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Deliverable D7.6

Report on adaptive measures to mitigate risks to project exploitation from possible future market trends

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1 EXECUTIVE SUMMARY

The frESCO “Report on Adaptive Measures to Mitigate Risks and Maximize Market Potential” provides strategies for ESCOs and aggregators to address the current challenges and opportunities in the energy sector regarding energy efficiency in the residential building sector. The report is based on future trend and market potential scenarios analyzed in frESCO Deliverable 7.5 "Report on Future Trends and Market Potential for frESCO Solutions".

The report acknowledges the complexity of energy markets and regulatory frameworks, but also highlights opportunities for energy efficiency retrofits, renewable technologies and demand side flexibility markets. It assesses risks in six main areas, including regulatory conditions affecting the ESCO market, general market conditions, diffusion of new technologies, consumer acceptance, pace of digitalization and barriers to entry for ESCOs and Aggregators. The key aim of the report is to present broad adaptation strategies to take into account potential risks to the implementation of related business models.

The report outlines several strategies to mitigate the risks associated with the development of ESCO and Aggregator business models. Concerning regulatory risks, it suggests proactive engagement with policymakers and regulators to shape supportive frameworks. To address market risks, it emphasizes the need for innovative business models that can adapt to fluctuating market conditions. Addressing technology risks involves staying informed about emerging technologies and prioritizing research and development investments. To overcome the challenges of consumer acceptance, effective communication of the benefits of ESCO and Aggregator services to final customers is crucial, along with gathering feedback from them and potential investors. For digitalization risks, the report advocates investment in digital infrastructure and skills development. Finally, to overcome barriers to entry, it recommends working with different stakeholders and better exploiting established networks.

Overall, this report provides an analysis of the risks and opportunities in the energy sector and offers practical strategies for achieving sustainable results in the European residential market to aggregators, ESCO and as well as other future project developers in the residential demand management market.

2 INTRODUCTION AND OBJECTIVES

The market outlook for frESCO's business models appears to be broadly favorable, but the complexity of energy markets and climate policies, as well as the diversity of social conditions in different European countries and the heterogeneity of geographical conditions and regulatory frameworks, offer significant opportunities, yet also pose significant challenges. Indeed, while the expected increase in energy efficiency renovations, the accelerated deployment of renewable technologies and the growing importance of demand-side flexibility markets provide the right conditions for frESCO's solutions deployment in the European residential market, there are still risks that need to be addressed and accounted for before project developers can achieve the desired sustainable results.

This report aims to provide strategies to make the ESCO and Aggregator business models adaptive to the challenges arising from future market trends in the energy sector and by this means offer strategies to develop appropriate capabilities to exploit their full market potential. Based on the scenarios for future trends and market potential analyzed in frESCO's Deliverable 7.5 "Report on future trends and market potential for frESCO solutions" (Kollmann, Villagarcia, and Kirchler 2023), this report will:

- showcase the risk emerging from the scenarios of future trends analyzed in D7.5,
- describe the impact and likeliness of risks for the frESCO's business models, and
- develop broad adaptation strategies to consider, should these risks indeed eventuate.

To this extent, risks have been assessed in six main areas:

(i) regulatory conditions affecting the ESCO and flexibility market,
(ii) general market conditions,
(iii) diffusion of new technologies,
(iv) consumer acceptance,
(v) pace of digitalization, and
(vi) barriers to entry for ESCOs and Aggregators.

3 IDENTIFIED RISKS AND MITIGATION APPROACHES

This section briefly describes the risks identified in deliverable 7.5 (Kollmann, Villagarcia, and Kirchler 2023) and provides mitigation strategies that can help to reduce the risks expected to trigger an unfavorable impact to the uptake of business models (BMs) developed in the frESCO project. The adaptations strategies are divided into the six groups of risks identified in Deliverable 7.5 as a result of a qualitative assessment of the future trends shaping the ESCO market toward 2030 as well as the latest findings about market barriers for ESCOs (UNEP Copenhagen Climate Centre and The Global ESCO Network 2023) and investing in energy efficiency projects in Europe (Bender 2022).

Strategies described in this report do not constitute a close list, but the most suitable measures to counteract the potential risks expected to impact frESCO business models as they go in line with the literature review and the expert assessment performed for this task. As some risks might be interlinked, implementation of strategies in a comprehensive manner may contribute to the overall efficacy of frESCO efforts. Wherever possible, the risk descriptions also inform about how frESCO dealt with these risks during the project runtime.

3.1 Adaptation strategies for risks emerging from regulatory and policy changes (high risk)

The frESCO project's Energy Service Company (ESCO) model offers transformative potential for the European residential energy services market. Its success, however, relies on the regulatory landscape, which presents distinct challenges. These include the absence of a unified legal definition for ESCOs across jurisdictions, the need for an appropriate accreditation system, and the requirement for comprehensive contract templates to mitigate transaction risks (see Table 1).

Table 1: Risks related to the regulatory landscape

Risk factor	Description
Broad legal definition of an ESCO	The lack of a common legal definition of an ESCO across different jurisdictions can lead to inconsistencies in market understanding and expectations. This lack of a standardized

	definition can hinder the scalability of ESCO projects by making it difficult to establish a universally accepted operating framework. The hybrid approach of the frESCO project, combining energy efficiency and demand response aggregation, requires clear legal recognition to ensure that the innovative business models (BMs) are compliant with local laws and can be replicated across different regions without legal ambiguity.
Appropriate accreditation system	Without an appropriate accreditation system, there is a risk that the market will be saturated with providers that do not meet certain quality or performance standards, thus jeopardizing the reputation of ESCOs as a whole. Accreditation acts as a quality assurance mechanism, ensuring that ESCOs are able to deliver the energy savings and performance they promise. Robust accreditation schemes that validate the competence and reliability of service providers are needed.
ESCO contract templates and transaction risk	The complexity of ESCO projects, particularly those involving innovative BMs such as those proposed by frESCO, requires comprehensive contract templates that can mitigate transaction risks. Standardized contracts can streamline negotiations, reduce legal costs and provide a clear framework for dispute resolution. However, the absence of such templates increases the risk of contractual misunderstandings and could deter potential investors.

Concurrently, according to ESCO associations and research by the UNEP Copenhagen Climate Centre and the Global ESCO Network (2023), Europe presents generally favorable regulatory conditions for ESCO business models. However, the risk of regulatory changes remains high due to imperfect legal recognition of ESCO-specific business models and the complex nature of European climate and energy policy implementation. To ensure the frESCO business model's success in this challenging, non-uniform regulatory environment, concerted efforts at local, national, and European levels are vital. This approach aims to establish ESCOs and the frESCO model as key solutions for boosting energy efficiency in the residential sector, delivering significant benefits to households, society, and the environment.

Table 2 presents an outline of measures that could enhance frESCO's capability to efficiently navigate the European renovations wave in the direction of a decarbonized residential building stock.

Table 2: Adaptive measures against regulatory risks

Risk factor	Adaptative measures
Broad legal definition of an ESCO	– Promote the adoption of ESCO/Aggregator legal definitions fit for purpose of the developed business models in the jurisdictions where that is not yet the case. – Establish professional ESCO/Aggregator associations at the national level to advocate for regulatory changes leading to suitable legal recognition of ESCO/Aggregator activities with the corresponding implications for financial mechanisms, requirements, standards and launching of governmental programs. In addressing this challenge, the frESCO project's D3.3 "New business models for ESCOs/aggregator for energy services in the residential sector" (Georgopoulos (2021) systematically describes its business models, detailing stakeholder interactions, contractual relations, service provision, and remuneration models, thereby providing a well-defined framework for frESCO's innovative business models.
Appropriate accreditation system	– Participate in the development of an accreditation system that makes sure accredited ESCO/Aggregator offer clients the needed qualifications regarding professional staff, financial stand, as well as the qualifications needed to successfully perform their services to end customers.
ESCO contract templates and transaction risk	– Engage in facilitating the availability of dedicated and suitable ESCO/Pay-for-Performance contracts to minimize transaction risks. – Create awareness about the benefits emerging from the innovative pay-for-performance contracts for both owners and tenants. – Simplify the key elements of the pay-for-performance contracts used for frESCO business models to emphasize

	the benefits for end customers in an understandable manner by for instance providing factsheets. – Get feedback from targeted end consumers and potential investors about risks perception related with pay-for-performance contracts. – Make sure pay-for-performance contracting takes root into pertinent regulatory frameworks covering energy efficiency and grid security within targeted jurisdiction. Acknowledging this risk from the very beginning of the project activities, frESCO's D3.6 "Report including the annotated template for contract models" (Burgstaller et al. 2022) provides an annotated contract model for multiple frESCO services, for the service providers (ESCOs and aggregators), and for each of the consumers and stakeholders involved in the delivery of the services. The contract model contains the relevant contract points and indicates which aspects play a role in relation to the service offered in each case. Thereby, it supports the stakeholders involved by providing them with a roadmap about how to approach the establishment of contractual aspects of the implementation of the business models.

3.2 Adaptations strategies for risks emerging from market and economic instability (medium risk)

Trends regarding the overall market performance of European economy and energy sector relevant for frESCO business models show favorable prospects for energy efficiency projects and the expansion of demand-side flexibility participation. However, Europe's economy and energy sector are facing several uncertainties, from fluctuating energy prices, inflation and the impact of geopolitical disruption. Hence, the overall risk emerging from general market prospects and projections was assessed as *medium* (see Kollmann, Villagarcia, and Kirchler 2023). In principle, increasing prices for fossil energy sources have a positive impact on the market uptake of renewable energy technologies and their economic potential. However, end customers targeted by frESCO business models have not yet fully recovered from the current

social and economic struggles and the energy recurring crisis does not equally affect all European economies.

European households are currently navigating through a path of unforeseen obstacles (e.g. pandemic, cost-of-living crisis, geopolitical frictions), which influences attitudes and decisions about long-term retrofitting projects requiring important up-front investments. The challenges for frESCO and the risks faced by frESCO business proposition (see Table 3) concern more aspects directly involved with the customers targeted by frESCO business models, financial stakeholders lacking reliable numbers and general awareness about current innovations and project developers with the necessary capabilities to yield relevant profit from a non-easy market segment.

Table 3: Risks related to emerging from market and economic instability

Risk factor	Adaptive measures
High upfront costs and long payback periods	ESCO projects often require significant initial investments in energy-efficient technologies and infrastructure. The long payback periods associated with these investments can be a deterrent to customers and investors seeking quicker returns. As we approach 2030, the challenge will be to innovate financial models that can provide more immediate returns or demonstrate the long-term value proposition of such investments.
Lack of access to financing	Access to capital is a critical factor in the implementation of ESCO projects. The lack of financing options, particularly for small to medium sized projects, can hinder the uptake of ESCOs. Financial institutions may be reluctant to lend because of the perceived risks associated with using energy savings as collateral.
Competing investment priorities	Consumers may have competing priorities for their capital, such as direct business investment or other immediate operational needs. Energy efficiency projects may be seen as non-essential or secondary, making it difficult for ESCOs to secure commitment and funding.
High perceived risk	The perceived risk of ESCO projects is often high due to uncertainties about performance outcomes, energy savings and the reliability of new technologies. This perception can be exacerbated by a lack of

	historical data and benchmarks for innovative projects such as those proposed by frESCO.
Split incentives	The issue of split incentives, where the benefits of energy savings are not shared equally between stakeholders (e.g. tenants and building owners), can discourage investments in energy efficiency measures. This misalignment of incentives is a significant barrier to the implementation of ESCO projects.
Energy prices	Fluctuating energy prices can affect the financial calculations of ESCO projects. When energy prices fall, the monetary savings from energy efficiency measures may be less attractive, reducing the incentive for customers to invest in such projects.
Small project scale	The relatively small scale of ESCO residential projects can result in higher transaction costs per unit of investment, making them less attractive to investors and financial institutions looking for large-scale opportunities.
Lack of recognized asset class	Energy efficiency projects have not yet been widely recognized by financial institutions as an asset class in their own right. This lack of recognition can limit the availability of specialized financial products and services tailored to the needs of ESCO projects.

To face the challenges outlined above, frESCO's business models will need to manage strategically those factors causing risks for a successful expansion and upscaling of operations across Europe. In such context, Table 4 displays adaptive measures with the potential to mitigate the risks involved with frESCO business models.

Table 4: Adaptive measures against general market risks

Risk factor	Adaptive measures
High upfront costs and long payback periods	– Financing mechanisms that can reduce or eliminate upfront costs to residential buildings' owners when building renovation take place. – Bulk procurement of energy savings technologies by ESCOs/Aggregators with the aim to leverage benefits from economies of scale that reduce costs.

	– Building up long term capital investments to finance projects with long payback durations. – Monetization of ESCO/Aggregator service packages offering benefits beyond energy savings. fRESCO's D3.2 "Mapping of the interactions between stakeholders and accompanying cash flows" (Aranda, 2021a) provided a list of all relevant stakeholders for the provision of each of the developed services, including services providers, end-users and other intermediaries such as technology/ICT providers and their direct and indirect interactions. The report also provided recommendations of possible payment flows among these stakeholders for ensuring the remuneration of all of them.
Lack of access to financing	– Explore financing mechanisms suitable for residential clients with low access to financial products (e.g. on-bill financing). – Target dedicated funding programs aiming energy efficiency projects at the local level. – Explore opportunities from microfinance, accessing to near-term resources while facilitating long-term credit.
Competing investment priorities	– Raise awareness about estimated returns on investments on energy efficiency and flexibility investments by implementing innovative frESCO solutions. – Explore financing mechanisms that optimize capital expenditure for end clients in order to prioritize expenditure of scarce financial resources.
High perceived risk	– Promote channels of dialogue among financial institutions, technology providers and frESCO developers to facilitate project execution and due diligence. – Standardize protocols for risk assessment and periodical project evaluation. – Evaluate introducing third party verification. – Develop financing mechanisms for a variety of projects cumulated to reduce risk exposure of investments through distributed sets of projects. – Improve the predictability of frESCO performance results to facilitate third-party evaluation of potential returns on investments

Split incentives	– Develop incentive programs targeting benefits specific for buildings owners, including green mortgages, higher rent potential after building retrofitting and real state revaluation. – Raise awareness about the total reduction of risk offered by frESCO/Aggregator business models specific related to property owners.
Energy prices	– Project evaluation based on multi-year average energy costs. – Project risks assessment based on both high and low energy cost scenarios. – Prospect benefits coming from participating on demand-side flexibility markets as a way to counteract impact of low energy prices on payback time. – Evaluate models with energy price floors to mitigate risks.
Small project scale	– Elaborate portfolios of targeted projects enabling economies of scales for the different project stages and ESCO/Aggregator business models. – Promote standardization of facility related and data related protocols to facilitate the reduction of overall implementation and operation costs.
Lack of recognized asset class	– Promote the transparency and reliability scores of investment attempts for ESCO/Aggregator business by standardizing processes, due diligence and insurances. – Develop instruments and tools to assess performance prospects of ESCO projects to facilitate evaluation of potential investment outcomes. – Align formulation of financing mechanisms related with frESCO business models to current policies for sustainable investments, such as the EU's Taxonomy, Non-Financial Reporting Directive (NFRD), Corporate Sustainability Reporting Directive (CSRD), European Sustainability Reporting Standards (ESRS).

3.3 Adaptations strategies for risks emerging from technological progress and integration (medium risk)

Demand for renewable energy is steadily increasing in Europe and globally, with production and manufacturing of such technologies developing rapidly, particularly in China, according to the International Energy Agency (IEA 2023). A key challenge for frESCO's business models is

the rapid development of technologies such as photovoltaics (PV). While these advances improve the efficiency and effectiveness of PV systems, they also pose a risk to frESCO's current service offerings. If frESCO does not adapt to these technological improvements, its solutions risk becoming obsolete. This is not just a question of the intrinsic efficiency of the technology, but rather how frESCO integrates these advances into its service model to remain competitive and relevant.

For example, the deployment of rooftop PV systems, a key area for frESCO, is currently constrained by a lack of skilled labour. This shortage highlights the need for frESCO to anticipate and adapt quickly to changes in technology. If new PV technologies require less maintenance, integrate more seamlessly with smart grids or offer better scalability, frESCO will need to evolve its business practices accordingly or could become inefficient compared to newer, more technologically advanced solutions.

Table 5: Risks related to technological progress and integration

Risk factor	Description
Pace of technological advancements and obsolescence	This concerns the risk related with new technologies entering the market and offering similar solutions than frESCO's offering without the necessity of significant up-front investments. Major producers of home appliances offer already smart home solutions with automated control mechanisms for European households. Hence, the challenge here is to remain an attractive and reliable business solution for households and investors by identifying and filling the right market niche.
Overdemand of supply chain, data centers and power grids	The growing demand for renewable technologies can stress supply chains in a way that affects frESCO solutions losing customers and investors by failing to deliver on tight schedules. Even if manufacturing capacity is responding favorably to the growing demand and increased deployment targets, this can reach limitations, which can be detrimental for frESCO specially at early stages of entering the market. Uneven development of renewable technologies with Internet of Things (IoT) systems for automated monitoring and the corresponding

	infrastructure for communication standards (e.g. 5G) can have a disadvantageous impact on frESCO operations.

Thus, the pace of technological progress is increasing rapidly and competition in such evolving terrain grows accordingly. The risks for frESCO business models related with relying on technology facing overdemand and can turn out of use or lose attractivity against more innovative solutions. The risk involved herewith is considered *medium* (see D7.5 Kollmann, Villagarcia, and Kirchler 2023). frESCO business will need to deal with innovative (price competing) smart appliances and devices as well as with the uptake of smart home solutions. Scarcity of raw materials and disruptions of relevant supply chains will constitute important challenges for delivering energy savings with sustainable returns.

Therefore, those implementing frESCO solutions will need to consider effective supply chain management systems that build up the needed expertise for an early detection of relevant market developments and innovative trends to leverage the full performance of frESCO solutions. Table 6 contains measures to reduce the risks involved with new technologies.

Table 6: Adaptive measures against technological risks

Risk factor	Adaptative measures
Pace of technological advancements and obsolescence	– Explore diversifying frESCO's offering to related products and services. Offering energy storage systems for residential customers could be interesting for authorities, building owners and tenants concerned about potential energy outages, willing to invest on the installation of additional backup systems for a secure energy supply at household level. – Remain vigilant about innovation and technical developments by participating on research and innovation partnerships assessing the development of frESCO-relevant technologies.
Overdemand of supply chain, data centers and power grids	– Develop an appropriate supply chain security concept that mitigates the potential uncertainties related with working with other market players/stakeholders as part of frESCO's supply chain (e.g. external suppliers,

	vendors, logistics; maintenance and effective delivery of products and services). – Evaluate the viability of contractual or insurance models that mitigate the performance risks associated with stakeholders' delayed performance, shortage of raw materials or other supply chain disruptions.

3.4 Adaptations strategies for risks emerging from consumer acceptance and awareness (high risk)

Based on the analysis of future trends and the market insight provided by the dedicated expert workshop for this task (described in more detail in D7.5 Kollmann, Villagarcia, and Kirchler 2023), risks emerging from a lack of consumer awareness have been assessed as a *high* risk causing unnecessary transaction costs and limiting the upscaling potential of frESCO services. For frESCO business models to succeed in such an environment will require a great deal of effort to develop a consistent and specialized service proposition that gains public visibility for residential final customers.

Misconceptions and misbelieves about the reliability of renewable technologies, potential impacts on comfort, the pay-back-times of the investment, among other factors, need to be accounted for. Public awareness and acceptance about the need for change and adaptation to the potential risks posed by a fossil-based economic system is not sufficiently widespread. Neither is there a widespread and clear understanding about the actual benefits this change can bring for single individuals, society and the environment. This condition increases the transaction risks and increases overall project costs of frESCO offering.

Table 7: Risks related to consumer acceptance and awareness

Risk factor	Description
Personal data leaks and breaches of privacy	Data vulnerability can be a significant concern for frESCO's digital platforms and services, as they may be susceptible to cyber-attacks. Such incidents have the potential to result in the leakage of customers' personal data, posing a serious threat to customers, ESCOs and aggregators alike. In addition, the handling of large amounts of personal data inherently raises concerns about data breaches. This could undermine consumer trust, a critical component of the ESCO business model. There is also the challenge of regulatory compliance. Failure to comply with strict data protection regulations, such as the General Data Protection Regulation (GDPR), can have serious consequences.
Lack of widespread awareness	Although ESCO have a long trajectory of development for providing energy efficiency upgrades and generating savings, the residential sector has not been an attractive market for this business models because of the challenges involved with small investments (compared with industrial and commercial customers) and the multiplicity of parties (i.e. building owners, tenants, households) to be addressed within a single retrofitting project. Technologies included in frESCO offering are not long in the market and thus frESCO solutions can face the difficulties building up an informed market segment with a diversity of expectations.
Lack of confidence about performance potential	This is a traditional risk for ESCO business models. When addressing the residential sector there could be indeed limited data to evaluate the profitability of frESCO projects for the concrete conditions given the diversity of the European building stock.
Lack of trust in new technologies	Innovative technologies are at the heart of ESCO offerings, but there can be skepticism and lack of confidence in their capacity to deliver comfort in an automated and reliable way. This is particularly true for

	technologies that have not yet been widely adopted or do not have a long track record of success.
Inclusion and affordability	A segment of the residential building sector is constituted by low-income households, for whom energy efficiency of their building does not represent a priority. frESCO project developer will need to prepare the services offering for addressing the needs of the diverse consumer/household groups (i.e. age, sufficient digital literacy, income class, etc.).
Lack of knowledge and awareness	A general lack of knowledge and awareness of the benefits of energy efficiency and the ESCO model can hinder market growth. Without understanding the potential savings and environmental benefits, potential consumers may not be motivated to engage in ESCO projects.

frESCO's solutions will need to articulate an easy to understand / close-to-market approach about frESCO's capability to deliver energy efficiency in an affordable, innovative way, using effective channels of communications to reach visibility at the residential level, providing relevant information capable of removing unfounded believes and misconceptions about the new technologies employed in their service offering. Table 8 entails the most effective measures identified for such risks.

Table 8: Adaptive measures against risks related to consumer acceptance

Risk factor	Adaptative measures
Personal data leaks and breaches of privacy	– Robust cybersecurity measures: Implement state-of-the-art cybersecurity protocols to protect data from unauthorized access and breaches. Regular security audits and updates are essential. – Data privacy policies: Establish clear privacy policies that outline how customer data is collected, used, stored and shared. Transparency in these policies can build consumer trust. – Regulatory compliance: Ensure full compliance with data protection laws, such as GDPR. This includes

	appointing a data protection officer (DPO) and conducting regular compliance audits. – Data minimization: Collect only the data that is absolutely necessary to provide the service. This reduces the risk associated with data storage and management. – Incident Response Plan: Develop a comprehensive incident response plan to quickly address any data breaches and minimize potential damage.
Lack of widespread awareness	– Communicate the benefits of energy efficiency renovations and the potential of demand side flexibility to residential customers, potential investors and local authorities in a clear and target-group specific way, for instance through the development of partnerships with service providers of building renovation (not necessarily those providing exclusively energy efficiency), energy communities, building cooperatives and social housing institutions. – Promote media-effective dissemination of key elements of frESCO business models in a simple and understandable way. – Make frESCO business models visible/essential for local authorities as facilitator of achieving energy efficiency and decarbonization targets in the residential sector in a way that corresponding regulation and funding schemes contribute to awareness. – Showcase successful case studies to win confidence about frESCO's solutions. – Facilitate access to latest findings addressing (unfounded) concerns related with latest innovations offered by frESCO (e.g. 5G, storage technologies, *etc*.) in order to promote trust about connectivity and new technologies.
Lack of confidence about performance potential	– Establish effective channels of communication with consumers to enhance trust in frESCO's solutions, confidence about performance outcomes and reduce transaction costs for instance by building up a suitable social media/web presence etc.

	– Inform consumers about upcoming regulation changes for advancing energy efficiency at residential level and the opportunities and benefits of buildings upgrades and smart home solutions as well as potential revenues streams to be realized from direct participation on energy markets. – Develop an online energy savings/costs/revenues calculator on apps/web platforms showcasing the concrete benefits emerging from the implementation of frESCO solutions for potential end clients.
Lack of trust in new technologies	– Exploit benefits from the effectiveness of demonstration projects carried out in the frESCO project and additional demo-sites in targeted markets. – Explore suitability of Energy Saving Insurance for guaranteed cost savings where certain level of performance cannot be achieved. – Develop audited profiles for the new technologies offered by frESCO/Aggregator business models to promote transparency and clarity over the benefits that can be achieved for investors and residential customers.
Inclusion and affordability	– Develop solutions to promote inclusion of vulnerable groups and (low-risk/risk-free) participation of owners/tenants with limited financial means.
Lack of knowledge and awareness	– Develop strategies to raise public sensibility on the benefits of energy efficiency renovations and the potential of demand-side flexibility. – Promote the diffusion of key elements of the frESCO business models showing financial mechanisms, implementation process and potential benefits to overcome barriers to adoption and transaction costs. – Connect public awareness campaigns with future targets for residential building and measures expected to facilitate/enforce building renovations.

3.5 Adaptations strategies for risks emerging from digitalization and data management (medium risk)

The frESCO business model, which partly relies on providing effective digital services, has assessed the risks associated with digitalization in the energy sector, both at grid and household levels, and the state of European digital infrastructure, in light of the EU's digital transition targets, as being of *medium* level. That is the case due to the barriers related with the lack of digital literacy among certain groups of residential households and certain lack of harmonization of standards across the different EU member states, which becomes visible at the (indeed advanced however) non-uniform level of progress regarding smart metering rollout across Europe.

Within the European Union, digitalization of the energy sector is a key policy priority since it facilitates real-time mapping and monitoring of efficient resource utilization, providing multiple opportunities for governments, business and the general public. However, delivering digitalization of the energy system has limitations and the struggles herewith involved can challenge frESCO's opportunities of successful market penetration and consequent expansion of operation across Europe.

Risk factor	Adaptative measures
Digital skills gap	There is a risk for frESCO business models related not only with the lack of digital literacy of building owners and tenants, but also with the lack of skilled workforce capable of processing and managing the complexity of large volumes of data produced by the different types of devices and appliances.
Supply chain disruptions	Relaying and offering digital services bring some risks for business related with the digital supply chain. Even if a thorough cyber security concept is in place, cyber risks will involve some vulnerability for the delivery of frESCO solutions. Cyberattacks, power outages, natural disasters or operational failure at any level of frESCO digital chain can be detrimental for the provision of energy services,

	which ultimately lead to financial losses or subpar performance.
Lack of harmonization of standards	Shared standards and requirements limit upscaling efforts intended by the frESCO project. This risk is already observed in the limitations concerning the rollout of the European smart meter infrastructure, but it is also present by the diversity of regulations in place to implement construction and building renovation requirements (e.g. Near Zero Energy Buildings in different EU member states).

As pointed out by participants of the dedicated expert workshop on "future trends expected to impact the successful implementation of frESCO solutions", project developers and energy communities have been implementing alternative strategies to overcome barriers posed by the lack of functionalities offered by current standards of smart metering systems in certain regions. For frESCO to succeed in this evolving field will require to stay upfront with the developments of digitalization in the energy sector in the targeted local markets. The following table shows some measures intended to favor this development and contribute to time-effective implementation of frESCO projects to advance energy efficiency and climate neutrality of residential households in an inclusive and affordable way.

Table 9: Adaptive measures against digitalization

Risk factor	Adaptative measures
Digital skills gap	– Train work force to enhance their skills in monitoring the correct functioning and compliance of frESCO's infrastructure and on-site equipment in accordance with specifications. – Promote the enhancement of the digital literacy of households to develop favorable attitudes and confidence towards data usage policies that respect privacy concerns. – Develop a simple and intuitive consumer friendly interface (app/platform) capable of empowering users about participating in energy consumption decisions,

	facilitating immediate implementation through the app/platform as well as enabling useful visualization of most pertinent parameters needed to make the most of participating at energy markets.
Supply chain disruptions	– Develop contingency plans for potentially adverse events (e.g. catastrophes, outages, climate change threats) to ensure continuity of operations, security of digital assets and to enhance security of supply for end customers.
Lack of harmonization of standards	– Promote the prompt implementation of requirements and standards for residential buildings and dwellings in accordance with frESCO-specific favorable conditions for interoperability and upscaling of operations.

3.6 Adaptations strategies for risks emerging from competition and barriers to entry (low risk)

The future market trends for frESCO services are favorable and thus the assessment of risks regarding competition and barriers to entry remains low. According to the latest view of ESCO associations (UNEP Copenhagen Climate Centre 2023), Europe is the region offering the best market conditions for ESCO services. However, some barriers remain at the ununiformed regulatory landscape in the European Union (Kollmann, Villagarcia, and Kirchler 2023), which could limit upscaling efforts of business models as the planned renovation wave starts hitting residential buildings properly with the start of operations of Emissions Trading System II and the rollout of heat pumps strategies in the coming years, to name two future policy strategies that are expected to significantly impact the market.

Table 10: Risks related to competition and barriers to entry

Risk factor	Description
Perceived differentiation	Misconception and lack of awareness about the nature of the ESCO concept (of mitigating the performance risk associated with energy efficiency upgrades) and the provision of solutions for attracting the financial standing required to implement such projects lead to an unfit regulatory recognition of the potential of frESCO to

	facilitate the achievement of energy efficiency and decarbonization targets within the residential sector.
Comprehensive regulatory recognition	Access to national energy efficiency programs and related financial instruments is critical to reducing performance risks and increasing the attractiveness of ESCO projects. These programs can provide guarantees or subsidies that mitigate the financial risks associated with Energy Performance Contracting (EPC). The frESCO solutions need to navigate these market conditions carefully, as they vary widely across the EU and can have a significant impact on their success. Similarly, tax and accounting policies specific to ESCOs can either encourage or discourage the adoption of EPCs/P4P ("Pay for Performance"). Favorable tax treatment, such as deductions for energy efficiency investments, can accelerate market growth. Conversely, complex or unfavorable tax regimes can increase operating costs and reduce net savings for customers, thereby affecting the marketability of ESCO services. The frESCO project's innovative BMs must be adaptable to different tax and accounting policies, which require a thorough understanding of the regulatory environment in each target market.
Diversity of clientele addressed by frESCO	The complexity of the residential sector involves not only the challenge of split incentives or reduced incentives for building owners to consider engaging in a retrofitting project, but also the challenge of tenant not having the needed financial means to invest. This could pose a limitation for frESCO business models specially when financial mechanisms to overcome this barrier are not clearly and comprehensively removed by a supportive legislation.

A strong competitive market for energy services is expected to arrive with the market uptake of renewable energy technologies becoming available at residential markets at increasingly competitive prices. frESCO's solutions can capitalize on first-mover advantages by showcasing their flexibility and the effectivity of automated energy control that delivers savings while increasing thermal comfort, health and well-being of occupants, and enabling a modern

lifestyle with a lower environmental footprint. The following measures (see Table 11) can play a part in contributing to the market exploitation prospects of frESCO business models.

Table 11: Adaptive measures against barriers to entry

Risk factor	Adaptative measures
Perceived differentiation	– Advocate for specialized legal recognition of ESCOs as professional risk mitigators rather than mere providers of renewable energy equipment. – Differentiate from mere traditional ESCO business models by bringing close the benefits of innovative performance contracting models and additional service bundles offered by frESCO.
Comprehensive regulatory recognition	– Raise awareness of investors about innovative frESCO's solutions to minimize financial and transaction risks by for instance providing validation of suitable financial mechanisms in accordance with financial, tax and accounting rules. – Advocate against adverse regulatory barriers posing additional requirements to qualify for investment instruments or funding schemes. – Develop financial mechanisms to make frESCO services more inclusive and affordable. The differences in market conditions were well-known from the start of the frESCO project and analysed in-depth for the demo-site countries - France, Spain, Croatia and Greece – in D2.2 “Overview of the regulatory and market framework for energy services in the residential sector” (Aranda, 2021b), which provides a review of the regulations that apply to current and new hybrid energy services for consumers and prosumers. This regulatory framework analysis clearly showed the national regulatory constrains that ESCO models are faced with.
Diversity of clientele addressed by frESCO	– Develop financial mechanisms to make frESCO services more inclusive and affordable by for instance offering mechanisms to reach even those with limited access to financial means.

Looking ahead to 2030, the six risk categories described above underscore the need for ESCOs to develop strategies that can mitigate regulatory, financial, operational and other uncertainties. This includes creating more attractive financial models, building partnerships with financial institutions, increasing market awareness, informing target groups and working with policymakers to create a supportive regulatory environment. In addition, ESCOs need to demonstrate the reliability and benefits of new technologies to build trust with potential customers. By addressing these risks, ESCOs can position themselves to capitalize on the growing demand for energy efficiency and sustainable energy solutions over the next decade.

4 FRESCO'S KEY EXPLOITABLE RESULTS

In addition to the assessment of risks related to frESCO services described above, an in-depth analysis of risks and challenges related to the five key exploitable results (KER) of the frESCO project was done in WP7 and WP8 of the project. These KERs are:

- Big Data Management platform
- Integrated energy service bundles for residential consumers
- Multi-service package toolkit
- Smart Energy Boxes
- Novel PMV methodology

In order to avoid repetition, the assessment of the challenges and risks associated with the market introduction of KERs, which was done in two other project reports, will not be repeated here. These reports are:

- D7.2 "New business models for ESCOs/aggregators of energy services in the residential sector", which defines and addresses the specific challenges of financing KERS, regulatory constraints and commercial issues.

- D8.8 "Final Publishable Report", which discusses the challenges related to KERS and the lessons learned from the project.

5 CONCLUSION

In navigating the future of frESCO's business models (BMs), several key risk categories emerge, each with unique implications in the rapidly evolving European energy landscape. At the forefront are regulatory and policy changes, which pose a high risk due to the EU's changing energy policies. The dynamic nature of regulations, such as the 'Fit for 55' package and the Emissions Trading System (ETS II), requires a nimble and forward-looking approach from frESCO in order to remain compliant and capitalize on new opportunities.

At the same time, market and economic instability is a medium risk with significant potential impact. This instability, driven by fluctuating energy prices and wider economic uncertainties, affects consumer and business investment in energy services. The future implementors of frESCO's solutions must navigate these economic ups and downs, balancing the drive for energy efficiency with market affordability.

Technological progress and its integration into frESCO's operations is another medium risk. Rapid advances in energy-related technologies require continuous adaptation and integration into frESCO's service portfolio. This includes not only keeping pace with innovation, but also addressing related, evolving challenges such as cybersecurity.

A key challenge is consumer acceptance and awareness, which has been identified as a high risk. Overcoming the general lack of awareness and skepticism towards ESCO solutions is crucial. Future market implementation strategy must focus on educating the market and demonstrating the tangible benefits of frESCO related services to build trust and acceptance among residential customers.

The digitalization of energy services and the management of the resulting data is a medium risk area. As frESCO increasingly relies on digital technologies, ensuring data security, system interoperability and effective data management is paramount to maintaining operational efficiency and customer trust.

Finally, competition and barriers to entry, although considered a low risk, require ongoing attention. The energy services market is growing and the frESCO solutions must continue to innovate and differentiate its offerings to stay ahead of the competition.

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