, indicators used by member states to implement EU legislation related to the building sector differ to some extent from each other to the point that makes comparison of efforts difficult. The fact that three (*energy use*, *GHG emissions* and *renovation rates*) reporting areas out of four (being *energy efficiency* **of** *building* the one with mandatory character) have a voluntary character constitute a limitation for the monitoring of progress as stated by the Joint Research Center (European Commission. Directorate General for Energy. 2023a). This challenge can be seen in the variety of targets for renovation rates reported by member states, differing from 1% to 6% annually to the missing cumulative targets for 2030, 2040 or 2050 milestones. Although the EPBD offers a definition for Nearly Zero Energy Buildings (NZEB) as it shall be enforced Europewide since 2021, member states have different requirements and indicators in place to comply with that definition, which differ even within single member states. Data reported by EU member states reveals the gap between new buildings - with an average primary energy demand of about 50 kWh/(m²y)- (see Figure 11) and renovated buildings - with an average primary energy demand of about 70 kWh/(m²y) - under the NZEB definition (see Figure 12). This issue is appointed to be addressed with the implementation of the upcoming Buildings Renovation Plans (BRP) as discussed at EU level (European Commission. Directorate General for Energy. 2023a; European Commission 2023c).

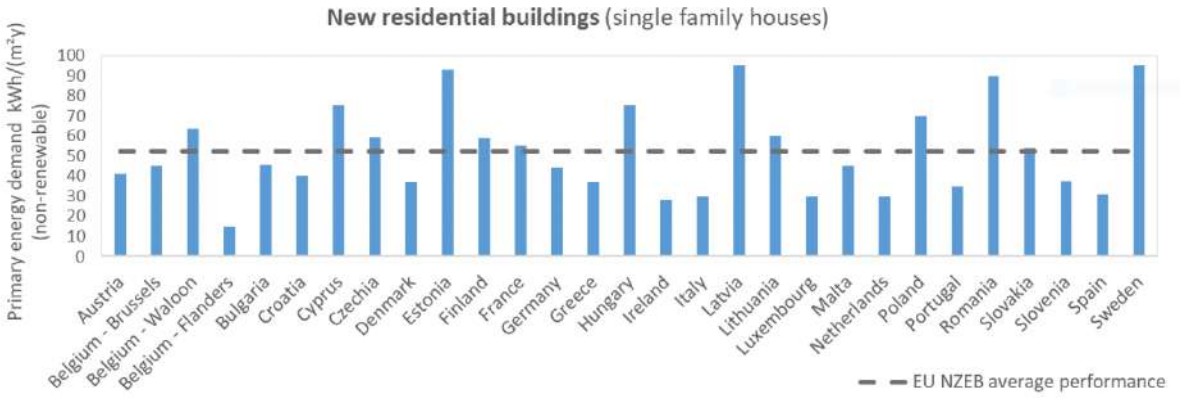

Figure 11: Energy performance of new residential single-family houses (expressed in non-renewable primary energy demand kWh/m²y) as of NZEB requirements. Source: European Commission, DG Energy (2023a, 23).

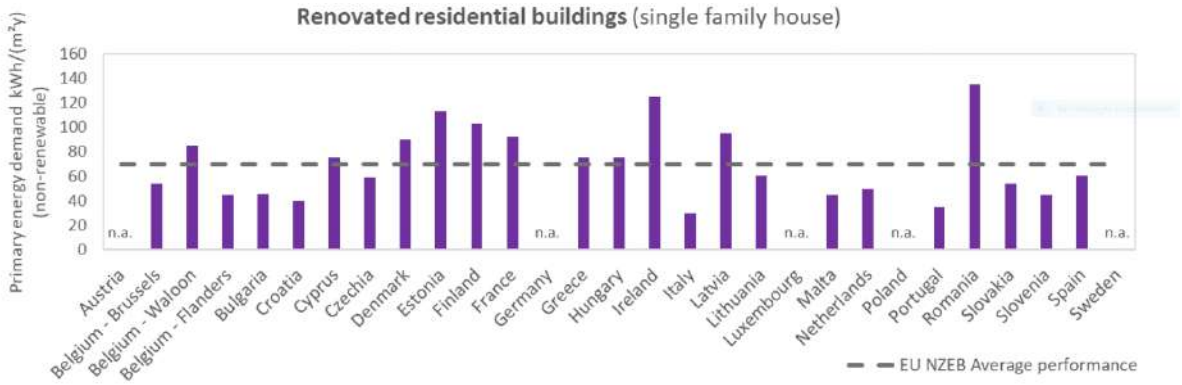

Figure 12: Energy performance of renovated single-family houses (expressed in non-renewable primary energy demand kWh/m²y) as of NZEB requirements. Source: European Commission, DG Energy (2023a, 24).

In summary, European legislation, in particular the EU Energy Efficiency Directive (EED) and the Energy Performance of Buildings Directive (EPBD), sets key rules for the housing market and the building sector. These directives guide Member States in setting cost-optimal energy performance requirements and implementing Energy Performance Certificates (EPCs), a key factor for ESCOs operating in the energy efficiency sector. The EPBD requires member states to standardize energy requirements for new residential buildings, considering factors such as outdoor weather, indoor climate and own energy production. This standardization creates a single framework within which ESCOs can operate, ensuring compliance and consistency across different EU regions. An important development is the introduction of the Smart Readiness Indicator (SRI) for buildings. Expected to be fully implemented by 2040, the SRI aims to improve the quality of EPCs and provides a standardized assessment tool for the smart readiness of buildings. For ESCOs, this means a shift towards more advanced, energy-efficient technologies that contribute to significant savings in primary energy consumption and CO2

emissions. However, challenges remain in harmonizing standards across member states. Despite the directives of the EPBD, differences in implementation and reporting hinder a consistent approach to energy efficiency in buildings. These inconsistencies pose challenges for ESCOs in terms of adaptability and compliance with different national standards. The definition and implementation of Nearly Zero Energy Buildings (NZEB) also varies between Member States. This variation affects the ESCO market by influencing the standards and requirements for energy efficient renovation and construction. The forthcoming Buildings Renovation Plans (BRP) are expected to address these issues and provide greater clarity and consistency, which will benefit ESCOs in the design and implementation of energy efficiency projects.

4.1.3 The need for revising EU strategies to achieve a prompt heat transition

In view of the energy price crisis originated from the Russia-Ukraine conflict, many associations committed to a more comprehensive decarbonization of the buildings sector by rolling out clean and sustainable technologies. In October 2022, these organizations -including *BIOenergy Europe*, *European Heat Pump Association*, *European biogas association*, *EnergyCities*, etc. - formulated a 10-points-plan tightening the current EU legislative and governmental efforts to deliver the net zero ambitious by 2050 (Energy Cities 2022). According to these European organizations of the energy domain, the EU heating and cooling transition can be accelerated making good use of the opportunities brought about by the energy price crisis and the favorable momentum that is bringing people to look for more reliable alternative to questioned Russian gas dependency.

These organizations recognize the importance of the measures included in the 'Fit-for-55' package to advance a heat transition towards a renewable heating and cooling sector. However, policy adjustments are needed urgently in order to achieve EU ambitious decarbonization goal timely. The proposed 10-Points-Plan addresses crucial policy areas that can advance the transition to renewable and decarbonized heating systems and strength energy independence: (i) elaboration of a Heating and Cooling strategy compatible with the Green Deal policy framework that outlines concretely the deployment of renewable heating solutions for the building sector; (ii) a stronger building renovation and the heat transition are to be carried out coordinately; (iii) Local authorities are to be entrusted with a mandatory heat planning focusing on enhancing the optimum use of heating resources while phasing out fossil-based technologies; (iv) invest in the professional retraining of the needed labor force; (v) improve financial schemes for sustainable district heating, while (vi) eliminating support for fossil fuels; (vii) Establish a level playing field that covers all different heating and cooling sources; (viii) further support a comprehensive deployment of sustainable waste heating that

integrates industrial waste heat and urban waste heat recovery; (ix) incentivize the deployment of renewable heating technologies in so-called renewable acceleration areas (RAA); and (x) holistic approaches need to be introduced for building decarbonization measures where GHG emissions, local sourcing and life-cycle indicators are equivalent to energy consumption measurements.

Addressing this need, the European Commission is for instance preparing a heat pump strategy for which feedback has been collected from institutions and the open public. The Commission is envisaging four main action fields to ensure the success of this strategy. Action fields include getting onboard member states, the heat pump industry and research and development institutions into a corresponding partnership; getting involved interest groups to develop skill partnerships to facilitate the rolling-out of heat pump technology; revision of the series of legislative instruments including RED and EPBD; and making available sufficient financial means.

4.1.4 National regulatory conditions influencing ESCO market development

frESCO BMs target energy efficiency buildings retrofit, appliance efficiency and the technology switch towards renewables as well as revenues streams from participation on demand-side flexibility markets. However, the development of ESCO and Aggregator BMs is limited by different kinds of barriers coming from regulatory conditions, non ESCO-specific regulatory conditions and regulatory frameworks affecting investments in buildings renovations. According to a latest survey of the UNEP Copenhagen Climate Center and the Global ESCO Network (2023), ESCO activities are widely recognized in many legislations across the world and in many European countries in particular, where ESCO Associations have long been actively promoting a dialogue among ESCOs, governments, market players and the public. ESCO-specific regulations in Europe are assessed as favorable in general, however, unfit and unfavorable conditions exist depending on the single country. Figure 13 shows the prevalence of responses from national ESCO associations regarding four key ESCO-specific regulatory conditions influencing the market development of businesses across Europe and beyond. These four key issues concern (i) the existence of a fit-for-purpose definition of ESCO, (ii) the existence of an optimum ESCO accreditation system that considers business, financial and technical criteria like certification, financial strength and measurement/verification standards among others, (iii) availability of dedicated and suitable ESCO contract templates reducing the transaction cost of complex contractual requirements, and (iv) the establishment of ESCO aggregator schemes. ESCO's associations responses show that across Europe ESCOs are legally defined but accreditation systems are not a standard. Suitable ESCO contract templates can be found in all the surveyed associations however some have been assessed as unfit for ESCO

market requirements. Regulatory frameworks for ESCO aggregators are seldom established across Europe according to ESCO associations assessment.

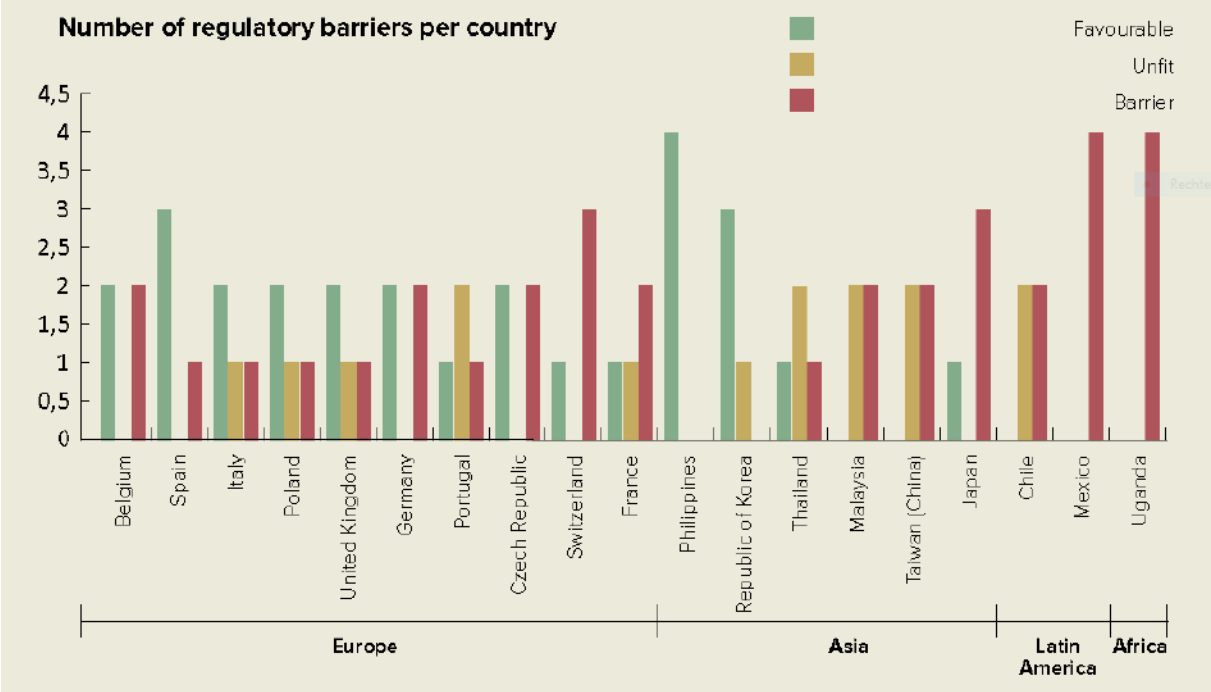

Figure 13: Result of survey on ESCO-specific favorable conditions and barriers from the perspective of national ESCO Associations. Source: UNEP Copenhagen Climate Centre (2023, 23).

Concerning non-ESCO-specific regulatory conditions influencing the future development of the market for ESCO BM, four categories have been surveyed among ESCO associations.

(i) Energy audit requirements are important to determine the actual use and cost of energy as well as to evaluate the profitability of a given energy efficiency project. Mandatory energy audit performed by skilled specialists increases overall costs but can be necessary to accelerate the achievement of national energy efficiency targets. Such a scenario can impact positively the ESCO market due to the degree of specialization of ESCO operations regarding energy audits.

(ii) Energy charges reflecting actual consumption which are also a basis for ESCO BMs. This factor concerns not only metering standards and data protocols but also charges for energy using criteria like space area instead of actual consumption. This is often the case for space heating in residential buildings.

(iii) Measures targeting split incentives or owner-tenant dilemma.

(iv) Favorable public procurement to engage in long-term service contracts (see Figure 14).

According to ESCO association's responses, Europe might be the region with the most favorable conditions non-specific for ESCO BMs.

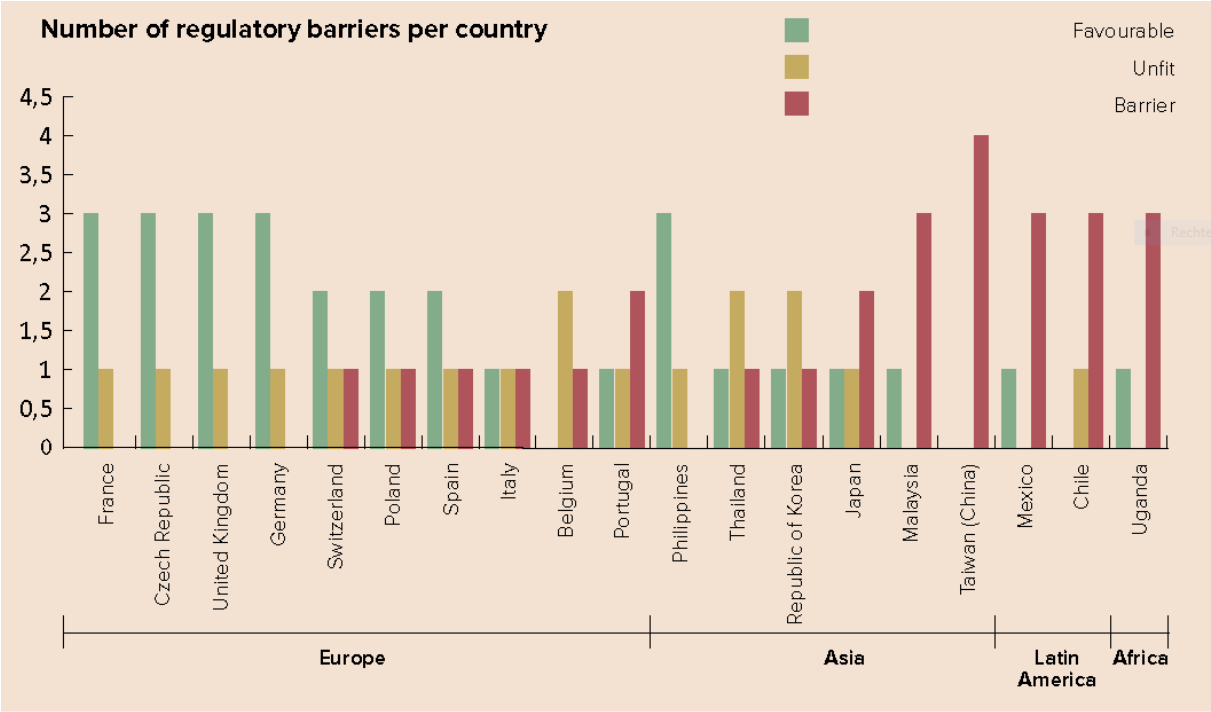

Figure 14: Result of survey on favorable conditions and barriers not specific to ESCOs from the perspective of national ESCO Associations. Source: UNEP Copenhagen Climate Centre (2023, 35).

Favorable conditions for energy efficiency investments can impact positively the development of the future ESCO market. The survey on ESCO associations' assessment covered the following regulatory conditions impacting efficiency investments: (i) Existence of grant programs fostering energy efficiency investments, (ii) mechanisms reducing costs and financial risk affecting ESCO cash flow, and (iii) suitable taxation and accounting regulations. Their responses reveal an uneven picture for the European region (see Figure 15). While most European governments have energy efficiency programs in place, ESCO associations see a need for mechanisms to alleviate the performance and financial risks involved with energy efficiency projects carried out by ESCOs. Taxation and accounting rules favorable to the ESCO BM were found only in three of the surveyed European ESCO associations.

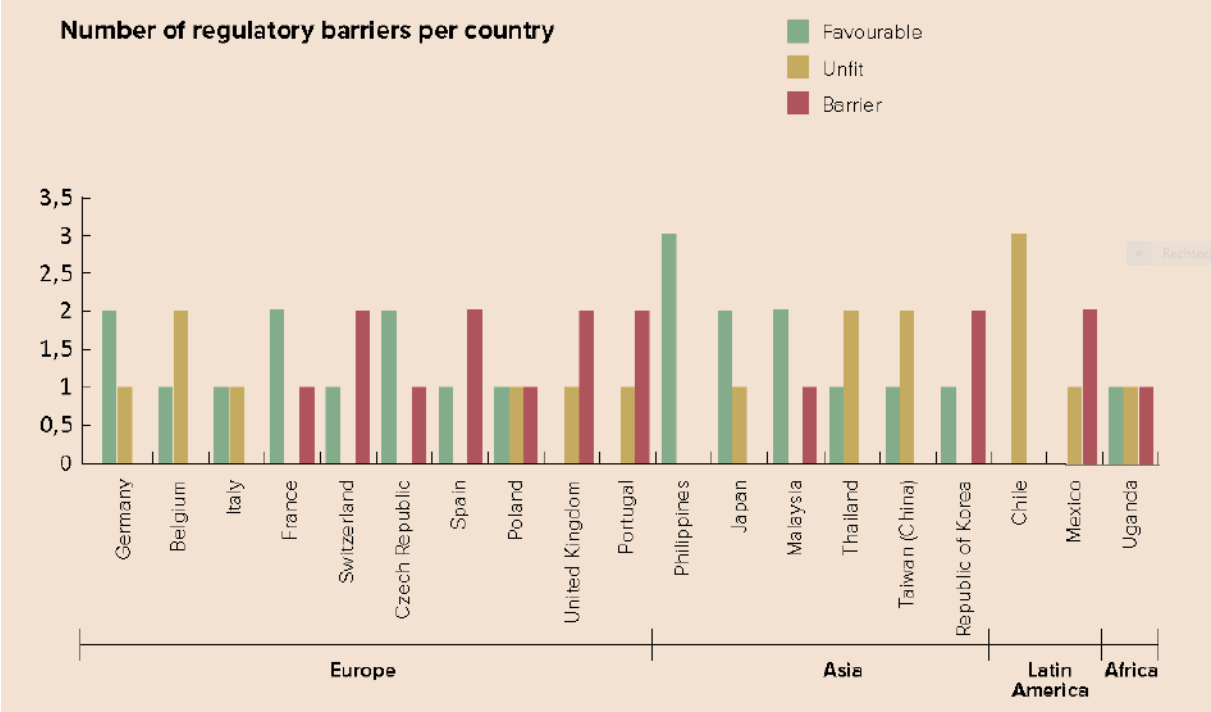

Figure 15: Result of survey on favorable conditions for and barriers to regulatory frameworks facilitating investments from the perspective of national ESCO Associations. Source: UNEP Copenhagen Climate Centre (2023, 43).

4.1.5 Take-aways from regulatory trends

Overall, within the EU there is a clear political commitment towards decarbonization of the (residential) building sector by increasing energy efficiency and supporting the uptake of renewable energy technologies. However, political action can be expected to put decarbonization rates on track and bring acceleration on the path towards an efficient, sustainable residential building sector. Indeed, despite a clear reduction trend on energy demand for heating and cooling for the next years and decades (see subsection 4.1.1.2), the envisaged technology switch towards renewable energy technologies will need further political support. *Space heating* and *hot water heating* exhibit the highest technical and economic energy saving potential, together accounting for over 90% of the estimated energy savings potential.

The effectiveness of policy frameworks and interventions have been currently assessed as being too slow on delivering a transition towards achieving 2030 ambitious. Nonetheless, major changes are planned in the coming years, which can provide a certain acceleration for the buildings sector and especially for decarbonizing the residential sector. The following are the main expectations that can be drawn from the current political action at EU level:

- The introduction of the ETS II - under preparation - at earliest by 2027 is expected to accelerate the achievement of the 2030 goals, increasing energy efficiency and supporting the uptake of renewable energy technologies within the building sector.

- The dedicated Social Climate Fund will start operations by 2026 with the aim of preventing uneven social effects on vulnerable households related with the expansion of carbon pricing to the building and road transport sector by means of the ETS II, which may include additional fiscal aids for the implementation of renovation projects in residential buildings.

- Continuous revision of policy frameworks and even progressive strategies are expected to be prepared and implemented at European and member state levels like currently in the case of the heat pump strategy.

- Harmonization of technical requirements under a Europewide minimum energy performance standards (MEPS) and facilitating tools like the SRI are being coordinated at EU level, which will contribute to easier market penetration of renewable energy technologies and energy service solutions for an efficient building stock across Europe.

- ESCO business model are widely recognized across Europe but regulatory conditions specific (and non-specific) for ESCOs will need to be adjusted to properly fit the requirements needed to enhance their market development potential in order enhance market penetration into energy efficiency projects for residential customers.

The future trends drawn here from political action related to the market penetration for energy performance services within the EU can be seen as favorable for frESCO's solutions, although uncertainty remains to the extent of political consensus to adopt corrective measures needed to achieve carbon neutrality with the corresponding timely implementation. A higher economic uncertainty together with the risk of energy security and an uneven competitive conditions in the global context might also influence the EU capacity to implement their ambitious goals (European Commission 2023b).

4.2 Prospects for demand respond services

Demand Response (DR) enhances the load flexibility of the energy grid by offering incentives to electricity end-users, thereby optimizing energy demand in both wholesale and ancillary power markets for a more efficient utilization of the grid as a whole (IEA 2023a).

In the European Union, demand response solutions are highlighted as one key aspect of the energy transition in the Directive 2019/944 Of The European Parliament And Of The Council on common rules for the internal market for electricity. In Article 17, this directive demands that "Member States shall allow and foster participation of demand response through aggregation. Member States shall allow final customers, including those offering demand response through aggregation, to participate alongside producers in a non-discriminatory manner in all electricity markets" (Article 17). The directive also focuses on the empowerment of consumers (Chapter III) and, among other provisions, specifies the consumers' right to conclude aggregation contracts (Article 13). With Directive 2019/944 in effect, the demand response market in the European Union is expected to develop significantly in the coming decade.

There are generally two mechanisms employed to achieve this load flexibility. Implicit DR employs pricing incentives or specialized tariff programs to encourage consumers to align their energy-dependent activities with grid availability. In contrast, Explicit DR offers direct financial compensation to consumers who are willing to participate in designated demand-side response programs, thereby agreeing to adjust their electricity consumption patterns. According to the International Energy Agency (IEA 2023c), the importance of the flexibility market is expected to grow in tandem with the expansion of multiple renewable energy generation systems. Because of inconstant energy production of renewable technologies, a gap of dispatchable capacity will increasingly constitute a concern for the European energy market in the long term (see Figure 16).

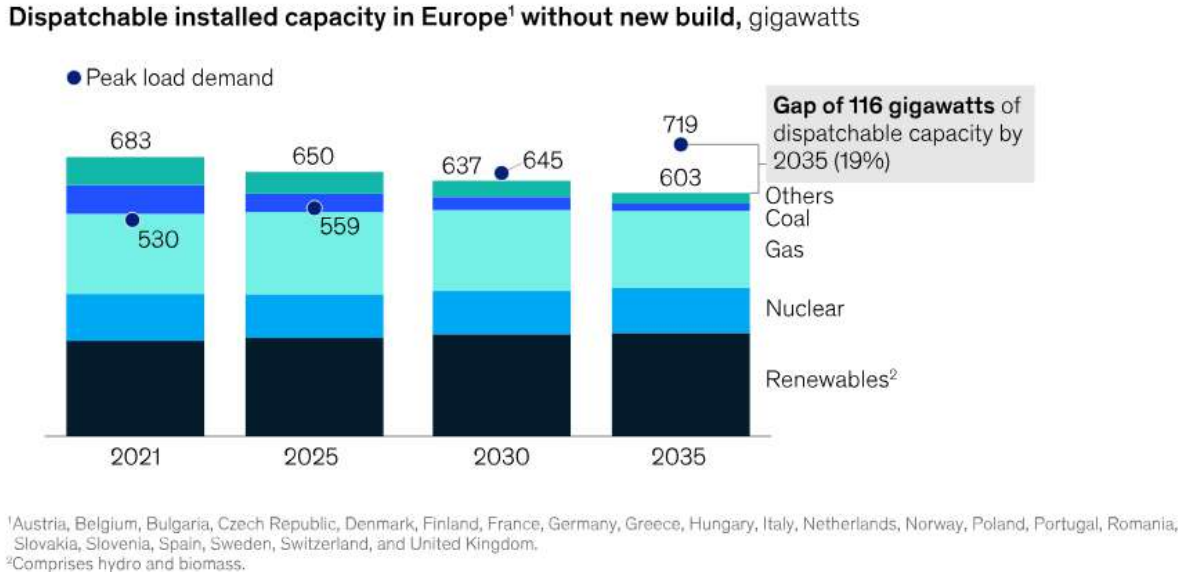

Figure 16: Prospected gap of dispatchable capacity in Europe towards 2030 and 2035 in a business-as-usual scenario. Source: Schülde et al. (2023).

Advancing the share of renewable energy generation will provide high levels of variable electricity loads, for which flexible consumption by end-users and smart technologies will be key to enable a full exploitation of such variable loads. Additional energy storage and flexible heating systems will be needed, as well as smart infrastructure, smart appliances and smart electricity tariffs compatible with real-time pricing (Gupta and Morey 2023).

The benefits of a demand side flexibility market for the European energy sector have been quantified using a macro-economic model by Smart Energy Europe and DNV (2022). Modelling a full deployment of demand side flexibility for the EU-27 by 2030, a total downward flexible power of 130 GWh and an upward flexible power of 164 GWh are estimated, which projects energy cost saving for end-consumers of about 5% yearly by activating a demand side flexibility capacity of 340.5 TWh and 397 TWh respectively. Further benefits could be leveraged for security of supply and investments in energy network, as well as lower energy prices directly beneficial for those participating in demand response markets and indirectly for all energy consumers bearing lower grid costs (Sáez Armenteros et al. 2022).

Residential electric heating could play an important role in the future demand side flexibility (DSF) market according to this report. Due to deficiency of data for the entire European residential stock, the report illustrates their modelling using the German residential heating market as a case study. Their calculations for a given week in 2030 (see Figure 17) estimate a total activated DSF of 195.5 TWh both directions for EU-27 and underscore the need for supply management in the residential heating sector, where supply of loads is to be balanced considering low real-time prices and consumption requirements.

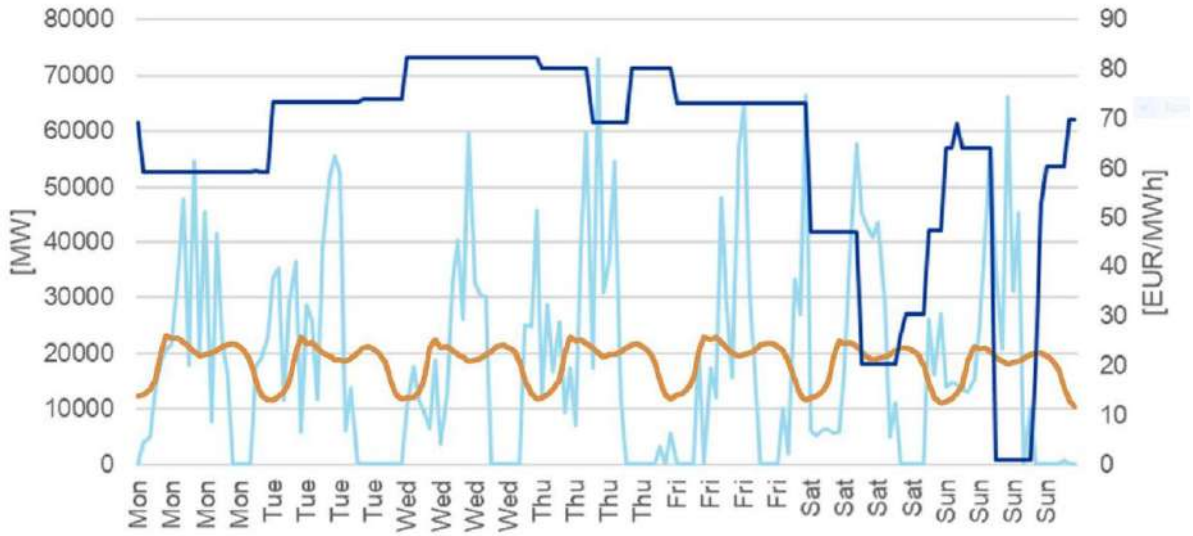

Figure 17: German residential heating and Demand Side Flexibility on a given week of 2030 as modelled by DNV, Source: Sáez Armenteros et al (2022, 22) .

As part of the REPowerEU package from 2022, the EU has set out the roll-out of 60 million heat pumps in addition to the 20 million units installed thus far across Europe. There are however barriers to achieving this target but according to the European Heat Pump Association (EHPA 2023) the European market would be in position to deploy 43.1 million heat pumps between 2023 and 2030 assuming no major changes are introduced till 2030. In such a case, heat pumps could be providing heating, hot water and cooling to about half of Europe's building stock by 2030. Figure 18 shows the additional heat pump production estimated by the EHPA, with France and Spain (among the top-5) installing about 8 and 3 million additional heat pumps respectively by 2030. Isolated heat pumps units alone do not represent much of an asset for demand response businesses. Joint under a coalition of heat pumps, aggregators can balance their energy consumption within a network of units to leverage the most of the network, depending on the given energy price and consumption needs and concrete climate conditions influencing its performance. With an increasing stock of installed heat pumps in Europe, opportunities for ESCOs and Aggregators grow accordingly (Lindahl 2020). Organizations committed to the deployment of heat pumps to transform the heating and cooling sector have developed a heat pump accelerator pointing out how to overcome current deployment barriers across the EU. The European Commission is currently preparing a heat pump action plan to be presented by the end of this year aiming at stimulating the technology switch in this sector (EHPA 2023).

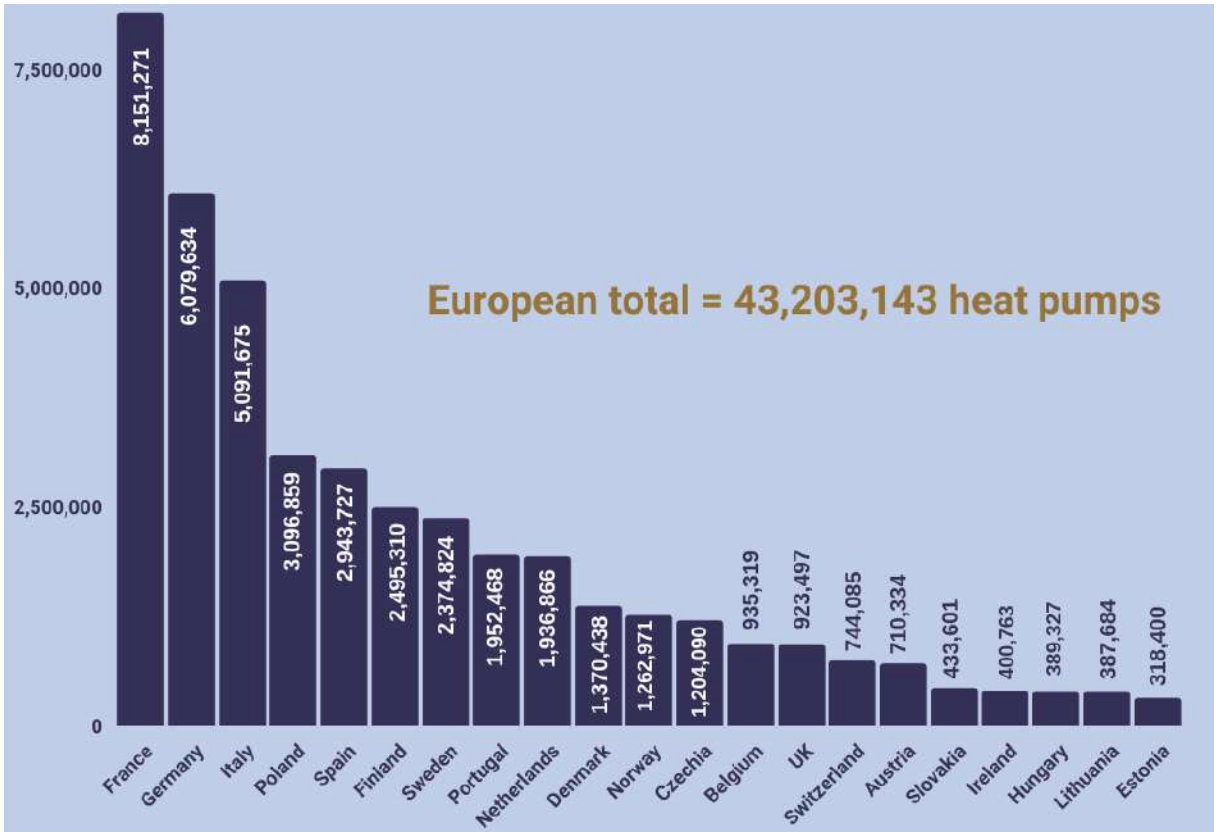

Figure 18: Estimation of heat pumps installations from 2023 till 2030 by selected EU member states. Source: European Heat Pump Association (2023).

In this context, market research institutions have estimated the growth potential of the European market for energy management systems - including Building EMSs and Home EMS - rating the market with a CAGR of 15.48% between 2022 and 2030. As determinants for that assessment, future volatility of energy prices, the rising need for smart solutions in the buildings sector and increasing governmental support schemes for efficient power consumption in the building sector have been mentioned (Inkwood Research 2022; P&S Market Research 2022).

4.3 General market trends in the energy services market

In the following, we take a broader approach by focusing on the energy service market in the residential sector and structural trends expected to dominate the energy sector over the coming years.

4.3.1 Future development of electricity prices and building renovations

According to the EU Reference Scenario 2020, electricity prices are expected to increase for residential consumers moderately by 2030 and remain stable from 2030 to 2050 (European

Commission. Directorate General for Energy., European Commission. Directorate General for Climate Action., and European Commission. Directorate General for Mobility and Transport. 2021). Two main factors are considered determinant of this development: (i) the introduction of carbon pricing and respective taxation, and (ii) increasing electricity grid costs caused by the expansion of renewable generation technologies (see Figure 19). Electricity charges for industrial consumers are clearly lower than changes for households and services because of the different weight of the price components - e.g. wholesale electricity prices, grid costs, capital costs, fixed costs and taxes on electricity - and energy-intensive industries are likely to be protected by national authorities.

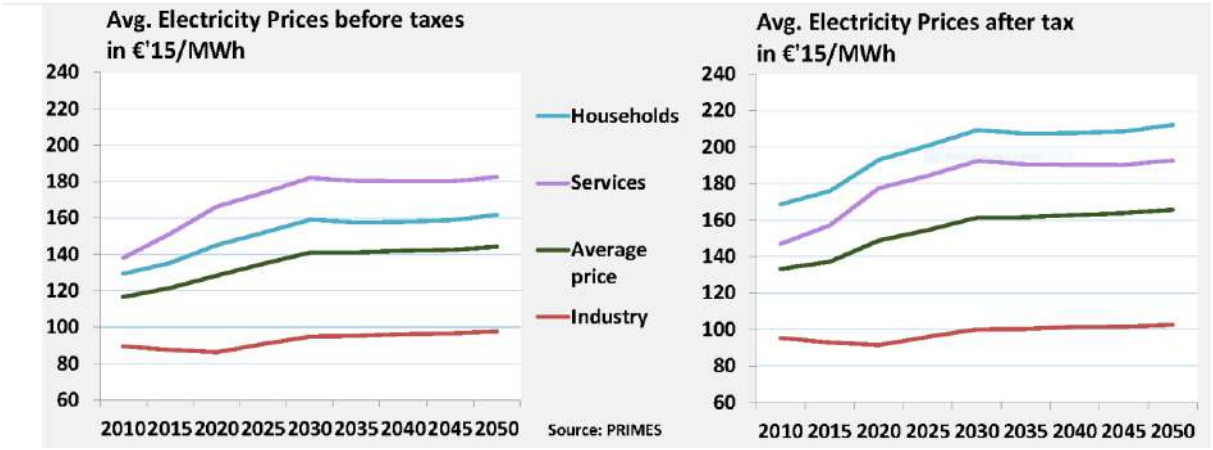

Figure 19: Estimated average electricity prices in the EU by sector till 2050 before tax (left) and after tax (right) according to the Reference Scenario 2020. Source : European Commission (2021, 100).

The energy price crisis that followed the beginning of the Russia-Ukraine conflict in 2022 underscored how volatile the wholescale energy market can get in Europe. The impact of increasing wholesale energy prices on final energy bills for end-consumers has been analyzed with special regard of the energy savings potential of renewable expansion across the EU (Eichhammer 2022). Wholesale energy prices are responsible for 15% of the final cost expressed on end-consumers' energy bills according to the EU reference scenario 2020. However, since energy prices have skyrocketed at such an unpredictable scale, this share may have changed for the long-term, showing more attractive figures for efficient building renovation delivering substantial energy savings.

The assessment of the economic saving potential by different target scenarios and different wholesale energy prices is showed in Figure 20. To the left, economic saving potential increases by higher reduction targets - i.e. 4% and 9% reduction targets - under the same EU reference scenario 2022. To the right, the economic saving potential increases by higher average wholesale prices - calculations are made for 17%, 30% and 100% increase at wholesale

market. Findings of this analysis suggest that because of the different price components of final energy prices for end consumers, a doubling - or even a tripling - of average wholescale prices will not result in increased energy bills by the same rate but rather moderate. Overall, with higher energy bills expected for the different scenarios, the rentability of energy efficient building renovations increases accordingly (Sante 2023; Eichhammer 2022).

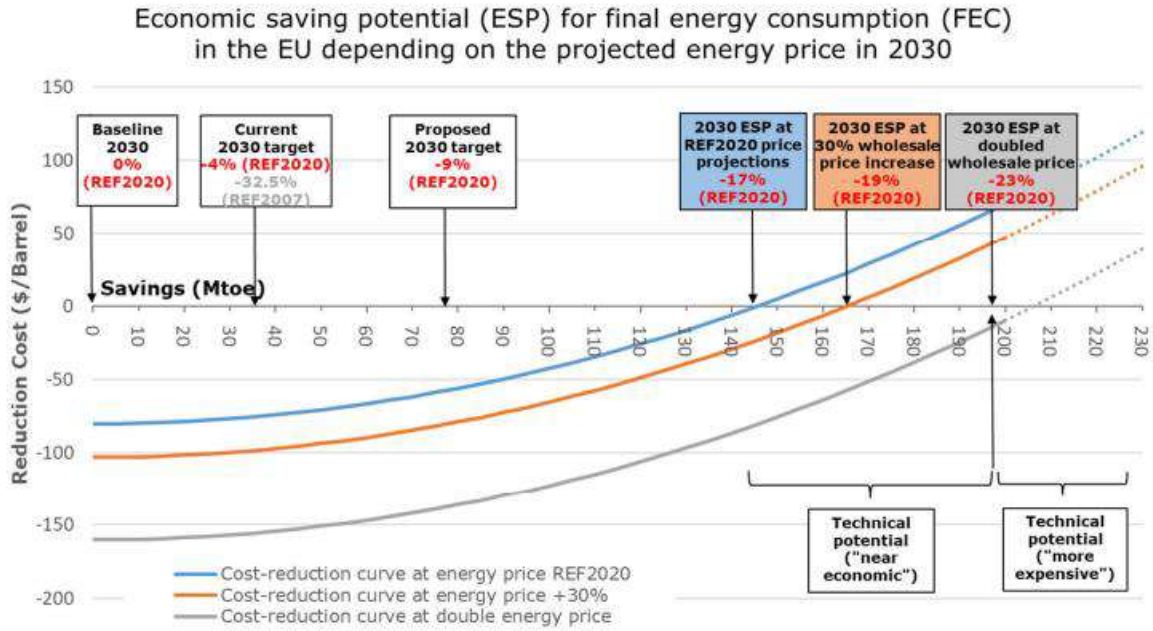

Figure 20: Impact of increasing energy prices on technical and economic savings potential in 2030 as projected from the EU reference scenario 2020. Source: Eichhammer (2022, 11).

To similar conclusions came for instance Hinz and Enseling (2022), when analyzing the impact of higher energy prices for fossil-based energy on the rentability of energy efficient building renovation of single and two-family houses with different construction yeas in Germany. They highlighted that considering a time horizon of 25 years, renovation projects will pay off providing higher energy savings and the high risk for expensive fossil-based energy costs. Political support on promoting energy efficiency and providing the corresponding financial schemes will still be necessary in the future building sector (Mandel et al. 2023).

The current trend in the European energy wholesale market aligns with official European working scenarios. After a historic peak in fall of 2022, wholesale energy prices have been falling back unexpectedly in European power markets. This trend is expected to continue in the near-term. Nonetheless, average wholesale prices will not reach pre-crisis averages according to prospects coming from market research institutions (see Schülde, Veillard, and Weiss 2023) and the latest International Energy Agency's electricity market outlook for the European region (IEA 2023b). Figure 21 shows that despite the current declining trajectory of

wholesale power markets, long term prospects for wholesale energy prices in Europe could fluctuate close to an average 3-fold higher than wholesale energy prices between 2016 and 2021.

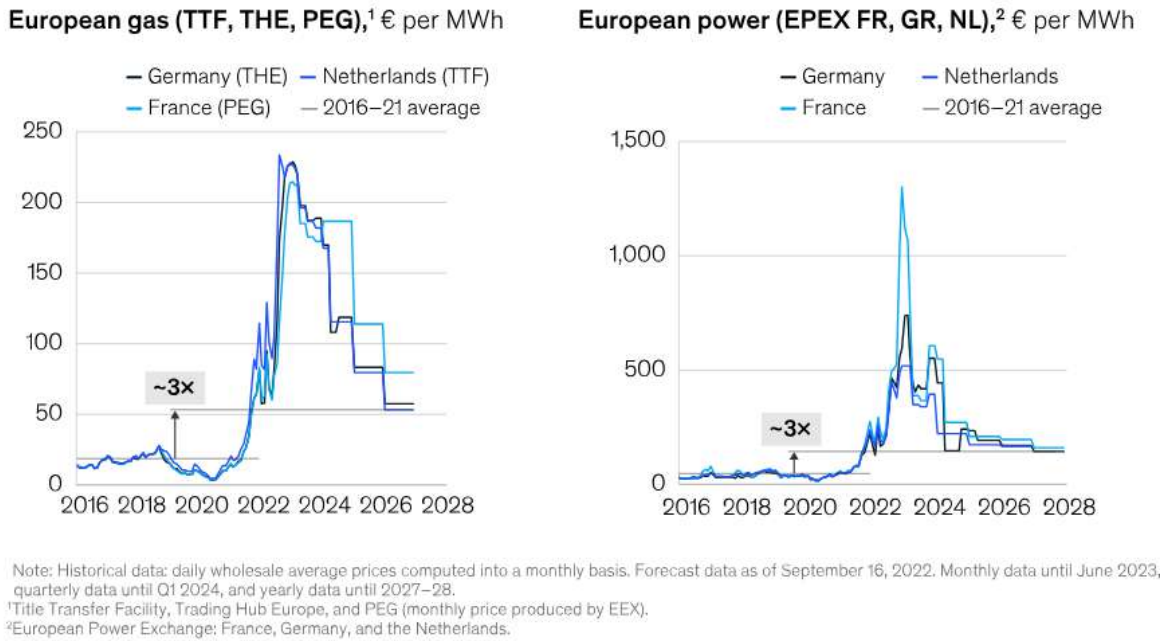

Figure 21: Prospects for whole sale power markets in Europe in EUR per MWh 2016-2028. Source: Schülde and colleagues (2023).

4.3.2 Prospects for the renewable energy market in Europe

According to the International Energy Agency's Renewable Energy Market Update (IEA 2023c), which includes outlooks for both 2022-2023 and 2023-2024, the EU appears well-positioned to achieve its recently approved ambitious target of a 42.5% increase in renewable energy deployment by 2030 (Council of the EU 2023), despite the various uncertainties in the energy market (see Figure 22). The growth in renewable energy capacity is largely fueled by the increase of distributed solar photovoltaic (PV) projects across Europe. This upward trajectory is anticipated to persist, thanks to regulatory shifts and the broadening scope of PV in both the residential and commercial sectors. This is particularly the case for countries like Germany, the Netherlands, Poland, Italy, and France. Meanwhile, the EU's contributions to onshore wind capacity have experienced limitations in recent years due to permitting challenges.

Two primary factors are significantly influencing this development. First, the European Union's heavy reliance on Russian natural gas imports has proven to be a considerable vulnerability for the Union's energy security. In response to Russia's invasion of Ukraine, numerous EU

member states have enacted policy changes aimed at reducing their dependence on Russian natural gas. This shift has catalyzed the expansion and maturation of the European renewable energy market, thereby creating a favorable political momentum for future advancements in energy efficiency and the increasing trend of renewable energy technologies.

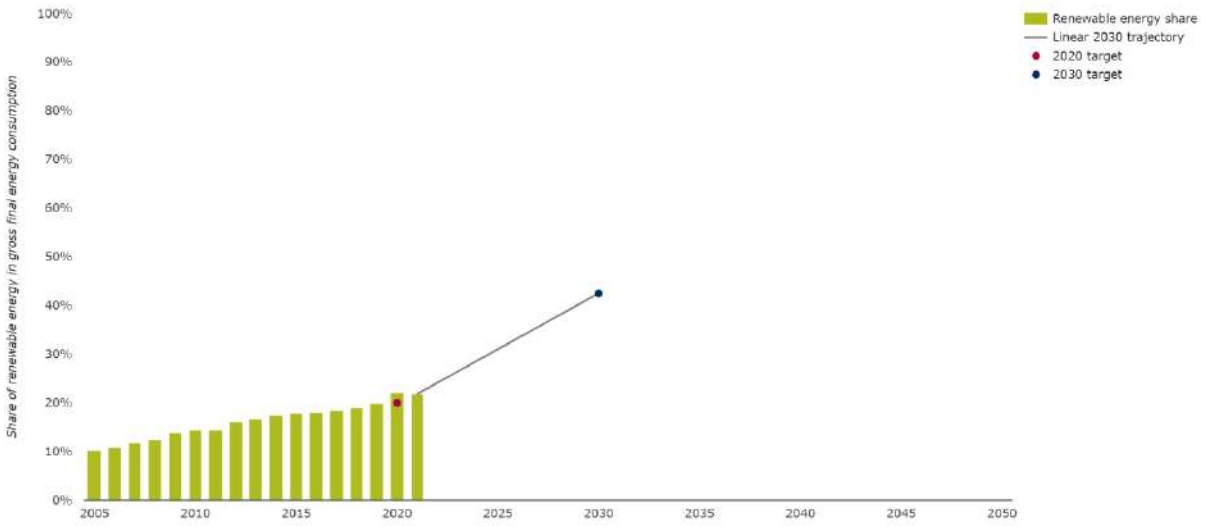

Figure 22: Share of energy consumption from renewable sources in Europe and projection till 2030. Source: EEA (2023).

On the other hand, significant increases in gas, oil, and electricity prices are positively impacting the competitiveness of renewable energy generation technologies. This situation is also contributing to a surge in solar PV capacity installed in Europe, which is expected to more than double from the current 221 GW to reach 475 GW by the end of this decade (Aurora Energy Research 2023). This aligns with global projections of the IEA (2023d) that foresee solar power becoming the largest energy source among renewables as early as 2027. In addition, manufacturing capacity is expected to double in 2024 and amount for 1,000 GW solar power production capacity per year, which at the same time increases prospects to reach the accelerating renewable deployment needs for 2030. Prospects for residential solar capacity are also favorable for the next years. Amounting to 40.4 GW, the residential solar capacity in Europe is expected to grow to 71. 1 GW by 2027. In this context, market research companies expect a CAGR of 9.6% for the entire European residential solar market between 2022 and 2027 (Businesswire 2023).

As a consequence of rising energy prices and the corresponding governmental support, there is a growing segment of energy prosumers in Europe who are willing to adjust their energy

consumption patterns and reap benefits from adapting to market requirements. Flexibility needs of the European energy system are expected to grow accordingly. Estimates of the EU Joint Research Centre (2023) show that the flexibility of the European power sector will raise from the 11% mark of the electricity demand in 2021 to 24% level by 2030. Aligned with the future growth of renewable -and especially solar- power capacity by 2050, flexibility requirements could even grow up to 80% of the future European electricity demand by 2050. Missing to develop corresponding energy storage capacity will result in an increasing pressure to energy system operators and price fluctuation can be expected, which will in turn influence strongly the development of a demand response market participation from household, ESCOs and aggregators.

4.3.3 Digitalization of energy grids

The expansion of renewable energy management systems is dependent on a high developed level of digitalization (European Commission 2023a). A widespread digitalization of energy grids allows for an optimum utilization of complex energy generation systems like in the case of renewables (R2M Solution. et al. 2021).

Net Zero targets and digitalization targets are known as the twin transitions of European economic development and climate policy (Dæhlen 2023). To further Europe's digital transition, the Commission has set out concrete goals for upskilling, infrastructure, businesses and public services by 2030 (European Commission 2020a; European Commission: DG Communications Networks Content and Technology 2023). Progress on the digitalization of business towards 2030 is shown exemplary in Figure 23.

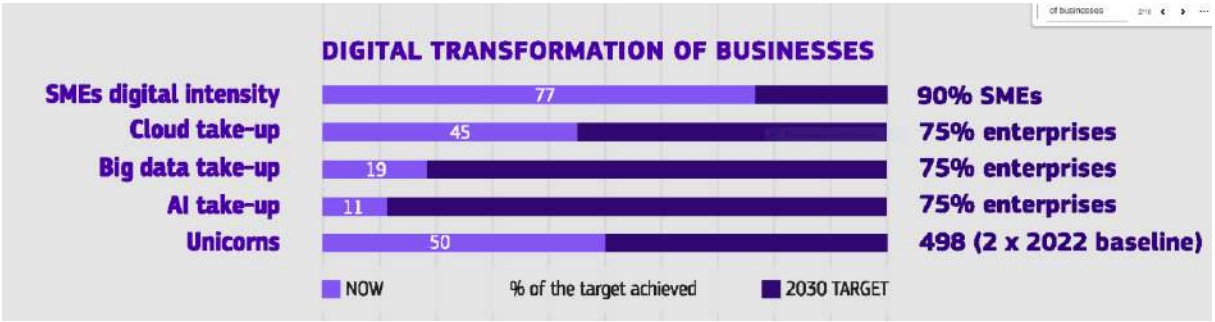

Figure 23: Progress towards Digital Decade targets regarding businesses set for 2030. Source: European Commission (2023, 3).

Concerning the energy sector, the digitalization policy of the EU includes the digitalization and continuous standardization of the entire energy system. Advancing the digital transformation, the EU supports transparency of the energy sector for consumers to enable active and informed participation on the market while optimizing their overall energy consumption, for which innovative digital tools and standardized European data spaces are necessary

(European Commission 2023c; European Commission: DG Communications Networks Content and Technology 2023). Simultaneously, the EU's digital policy for the energy sector aims to ensure that the energy consumption of the increased demand for ICT technologies in the strong digitalized future keeps up with the best energy efficiency standards, making provision for energy labels and certificates for the energy sector's blockchain, as well as enhancing the cybersecurity of the European energy network. Figure 24 shows the support actions aiming at advancing the digitalisation of the European energy system conducted by DG CONNECT -the Directorate-General for Communications Networks, Content and Technology-.

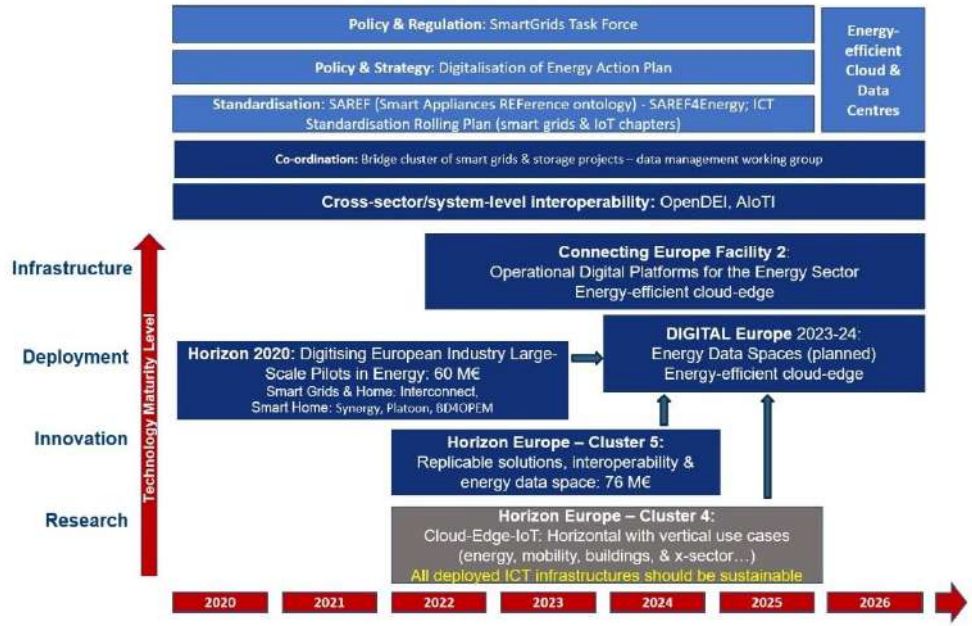

Figure 24: EU support actions for the digitalisation of the energy system. Source: European Commission (2023a).

In this context, the development of smart energy grids and promoting the full deployment of smart metering system across Europe are fundamental for the digitalization of the European energy sector and the achievement of the net zero targets. Smart meters allow households and commercial consumers to take control of their power consumption and are fundamental for the development of new business models. In 2014, the European Commission set out the target to deploy 80% of residential smart meters by 2020 (European Commission. Directorate General for Energy. and Tractebel Impact. 2020). By the end of 2021, market penetration of smart electricity meters in the EU 27(+3) reached 56% according to *Berg Insight* (2022), showing robust development prospects of CAGR 5.8% (see also Figure 25). By 2027, market penetration could reach the 76% mark. However, the variety of technologies among the

current stock of smart meters available across Europe does not offer the same functionalities, which currently represents a challenge for more timely consumption data and information exchange, e.g. in a 15 minutes frequency.

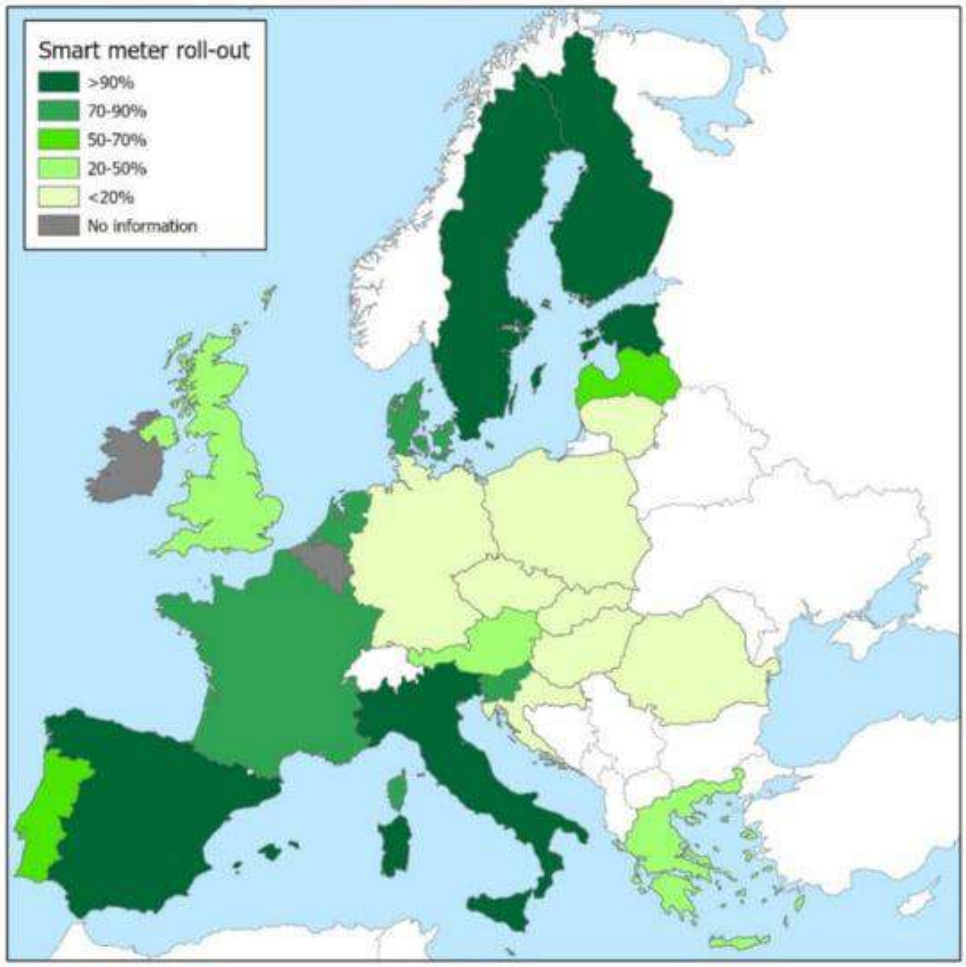

Figure 25: Progress on smart metering roll-out across Europe. Source: Vitiello et al. (2022, 7).

As part of the proposal for a recast of the Energy Performance of Buildings Directive included in the 'Fit for 55' package, the European Commission suggested the introduction of an information tool about relevant data generated by buildings throughout its life-cycle to ensure transparency, compliance and interoperability. The proposal is known as the *Digital Building Logbook* (DBL) and its feasibility is being tested and assessed under Horizon 2020 research projects. Relevant EU-supported projects in this regard are Demo-BLog (Grant agreement ID: 101091749), DigiPLACE (Grant agreement ID: 856943), CHRONICLE (Grant agreement ID: 101069722) and DigiBUILD (Grant agreement ID: 101069658).

An efficient Europewide implementation of such DBLs could facilitate the achievement and monitoring of energy efficiency targets for the European building stock as well as taking

informed decisions about constructing new building, renovating existing ones and developing maintenance plans. In addition, a widespread coverage of DBLs goes in line with the digitalization targets for the construction sector, allows governmental authorities to realign public policies and strategies, while transparency of information constitutes a valuable asset for business and society (R2M Solution. et al. 2021; Gómez-Gil et al. 2023). A study of DBLs in Spain and Italy suggest that standardization of data protocols is needed to guarantee interoperability of data regarding buildings across Europe (Gómez-Gil et al. 2023). Altogether, the digitalization of the European building stock is a major policy action field at EU and member state levels and their progress trend will impact positively the ESCO market in the long-term (European Commission 2023a; 2023c).

4.3.4 Take-aways from general market trends

General market trends show a high degree of uncertainty about the potential disruptive factors affecting energy price developments in the coming years. This is also influenced by the impact of energy prices and cost of living crisis, from which European countries are affected unevenly. The affordability of the energy transition for households, businesses and governments has become a matter of public and political concern and is increasingly influencing the implementation of policies in the context of inflation and low economic growth. Acceptance of the energy transition in Europe is high, but so are concerns and uncertainties about how to adapt to the threats posed by climate change and disruptive economic and social developments. The following are the main expectations that can be drawn from the future trends that are expected to shape the European energy system and the residential sector towards 2030:

- Despite the fact that wholesale energy prices in Europe are declining and recovering from a record peak in the third quarter of 2022, energy markets in Europe are expected to remain (even triple) higher than pre-crisis conditions. Household energy costs are also expected to rise progressively towards 2030 due to carbon pricing , taxation, higher electricity network costs and new levies for storage installations. This is expected to have a positive impact on public and private demand for energy efficiency renovations in the residential sector.
- The deployment of renewable generation technologies is expected to increase at a faster pace due to the energy cost crisis and adaptation policies to reduce Europe's dependence on imports of Russian fossil fuels.
- The importance of the DSF market will increase in parallel with a higher penetration of renewable energy technologies in the European energy mix. This development of DSF

could play a crucial role in the European residential sector experiencing higher renovation rates by 2030 and beyond, depending on national renovation targets for the private sector.

- The digitalization of the energy grid and its impact on households and businesses is a key trend in Europe. Progress in the deployment and use of big data and artificial intelligence is limited in the European energy sector. Smart metering deployment targets have been largely met across Europe, but smart metering technology standards and data availability requirements are a major challenge for businesses that rely on real-time data processing and data-driven decision making.

4.4 Dedicated expert workshop on future trends

As part of the frESCO activities, an expert workshop was conducted in the course of a virtual meeting held on 30 October 2023, in the final part of the project implementation, in order to obtain informed advice and relevant insights from observed developments experienced in the practice of energy services relevant for frESCO business models. The expert discussion was structured around four main topics: (i) general market trends, (ii) the increasing role of digitalisation, (iii) the role of new technologies and the innovative nature of frESCO business models, and (iv) expected risks for future frESCO operations. Table 3 summarizes the observations made by the experts during the workshop.

Table 3: Key outcomes from the dedicated expert workshop on future trends

Discussion subject	Observations relevant to frESCO operations
Subject area 1: General market trends influencing frESCO BMs	The market penetration of similar aggregator/frESCO BMs in the residential sector is limited. This is particularly challenging as there is a lack of awareness among residential customers and financial institutions of the benefits that such BMs can bring, which in turn increases the overall cost and hinders the uptake and up-scaling opportunities of the technology offered by frESCO. • Even though frESCO BMs offer multiple benefits to residential customers, the perception of business partners offering solutions to residential customers is that the benefits of innovative ESCO solutions are too limited or not tangible enough for residential customers. • From the perspective of energy co-operatives, there is still a lack of awareness of ESCO solutions among residential customers. Energy cooperatives can play a role in raising public awareness of ESCO/aggregator solutions at the local level. • ESCO/aggregator players need to be active in developing a public dialogue on the opportunities offered by ESCO solutions at the household level. In Germany, for example, a lack of public acceptance is limiting the mandatory roll-out of smart metering systems, even though

	residential customers expect efficient and understandable data processing about their energy consumption.
Subject area 2: Increasing role of digitalization •	• There is a growing need for demand-side flexibility services among residential customers. Trust in these solutions has been observed. However, residential customers expect concrete benefits from these solutions that are worth the time and resources invested. • The roll-out of smart meters has been completed in several EU member states, but the existing technology is not always fit for purpose. In several projects, additional smart metering solutions had to be provided because the grid standard did not allow real-time data delivery, which is essential for participation in commodity (wholesale energy) markets.
Subject area 3: The role of new technologies and the innovative character of frESCO BMs	• There are a number of technical requirements that need to be implemented in residential buildings in order for ESCO/aggregator BMs to operate properly. However, these requirements are not yet standard in the residential sector. Therefore, technical requirements and standards for residential buildings need to take ESCO/aggregator specific requirements into account. This applies, for example, to smart meter standards, but also to technical requirements that allow remote control of energy loads transmitted to all types of electrical appliances. It may therefore be necessary to adopt regulations on some technical standards to facilitate ESCO activities. • Residential consumers have high expectations when it comes to new technologies. Experience from implemented projects shows that end-users want real-time access to consumption records and market prices in a way that facilitates decision making and performance monitoring.
Subject area 4: Expected risks to hit the future frESCO operations	• The cost of energy can be a high risk for frESCO's operations. Market institutions and business partners expect wholesale energy prices to fall in the long term. This scenario may lead to a longer payback period for energy efficiency projects under frESCO BMs, resulting in a loss of profitability if that drop directly reflects the final consumer price. • Transaction risks remain high, as residential customers lack the necessary awareness of the solutions offered by frESCO BMs, which involve complex contractual and financial instruments. The meetings and bureaucratic requirements to set up and establish an energy community in Spain can still take more than a year. • Not only will energy prices remain an uncertain factor, but so will the economic conditions in the region. Renovation projects are in decline as the construction sector struggles with high interest rates. However, investment in storage capacity is starting to pick up. Uncertainty in energy markets and economic conditions will be a major risk to the success of the frESCO BMs.

5 ENERGY SERVICES STATUS IN THE EU's RESIDENTIAL SECTOR BY 2030

The transition to a greener and more sustainable energy future is profoundly shaping the policy and regulatory landscape of the European Union, as detailed in the previous chapters. In this evolving context, the role of energy services in the EU's residential sector is taking on an unprecedented importance. This increased importance is not only driven by the need to improve energy efficiency and increase the integration of renewable energy sources, but also by rapid technological advances and changing consumer expectations.

As we approach 2030, a pivotal point marked by ambitious sustainability goals outlined in various strategic frameworks, the energy services landscape is poised for significant change. This impending change is not only policy-driven, but also reflects a societal shift towards more sustainable lifestyles and a growing demand for smarter, more efficient homes. The convergence of digital innovation, growing awareness of environmental impact and the urgency to mitigate climate change is leading to a redefinition of energy services in the residential sector.

This section aims to provide an assessment of the future potential and dynamics of energy services in the EU residential sector up to 2030. It will examine how policy, technology, market trends and consumer behavior are expected to shape the provision and consumption of energy services. The analysis will consider the impact of ongoing developments such as the increasing adoption of smart home technologies, the growing importance of energy prosumers and the integration of renewable energy sources at the household level. It will also explore the challenges and opportunities that lie ahead for energy service providers, including ESCOs, aggregators and other market players, in adapting to and capitalizing on these changes. It will also look at the critical role of regulatory frameworks and incentives in fostering an environment conducive to innovation and investment in energy services and will assess the potential impact of evolving energy markets on the affordability and accessibility of these services for average consumers, particularly in light of the ongoing energy transition and the broader economic context.

5.1 Effect of scenarios on frESCO Business models and market potential

As outlined in the previous chapters, the evolving energy landscape in the European Union, characterized by a strong push towards decarbonization and improved energy efficiency, provides a transformative backdrop for frESCO's business models. frESCO, with its focus on energy efficiency in buildings, the deployment of renewables and demand-side flexibility

markets, is at the nexus of significant policy shifts and market developments as we move towards 2030.

Impact of policy and regulatory frameworks

Energy legislation and frESCO: Stringent EU regulatory frameworks, including the 'Fit for 55' package, the Renewable Energy Directives and the Energy Efficiency Directive, have a profound impact on frESCO BMs. These policies not only incentivize the integration of renewable energy and energy efficiency improvements, but also have the potential to accelerate the uptake of frESCO services in the residential sector. For example, the introduction of the Emissions Trading System II (ETS II) and the Social Climate Fund are likely to increase market opportunities for energy services with a sustainability focus.

Digitalization of energy networks: The EU's focus on digitalization as part of the twin transition is central to the development of frESCO BMs. The deployment of smart grids and smart metering systems across Europe is expected to facilitate more efficient energy management and open new avenues for innovative energy service models. This digital transformation, encompassing big data and AI, is likely to enhance the operational efficiency of frESCO business models, particularly in terms of real-time energy monitoring and demand response capabilities.

Technological advances and consumer behavior

Renewable energy trends: The shift towards renewable energy, particularly solar PV, will have a significant impact on frESCO's BMs. As households and businesses increasingly adopt renewable solutions, frESCO can expand its services to include the installation, maintenance and optimization of these systems. In addition, the growing market for residential solar capacity provides opportunities for frESCO to engage in energy aggregation and management services.

Demand response market growth: The expansion of the demand response market is in line with frESCO's activities, particularly in providing services that help manage and optimize energy consumption patterns. The increasing penetration of smart home technologies and the shift towards prosumerism are likely to increase the market potential for frESCO's demand response services.

Economic and market dynamics

Energy price volatility: Fluctuating energy prices and the ongoing energy transition present both challenges and opportunities for frESCO. While high energy costs can drive demand for energy efficiency solutions, they can also affect the affordability of the transition for households and businesses. frESCO BMs must navigate these economic uncertainties by offering cost-effective, scalable solutions that meet the evolving needs of the market.

ESCO market barriers: Despite the recognition of ESCO solutions, the market faces challenges such as varying regulatory frameworks, lack of standardization and public awareness. frESCO needs to address these barriers by advocating for more favorable regulatory frameworks, increasing public dialogue and demonstrating the tangible benefits of its solutions to potential residential customers.

Future perspectives and strategies

Adapting to evolving standards: frESCO will need to continuously adapt to evolving technical standards and regulatory requirements to remain competitive. This includes adapting to standards such as smart metering technologies and digital building logs, which are critical for efficient energy management and regulatory compliance.

Market penetration and collaboration: To maximize its market potential, frESCO should focus on strengthening collaboration with local authorities, energy cooperatives and other stakeholders. This collaborative approach can help raise awareness, improve public acceptance and facilitate the widespread adoption of ESCO/aggregator solutions.

Addressing financial and transaction risks: ESCOs need to address the complexity of financial and transaction risks, particularly in the residential sector. This includes simplifying contracting processes, improving the affordability of energy transitions, and leveraging government support schemes to mitigate risks and improve profitability.

In summary, the scenarios outlined for the EU's energy landscape in 2030 present a diverse and dynamic environment for frESCO BMs. To capitalize on these opportunities, frESCO will need to strategically navigate policy changes, technological advances, market trends and economic uncertainties, thereby enhancing its role in the EU's journey towards a sustainable and efficient residential energy future.

5.2 Risk assessment

In the context of the evolving European energy sector and the ambitious targets set for 2030, it is imperative to conduct a comprehensive risk assessment of frESCO's business models (BMs). This subchapter aims to identify potential risks that could impact the growth and sustainability of frESCO's activities in the residential sector. The assessment will consider various factors, including policy changes, market dynamics, technological advances and socio-economic trends. It is important to note that specific risk mitigation strategies will be developed in a subsequent chapter. The risk assessment is carried out using a qualitative approach that focuses on identifying, analyzing and prioritizing potential risks (Abba, Balta-Ozkan, and Hart 2022). Each risk is evaluated based on its likelihood of occurrence and potential impact on frESCO's operations. Risks are then categorized as high, medium or low, providing a framework for future risk mitigation strategies.

5.2.1 Regulatory and policy changes (high risk)

- Likelihood: High, given the rapidly changing political landscape in the EU.
- Impact: High, as frESCO BMs are highly dependent on a favorable regulatory environment.
- Changes in energy policies, subsidies and incentives can have a significant impact on the viability and feasibility of frESCO projects. The introduction of new regulations or changes to existing ones (e.g. ETS II, Social Climate Fund) could either benefit or hinder the market potential of frESCO.

The landscape of regulatory and policy changes within the European Union, as discussed in detail in previous chapters, represents a high-risk scenario for frESCO's business models (BMs). These risks are exacerbated by the dynamic and often unpredictable nature of energy policies, which are currently undergoing significant changes in response to the EU's sustainability and decarbonization objectives (see Chapter 4). One of the main concerns is the evolving regulatory framework around the 'Fit for 55' package and the Emissions Trading System II (ETS II), as described in Chapter 4. While these initiatives aim to accelerate the transition to a low-carbon economy, they introduce uncertainties for frESCO, particularly regarding the specifics of implementation and potential impacts on energy pricing and market dynamics. The introduction of new tax policies, carbon pricing and shifts in the subsidy landscape could either create new opportunities or present hurdles to the viability and feasibility of frESCO's projects.

Furthermore, as highlighted in chapter 4.4, where the results of the dedicated expert workshop are presented, the reliance of frESCO BMs on a favorable policy environment means that any abrupt policy changes could disrupt existing business strategies. The rapid pace of legislative change, including changes in energy efficiency directives and renewable energy deployment policies, requires a flexible and adaptive business approach. frESCO must continuously monitor these developments to ensure compliance and to take advantage of emerging opportunities. In addition, the risks are compounded by the different levels of policy implementation across EU member states, as evidenced by the different levels of adoption of smart metering and renewable energy technologies (see chapters 4.3.3 and 4.3.4). This inconsistency poses a challenge to standardizing frESCO's solutions across different national markets, with implications for scalability and market penetration strategies.

The potential impact of these regulatory and policy changes is not limited to operational constraints, but also extends to consumer perception and market demand. As consumers become more aware of and influenced by policy-driven incentives and subsidies, their willingness to invest in energy efficiency and renewable solutions could fluctuate, impacting demand for frESCO's services.

In summary, regulatory and policy changes within the EU present a complex and high-risk environment for frESCO BMs. Navigating this landscape requires a keen understanding of policy developments, an agile business model capable of adapting to rapid change, and a proactive approach to aligning business strategies with emerging regulatory trends. Recognizing and addressing these risks is critical for frESCO's BMs to capitalize on potential opportunities and mitigate adverse impacts on their operations.

5.2.2 Market and economic instability (medium risk)

- Likelihood: Medium, given the current economic climate and energy market volatility.
- Impact: High, as economic downturns and fluctuating energy prices can affect consumer spending and investment in energy services.
- Economic uncertainties such as inflation, interest rate increases and energy price volatility could affect demand for frESCO services and the overall investment climate.

Market and economic instability are a medium risk with a high potential impact on frESCO's business models (BMs). This risk is primarily driven by the current economic climate characterized by fluctuating energy prices, inflation and the aftermath of geopolitical events

such as the Russia-Ukraine conflict, as discussed in chapter 4.3. The energy market, particularly within the European Union, has experienced significant volatility: wholesale energy prices are expected to remain high compared to pre-crisis levels, despite showing signs of recovery from their peak in 2022. For frESCO, this is a double-edged sword: on the one hand, high energy costs may increase demand for energy efficiency solutions, potentially boosting the market for frESCO's services. On the other hand, these escalating costs can strain the financial viability of energy transition projects, affecting both consumer affordability and the willingness of businesses and governments to invest in energy services. Furthermore, the broader economic context, characterized by low growth and inflationary pressures adds a layer of complexity to frESCO's operating environment. The affordability of energy transition becomes a critical factor influencing the prioritization of investments in energy efficiency and renewable technologies by households and businesses. Economic uncertainties may also affect the availability of finance and investment for energy projects, which are critical to the expansion of frESCO's activities.

The risk of market and economic instability is also linked to consumer behavior. In a context of financial constraints, residential customers may be reluctant to commit to long-term investments in energy efficiency or renewable energy, despite the potential long-term savings. This reluctance could be exacerbated by a lack of clear and stable policy signals, as consumers look to governments for guidance and support in making sustainable energy choices. The impact of market and economic instability on frESCO's activities is not straightforward. While economic downturns can reduce overall spending on energy services, they can also create a heightened awareness of the need for energy efficiency as a cost-saving measure. frESCO must therefore strategically position its services to align with evolving market conditions, emphasizing the long-term economic and environmental benefits of energy efficiency and renewable energy deployment.

In summary, the medium risk of market and economic instability requires frESCO to adopt a flexible and responsive approach. This includes closely monitoring market trends, adapting service offerings to meet changing consumer needs, and leveraging policy developments to support the economic case for energy efficiency and renewable energy projects. Navigating this complex economic landscape is crucial to maintaining frESCO's competitiveness and relevance in the evolving EU energy market.

5.2.3 Technological progress and integration (medium risk)

- Likelihood: Medium, given the rapid pace of technological innovation.
- Impact: High, as technology plays a critical role in frESCO's service delivery.
- The risk lies in keeping pace with technological advances and integrating new technologies (e.g. smart meters, AI, big data analytics, renewable energy solutions) into frESCO's existing infrastructure and services.

Technological progress and its integration into ESCO business models is a medium risk with significant implications. This risk stems from the rapid evolution of technology in the energy sector and the need for ESCOs to effectively integrate these advances into their service offerings. As discussed in Chapter 4, the digitalization of energy networks and the emergence of smart energy technologies are revolutionizing the energy sector. While these advances offer significant opportunities for innovation and efficiency, they also pose challenges in terms of keeping pace with technological advances and integrating them effectively into the ESCO's operational framework. The risk is that frESCO's solutions may lag behind in the adoption of these new technologies, which could result in lost market opportunities or reduced competitiveness. The increasing focus on renewable energy, particularly solar photovoltaic (PV) systems, also highlighted in Chapter 4, requires ESCOs to integrate these technologies into their service portfolio. The challenge is not only to install and maintain these systems, but also to optimize their operation within the broader energy management services that frESCO's solutions offer. Failure to effectively integrate renewable technologies could hinder their ability to provide comprehensive energy solutions and reduce their attractiveness to environmentally conscious consumers.

The ongoing roll-out of smart meters is a crucial element in the modernization of the energy grid. However, the diversity of smart metering technologies and standards across Europe poses a risk to frESCO in terms of data management and real-time energy monitoring. Ensuring compatibility and maximizing the utility of data from different smart metering systems is essential for the effective delivery of frESCO services. As discussed in chapter 4.4, residential consumer expectations of new technologies are evolving rapidly. End-users now demand real-time access to their consumption data and are looking for technologies that facilitate decision making and performance monitoring. frESCO's ability to meet these expectations through technological integration is critical to customer satisfaction and retention. With increasing digitalization, as frESCO integrates more sophisticated technologies into its operations, the risk of cybersecurity threats increases. Protecting data and ensuring the security of

operational technologies becomes paramount, as any breach could lead to significant operational disruption and loss of customer trust. To meet these challenges, ESCOs must prioritize continuous technological innovation and ensure the seamless integration of new technologies into its existing systems. This will require investment not only in technology, but also in skills development and training to keep the workforce adept at using new technologies. In addition, frESCO must closely monitor evolving consumer preferences and regulatory standards related to technology to ensure that its services remain relevant and compliant.

5.2.4 Consumer acceptance and awareness (high risk)

- Likelihood: High, based on current levels of consumer awareness and acceptance of ESCO models.
- Impact: High, as consumer participation is critical to the success of frESCO's BMs.
- Lack of awareness or misconceptions about the benefits of energy services can hinder market penetration. Public resistance to new technologies such as smart meters can also be a challenge.

Consumer acceptance and awareness is a high risk for frESCO business models (BMs), particularly in the context of the residential sector in the European Union. As explored in previous chapters, this risk is magnified by the complex interplay of rapidly evolving energy technologies, changing policy landscapes and fluctuating economic conditions. We identify five particular aspects that need to be considered:

1. Lack of consumer awareness: One of the key challenges, as highlighted in Chapter 4 is the general lack of awareness among residential customers of the benefits and functionality of ESCO solutions. Many consumers are still unfamiliar with the concept of ESCOs and the benefits they can bring in terms of energy efficiency and cost savings. This lack of awareness can lead to hesitation or reluctance to adopt new energy solutions offered by frESCO's services.
2. Perception of benefits: Even when consumers are aware of ESCO services, there is a perception that the benefits, particularly of innovative solutions such as smart metering or demand response systems, are limited or not immediately tangible. This perception can significantly hinder the uptake of ESCO services, as consumers may not see the value in investing in or switching to new energy solutions.

3. Confidence in new technologies: The rapid introduction of new technologies, can lead to a trust deficit among consumers. As residential customers are increasingly expected to integrate smart technologies into their homes, concerns may arise about privacy, system reliability and the complexity of managing these technologies. Addressing these concerns is critical to the widespread adoption of frESCO services.

4. Public acceptance and dialogue: Public acceptance, particularly in the context of mandatory roll-outs such as smart metering, is a major challenge. Active public dialogue and engagement is needed to build acceptance and trust in ESCO solutions.

5. Working with local authorities and energy co-operatives: Building partnerships with local authorities and energy co-operatives could be key to increasing public awareness and acceptance. These entities can play a crucial role in educating consumers and promoting the adoption of ESCO solutions at the community level.

5.2.5 Digitalization and data management (medium risk)

- Likelihood: Medium, given the increasing focus on digitalization in the energy sector.
- Impact: Medium, as digitalization is key to optimizing energy services.

The risk is in ensuring the security, interoperability and effective management of digital infrastructure and data, which are essential for efficient energy management and service delivery.

The process of digitalization and the associated data management challenges represent a medium risk for the frESCO business models (BMs), as this transformation is fundamental to the modernization of energy services in the European Union. While digitalization offers significant opportunities for efficiency and innovation, it also poses risks related to integration, data security and interoperability, as discussed in previous chapters.

The expansion of digital technologies in the energy sector, highlighted in chapter 4.3.3 is a key driver for operational efficiency and service improvements. However, the integration of these technologies into existing systems can be challenging. The risk lies in the potential for technological obsolescence, system incompatibility and the need for continuous upgrades to keep pace with rapid technological advances. With the increased reliance on digital solutions comes the increased risk of cybersecurity threats, as mentioned in Chapter 4.4. Protecting

consumer data and ensuring the security of operational technologies is paramount. A breach in data security could lead to significant operational disruption, financial loss and erosion of consumer confidence.

Another key aspect is the deployment and effective use of smart technologies, such as smart meters and smart energy management systems. As discussed in chapter 4.3 the different standards and functionalities of smart metering systems across Europe pose a challenge to ensuring interoperability and real-time data availability. This inconsistency can hinder frESCO's ability to deliver seamless and efficient energy services. This goes hand in hand with the shift towards data-driven decision making, which requires robust data management capabilities. The ability to collect, process and analyze large volumes of data is critical to optimizing energy services and tailoring solutions to consumer needs. The risk lies in the potential inadequacy of data management infrastructure and analytical capabilities, which could hinder the delivery of personalized and efficient energy solutions.

Finally, the increasing digital literacy and expectations of consumers, particularly in the context of smart home technologies, is a challenge for frESCO. Consumers expect user-friendly, transparent and interactive digital interfaces that provide real-time insights into their energy consumption. Meeting these expectations is critical to consumer engagement and satisfaction.

5.2.6 Competition and barriers to entry (low risk):

- Likelihood: Low, given the current market structure.
- Impact: Medium, as increased competition may affect market share and profitability.
- The risk relates to the entry of new competitors and potential market saturation, which could challenge frESCO's market position and revenue streams.

The area of competition and barriers to entry, while considered low risk for frESCO's business models (BMs), has significant implications in the context of the rapidly evolving energy market in the European Union. This aspect encompasses the challenges and dynamics of entering and maintaining a competitive position in the energy services market, particularly in the residential sector. As discussed above, the energy services market is witnessing a wave of new entrants, driven by the growing demand for renewable energy solutions and energy efficiency services. While this brings more competition, it also confirms the potential and growth of the market.

For frESCO' solutions, staying ahead in this competitive landscape requires continuous innovation, differentiation in service offerings, and a strong value proposition to customers.

Regulatory hurdles, discussed in chapter 4.1.4, can create barriers to entry, especially for new and emerging business models such as frESCO's BMs. Navigating complex regulatory landscapes requires agility and a deep understanding of local and EU-wide energy policies.

To address the challenges of competition and barriers to entry, ESCOs applying the frESCO solutions need to focus on leveraging its strengths, such as expertise in energy efficiency and renewable solutions, strong customer relationships, and a track record of innovation. Working with local partners, understanding regional market dynamics and continuously improving service offerings are key strategies to maintain a competitive edge in the market.

6 CONCLUSION

This report has comprehensively analyzed the evolving landscape of the EU's residential energy sector and the key role that frESCO's business models (BMs) will play in this transformation with a perspective towards the year 2030. The analysis has shown that while there are significant opportunities ahead, frESCO also faces a multitude of challenges that require strategic navigation and adaptability.

The EU's ambitious sustainability goals, coupled with rapid advances in energy technologies and a changing regulatory landscape, are reshaping the market for energy services. frESCO, which sits at the nexus of these changes, is well positioned to take advantage of these developments. However, success in this dynamic environment depends on the ability to adapt to regulatory changes, embrace technological innovation and respond to evolving market demands and consumer expectations.

Regulatory and policy changes, identified as a high-risk factor, underscore the need for frESCO to maintain a proactive stance, adapting its strategies to align with new regulations and capitalizing on the opportunities they present. The medium risk of market and economic instability requires a balanced approach where frESCO must manage economic fluctuations and energy price volatility while maintaining its commitment to providing affordable, sustainable energy solutions. Technological advances, particularly in digitalization and smart energy solutions, offer frESCO opportunities to improve its service offering and operational efficiency. However, this also requires continued investment in technology integration and cybersecurity measures to stay ahead in a competitive market. Consumer acceptance and awareness remain critical challenges. frESCO needs to invest in consumer education and engagement initiatives, demonstrating the tangible benefits and ease of use of its solutions to build trust and drive market adoption. The report also highlights that competition and barriers to entry, while considered low-risk factors, require ongoing attention. frESCO must continue to differentiate itself through innovation and customer-focused services to maintain its market position.

Looking ahead, future scenarios for the EU energy sector present a complex picture of opportunities and challenges. The expected increase in energy efficiency renovations, the accelerated deployment of renewable technologies and the growing importance of demand-side flexibility markets provide fertile ground for frESCO's growth and innovation.

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