SmartSPIN

Smart energy services to solve the **SP**lit **IN**centive problem in the commercial rented sector

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D2.2 – REPORT ON MARKET STATUS AND REVENUE STREAM MAPPING

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List of Abbreviations

DER	Distributed Energy Resources
SES	Smart Energy Service
WP	Work Package
ESCO	Energy Service Company
EPC	Energy Performance Contracting
SMEs	Small and Medium Enterprises
P2P	Peer to Peer
AI	Artificial Intelligence
EEO	Energy Efficiency Obligation
HVAC	Heating Ventilation and Air Conditioning
PPA	Power Purchase Agreement
PV	Photo Voltaic
EV	Electric Vehicles
BMS	Building Management System
CHP	Combined Heat and Power
ICT	Information and Communication Technology
EaaS	Energy-as-a-Service
GHG	Greenhouse Gas
SEAI	Sustainable Energy Authority of Ireland
ICT	Information and Communication Technologies
IoT	Internet of Things

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EXECUTIVE SUMMARY

The Smart Energy Services (SES) are energy services which use Information and Communication Technologies (ICT) in energy generation, storage, transmission, and consumption, to increase energy efficiency and decrease the emission of GHG while satisfying the needs of end-users.

Digital services and physical products can be combined into SES, sometimes defined as the “smart energy services in a broader sense” as opposed to purely data-driven digital services, which are the “smart energy services in a narrow sense”.

Nowadays the Energy Service Companies (ESCOs) can offer SES which combine multiple smart energy products (such as smart meters, thermostats and PV systems), the big-data streams which they can generate, their flexibility and controllability by means of building and energy management systems, and optimised control logics to increase energy efficiency and to reduce operational costs; thus delivering high energy performances to their customers. The contractual framework used by the ESCOs is the Energy Performance Contracting (EPC).

EPC is a contractual agreement between the client and energy service provider (ESCO) for delivering the energy efficiency improvement service which is verified and monitored during the course of contract period. In EPC contracts the service fee/charges are paid as per the agreement between the client and ESCOs based on the level of service being provided and energy performance improvement being achieved. ESCOs offer financial service as well in conjunction with the several financial service providers. ESCOs are incentivised for better results/outcome of the project. EPC usually have performance guarantee clause in place, which puts performance risk on ESCO side.

Article 18 of the Energy Efficiency Directive requires Member States to increase energy efficiency by encouraging energy service market and supporting their operations by creating awareness among end customers and remove regulatory and non-regulatory barriers to their functioning.

SmartSPIN is EU funded Horizon-2020 project which aims to address the split incentive barrier in the rented commercial sector by implementing SES via EPC being delivered by ESCOs. The pilot implementation of proposed solution will be demonstrated in Greece, Ireland and Spain.

SmartSPIN WP2 is about Review of smart energy service market for commercial rented sector and D2.2 corresponds to ‘T2.2 Market & revenue stream mapping’. This task started with reviewing maturity of ESCO and SES market in the countries represented by project consortium members (Greece, Ireland, Netherland and Spain). This task also mapped the potential revenue streams and potential opportunities of energy efficiency measures in various types of commercial buildings. Further the potential of dynamic tariff structure and peer-to-peer energy trading was evaluated along with estimation of energy and non-energy value creation due to energy efficiency uptakes was done. All these research was carried out using a T2.2 standard template, which can be found in Annex-1 of this report.

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1 INTRODUCTION

Energy services or Energy as a Service (EaaS) were defined in 2019 by Deloitte as the “end-to-end management of a customer’s energy assets and services”, often representing the nexus between technologies such as IoT (Internet of Things), Blockchain, e-mobility, renewable and energy delivery [1]. Smart energy services may be also defined “as the use of ICTs in energy generation, storage, transmission, and consumption, aiming at increasing efficiency, encouraging eco-friendly behaviour, and decreasing the emission of GHG [Greenhouse Gas]” [5].

Energy services stem for the fact that people do not care much about kWh of consumed energy, but rather value the befits coming from energy utilisation such as heating at the right time, the right level of refrigeration or the having the batteries of their electric vehicle charged when needed. Furthermore, a user of an energy service does not need to own the product or technology delivering a specific service, but would rather use the service offered by an ESCO [4]. In 2019 the global smart energy market had a value of $124.0 billion and it is forecasted that it will grow up to $253.1 billion by 2027 with a compound annual growth rate of 9.6% from 2020 to 2027 [2]. The smart energy services are sustainable solutions based on the integration of different energy assets which are flexible and may serve a large number of end users, enabling them to reduce energy costs, improve reliability, and decrease harmful emissions. The electricity consumers can adapt their energy demand in response to real time prices and thereby manage their energy costs. Most advanced smart energy services may be based on energy management algorithms processing near real-time data about energy consumption and building performance from smart sensor networks and IoT (Internet of Things) devices. The goal is to maximise efficiency in building operations while meeting targets related to user comfort metrics. User occupancy and activity within a building may be monitored such that lighting and heating in empty rooms is properly controlled to minimise waste of energy. HVAC (heating, ventilation and air conditioning) systems can be remotely controlled and turned off at specific time or temperature set-point, while data streams received from weather forecasting stations or utility companies can be used to improve the accuracy of operational decisions related to building systems and reduce the operational costs [3].

The market growth of energy services will be driven by the application of renewable energy sources such as solar and wind and the installation of smart meters. In many EU and non-EU countries the Governments are planning to replace millions of conventional meters with smart meters shortly. Additional drivers for the market’s growth are the new technologies related to energy efficiency and IoT. Smart metering is one of the main technologies to improve system efficiency and reliability and provides the customers with well-structured information about their electricity consumption. The consumer obtains accurate and error free data at regular intervals in contrast to the manual meter reading. Some smart energy services may be favoured by particular government policies such as the net metering tariffs, the time-of-use pricing, subsidies, technology standards, etc. [2].

A classification of Smart Energy Services for private households was proposed in [6]. In SmartSPIN we consider the Smart Energy Services applicable to the commercial rented sector.

The Smart Energy Services relevant with SmartSPIN can be grouped in the following categories:

Energy Supply & Billing Services (including utilization of decentralized energy resources): energy supply services include the provision of heat, lighting, cooling. It can utilize distributed energy resources such as PV-systems, hybrid heat pumps, combined heat and power (CHP) systems, wind turbines or mini gas turbines. Energy storage may also be used in an energy supply service in the context of microgeneration. Different contractual options are available for DER

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planning, installation or upgrade, operation, maintenance, financing, renting or contracting. Energy billing can be facilitated by smart metering. Remote meter reading and real-time metering enable more accurate billing and provides energy consumption information to the customers.

Monitoring, Smart Metering and Training of the Users: These services are based on data gathered from smart metering and/or smart appliances to monitor the energy consumption and production of commercial buildings. The purpose of these services is to offer a rich set of real-time information which can be used as feedback to implement energy management strategies and behavioral changes of users such that poorly energy efficient behaviors and highly energy consuming loads and processes can be identified and better managed. Energy monitoring may be implemented at appliance level and alarm notifications may be used to highlight unexpected high consumptions. Monitoring services enable comparison of historical energy consumption data with reference data as well as forecasting of energy consumption.

Peer-to-peer energy trading: Peer-to-peer energy trading services enable to sell or purchase the energy produced by prosumers in online marketplaces. Automated agents act on behalf of the prosumers considering user demand, user behavior, current and forecasted renewable productions, energy storage availability, energy market prices, etc.

Demand response services: Demand response (DR) services enable to shift energy consumption to times when there is a high energy production using renewables to reduce peak loads to reduce the stress on the grid. DR services can comprise incentives that are given to consumers for enabling the utility to shut off household's appliances. Other DR services send signals to the consumers who respond on their own to shift their loads in exchange for financial compensation. Flexible prices (real-time prices, time-of-use pricing etc.) can be further used for load shifting

E-Mobility services: This category of energy services includes "Vehicle to Grid" (V2G) and "Grid to Vehicle" (G2V) services as well as other variants. The V2G service enables to use of a plugged-in electric vehicle (EV) or a fleet of EVs as an energy storage system controlled by a local Energy Management System (EMS) or as a source of power supply which can be used to provide energy reserves or ancillary services to the respective markets. The G2V service is the charging of the batteries of the EV paying for the electricity obtained from the grid. Other services are the "*Intelligent EV charging*" which allows to charge the EV preferably when the electricity price from the grid is low and the "*Vehicle for DR*" which enables to shift the EV charging at times of low energy demand and to stop the charging to prevent or mitigate grid instabilities.

Energy Community services: these services are based on Micro-grids (MGs) and Virtual Power Plants (VPPs) concepts[1] and enable to share energy resources between community members such as microgeneration units and storage units. The produced and consumed energy are balanced within the community. In addition, the generation and consumption flexibilities can be aggregated and offered to the local or national markets.

Smart Energy Management services: Smart energy management services use optimised control rules and other customized settings to reduce energy consumption while fulfilling specific user comfort requirements. These services can be based on predefined control rules or on more

[1] MGs are physically connected to the smart grid whereas VPPs are not tied to a local region but are rather virtually aggregated.

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advanced artificial intelligence algorithms, including those which can perform the self-learning of user demand patterns to minimize the energy consumption.

The remaining part of this deliverable is structured as follows. In section 2 background information about SES are reviewed. Section 3 analyses the maturity of the SES market in EU and more specifically in the countries where SmartSPIN will run demonstrations to validate the proposed business model (Spain, Ireland and Greece). In section 4 the potential opportunities for improving energy efficiency, flexibility and penetration of renewable generation in the commercial rented sector are analysed. Section 5 summaries the insights from key stakeholders about the status of ESCO market, Section 6 concludes the deliverables. Section 7 includes the desktop research performed as part of Task 2.2 regarding the markets of SES in the SmartSPIN countries.

2 BACKGROUND

The potential revenue streams which could be included in a smart energy contract (across the different building typologies) are determined by the various sources from which ESCOs and building owners earn money from the sale of energy services and available flexibilities. The main value creation for the commercial rented sector is determined by the provision of one or more energy efficiency services (such as those reviewed in section 1) which determine a revenue stream for the ESCO and the landlord depending on the contractual agreements between the two parties [7]. These are operating revenues for the ESCO because are amounts earned from the company's core business operations, whereas they are non-operating revenues for the landlord because they are earned from a side activity.

Figure 1 shows the case where the ESCO shares the savings with the landlord. Both ESCO and landlord obtain a revenue stream from energy efficiency service delivered by the ESCO. The ESCO is responsible for designing, financing, and implementing the energy efficiency project, usually obtaining a fixed portion of the savings over a fixed period. The ESCO is also responsible for the verification of the savings during the contractual period. The tenant pays the fees for the energy efficiency service to the ESCO and enjoys non-energy benefits such as a renewed premise and lower carbon-dioxide emissions. The risks for the landlord related to the implementation of the energy efficiency projects are minimal.

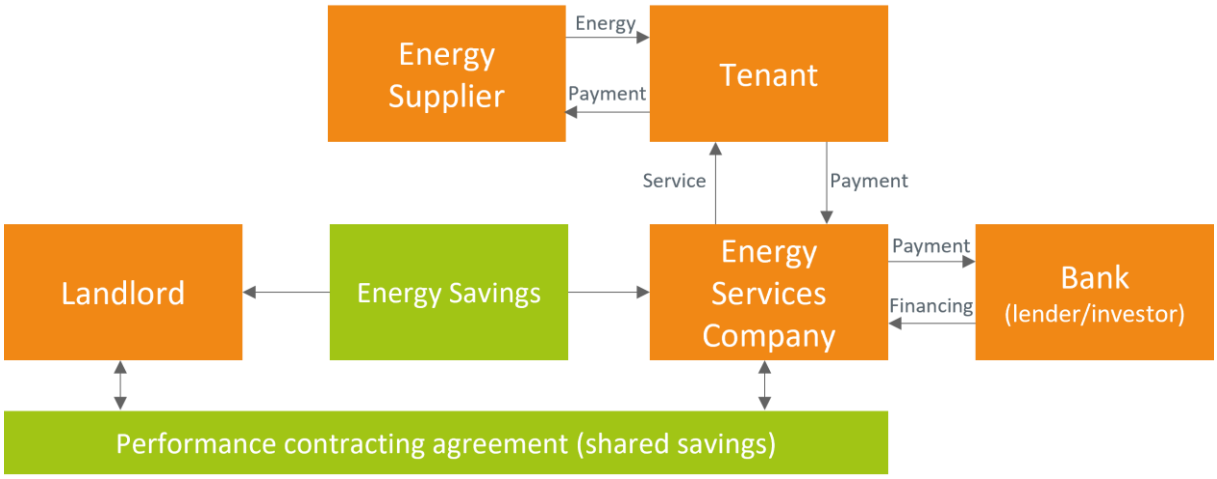

Figure 1: Revenue streams from shared energy savings between ESCO and landlord.

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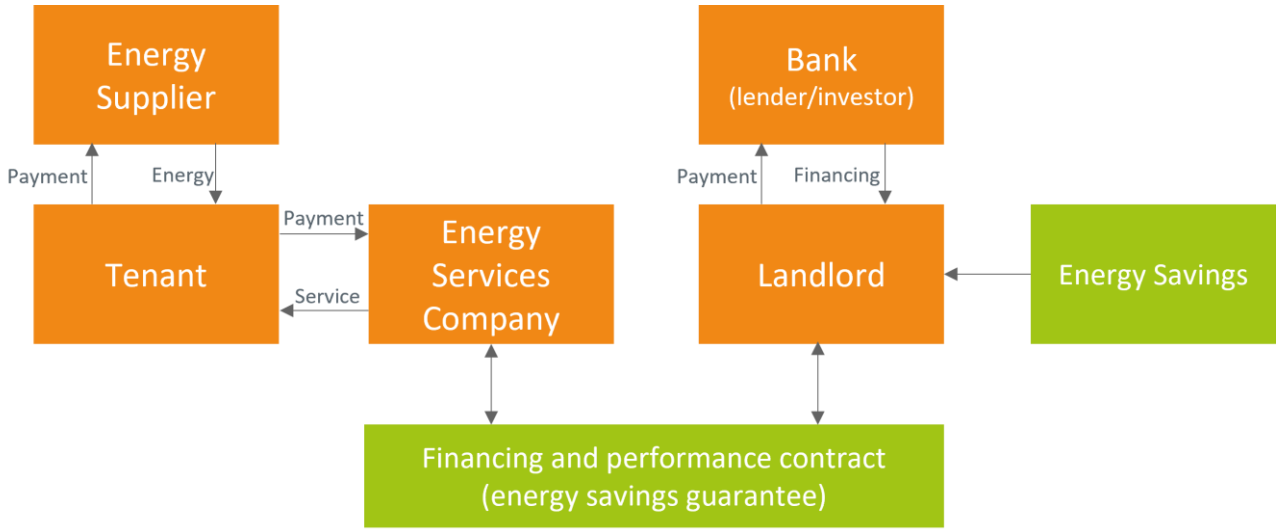

Figure 2: Revenue streams from guaranteed energy savings for the landlord

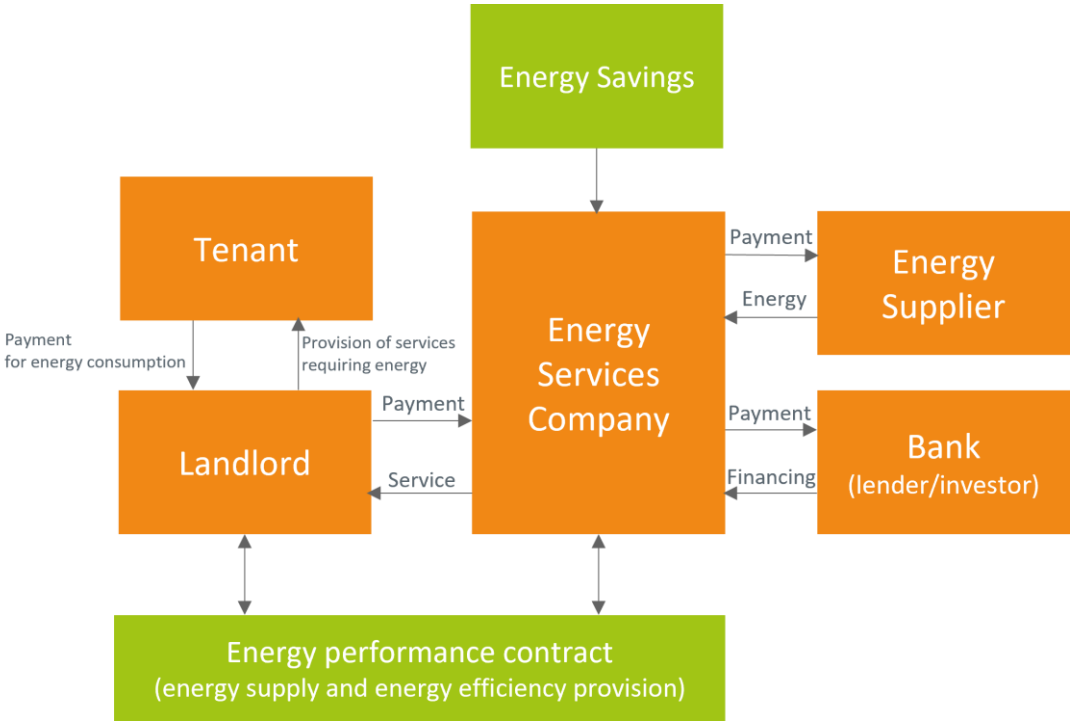

Figure 3: Revenue streams from provision of energy supply and energy efficiency services by ESCO

The ESCOs may also be offering an energy efficiency service guaranteeing a stable revenue stream to the landlord (guaranteed energy savings, Figure 2). In such a case the ESCO may be still responsible for designing and implementing the energy efficiency project but would leave the

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responsibility for financing it to the landlord. Also in this case, the tenant pays the fees for the energy efficiency service to the ESCO. The landlord enjoys a stable revenue stream at the price of having to directly liaise with a bank or another investor for the financing of the energy efficiency measures.

Finally, an ESCO may offer a complete energy service including both energy supply and energy efficiency to the commercial rented facility. This is sometimes referred in the literature as Chaffee model. In such a case the ESCO is responsible for the operation and maintenance of the entire energy system of its customer. The ESCO has the opportunity of securing a substantial revenue stream getting all the savings if contractual targets are met. The ESCO needs to manage and transform the customer's energy system to achieve the targets specified in the contract and self-finances the related upgrade projects. If the targets are not met the ESCO pays a compensation which depends on the energy savings shortage. The landlord has a contract with the ESCO and pays for both energy provision and the energy efficiency. Rather than a revenue stream from the energy efficiency, the landlord enjoys a thorough energy service from the ESCO with favorable contractual conditions. Moreover, the landlord receives a payment from the tenant(s) for the energy expenses due to the energy consumption of the tenant.

3 MATURITY OF SES MARKET REVIEW

The maturity of the SES market is being measured via maturity of ESCO market in the Member States. Maturity of SES market in Spain, Greece and The Netherlands is summarised in table 1.

3.1 IRELAND

In Ireland Energy Performance Contracting is supported by Statutory Information 426 of 2014 and article 18 of Energy Efficiency Directive (EED) has also been implemented in Ireland. Ireland is a developing ESCO market since 2015. According to the JRC report published in 2019, Size of ESCO market in Ireland has been estimated as €20m [8], although no official data is available. In terms of ESCO market it could be segmented by technologies in terms of single technology v/s multi technology. Companies that focus on Lighting as a service or energy management as a service and those that offer multiple technologies as part of a composite solution to meet overall site or portfolio opportunity. Activity in the private sector at this stage is dominated by single technology approach with ESCO activity across composite solutions only now beginning. In terms of demand response this market is growing in Ireland however as the grid is decarbonizing the activation events for sites subscribing to demand response is increasing causing some existing clients to opt-out of the schemes.

Irish government is offering support for EPC market for public sector buildings and ESCOs are offering attractive market bargains to appeal to more customers. Since energy efficiency implementation plays a significant role in achieving the energy efficiency target and ensuring energy security, energy service market is hugely supported by government.

There are no ESCO association set up in Ireland, informally Sustainable Energy Authority of Ireland (SEAI) acts as ESCO association to promote ESCO business and their market activities.

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SEAI have developed and provided model ESCO contract template to be used by ESCOs. SEAI also offers support (expert advice and technical support) to businesses and encourage them to avail the energy services being offered by various ESCOs. Furthermore, SEAI offers several financial supports to encourage ESCO business and implementation of energy efficiency upgrades. SEAI website provides a list of registered contractors for the businesses and other clients to avail several energy services in Ireland.

SEAI has developed National Energy Services Framework to support the energy efficiency market for non-domestic sector in Ireland. National Energy Services Framework stimulates the energy service market by providing guidelines on standard and organized approach for Energy Performance Contracting along with model contract templates, M&V requirements, guidance document etc. SEAI also developed and issued an Energy Performance Contracting Handbook for business to help with planning before entering into energy performance contracting.

Integration of advanced energy services based on ICT technologies has been listed under innovation and enterprise opportunities of Ireland's transition to a low carbon energy future 2015-2030. This report also talks about integration of smart energy services and smart metering system being controlled and driven by mobile applications and broadband facilities in the energy service market[2].

The opportunity to increase renewable energy penetration in Ireland currently (Q2- 2022) is curtailed in scale by the absence of a tariff to remunerate PV asset owners for electricity not consumed on their site and given to the grid. This is due to change in (Q3-2022) however uncertainty on the remuneration level exists. Energy trading is not permissible in Ireland at this stage and only registered energy providers are allowed sell electricity. Renewable penetration will increase with these restrictions removed however it is dependent on reasonable market rates for excess electricity and in the case of energy trading ensuring that use of grid is set at a commercially viable level.

In Ireland three types of energy performance contract is available – Energy Performance Related Payment (Guaranteed energy saving approach), Energy Performance Contract (ESCO fee is paid from saving accrued) and Local Energy Supply Contract (ESCO installs works and supplies energy; ESCO is paid for quantity of energy supplied)[3].

In Ireland energy supply companies, utilities, facility management, energy auditors, energy consulting and engineering & construction companies acts as energy service companies. Most of these companies are small private national companies (<50 employees) offering a wide of services not just limited to EPC services. Along with these companies, electricity supplier ESB also provide smart energy services in Ireland. Public buildings (hospitals, schools, colleges, offices) followed by commercial office buildings and hotels are the typical customers of ESCO services. Average duration of ESCO projects in Ireland is 5-8 years.

[2] https://assets.gov.ie/77389/e5aa9f25-da81-43eb-804d-57309615681e.pdf
[3] https://www.seai.ie/business-and-public-sector/business-grants-and-supports/energy-contracting/

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Lack of appropriate forms of finances and lack of experienced energy service providers are the most prevalent barriers limiting the development of ESCO market in Ireland. Perceived business and technical risks and uncertainty of prolonged Brexit negotiation also set back the ESCO market development. Government support, standardisation and simplification of EPC and promotion of successful ESCO project case studies are the main drivers to help development of ESCO market in Ireland. The SES market will be substantially driven from a demand perspective by the huge demand to control, reduce and offset carbon footprints. The emergence of new technologies and accessibility in terms of cost of new technology through scaling and mass production are also key enablers for this market.

More details can be found in section 7.4 Ireland.

3.2 SPAIN

The role of energy service providers was introduced into Spanish legal order by Spanish Royal Decree-Law 6/2010 on 9 April 2010. The Royal Decree –Law 6/2010 also outlines a definition of Energy service companies and this definition follows exactly with the definition outlined in Directive 2006/32/EC. Also Royal Decree-Law 8/2013 encourages energy efficiency uptake by outlining measures for financing energy efficiency implementation investment. Article 18 of EED is well implemented in Spain. Article 18 of the EED requires EU MSs to encourage the energy services market and to support its operation, by various support means, for example, providing energy service market information to final consumers. Integrated National Energy and Climate Plan (INECP) 2021-2030 of Spain sets target of 39.5%[4] improvement in energy efficiency by 2030 with respect to PRIMES reference scenario 2007. This target was set in line with the EU wide target of 32.5% improvement in energy efficiency by 2030. INECP considers energy service providers will play an important role in achieving 2030 energy efficiency targets. INECP requires national and regional energy agency to provide new contract templates for energy service so as to adapt the recommendations of Eurostat and compliant with the new Public Sector Contracts Law. They also need to provide information on available financial instruments, incentives and loans to support ESCO services.

ESCO market in Spain is in developing stage and growing slowly since 2015. There are three major national energy service associations established in Spain – Association of Maintenance Companies[5] (AMI), Association of Energy Service Companies[6] (ANESE) and Association of Energy Efficiency Companies[7] (A3E).

There is no official data available regarding the size of Spanish ESCO market. As per AMI estimation, size of Spanish ESCO market is about €1.5 billion in 2018, whereas ANESE estimated the size of ESCO market in Spain is about €1 billion and 70 ESCOs. According to ANESE in 2018

[4] https://ec.europa.eu/energy/sites/ener/files/documents/es_final_necp_main_en.pdf
[5] http://www.amiasociacion.es/
[6] http://www.anese.es/
[7] http://www.asociacion3e.org/

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96 Spanish companies (out of which 48%- small, 29% - medium and 23% large enterprises) were offering ESCO services. Whereas AMI estimates 90% of all Spanish ESCOs are large enterprises.

As per Institute of Energy Diversification and Savings (IDAE) in year 2017 there were 1238 companies registered as ESCO and more than half of these companies are based in Madrid and Andalusia. However, many of these companies provides, either manufacturing, or consulting or financial services, they do not invest in energy performance (which is one of the most important requirement of ESCO). In Spain companies offering following services are considered as ESCOs - energy supply companies, utilities, facility maintenance companies, and engineering and construction firms, and facility management and operation companies, and automation, control and equipment manufacturers, and equipment supplies and/or installers, distributors and installers of renewable technologies and consulting firms, energy auditors, other energy specialists as well as Issuers of energy performance certificates. Building level heating and heating systems, industrial processes, horizontal technologies, motor systems and street lighting are example of technologies being implemented by ESCOs at client premises.

Public buildings (hospitals, schools, colleges and offices), Commercial office buildings & hotels, and public lighting as well as industry sites and processes mainly avail the ESCO services in Spain. According to ANSES the average cost of an ESCO project in Spain is €433132 and average duration is 7-8 years. Whereas AMI's and ADHAC's (Spanish Association of District Heating ESCOs) estimation for same is €500000 - €5000000 and 10-15 years. Shared saving model of ESCO contract is most popular contract type among the Spanish clients.

Smart Energy Services implementation is at very starting phase. Under the current law aggregation of demand is permitted only with a sufficient volume of flexible generation, such as industries and tertiary buildings. However, it is expected it will open up further to independent aggregators in 2022[8]. There are very few companies who have started working and developing use of artificial intelligence and block chain for flexibility in energy service.

There are number of barriers exists, that prevent the uptake of ESCO services in Spain. Lack of standardisation and high cost against the small size of project are the most prevalent barriers. The barriers can be listed as mistrust from the client, ambiguities in legislative framework and lack of appropriate forms of finances. Increasing energy price and offering external expertise are the driver for the uptake of ESCO services among the clients.

More details can be found in section 7.1 Spain.

3.3 GREECE

The energy service market in Greece has started to foster in late 1990s, since then there is not much development in this market and has become stagnant due to economic instability. Most of the organisation lack enough capital to invest in availing energy efficiency services. As per JRC

[8] https://www.smart-energy.com/industry-sectors/energy-grid-management/spanish-startup-eyes-consumer-participation-in-flexibility-markets/

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report (Energy Service Market in EU) published in 2019, Greece has scored 1 (out of 10) as the maturity of market. The maturity of market was assessed based on several indicators.

Greece is following and implementing EU directive obligation for renovation of 3% public building surface area. However, non-SME organisations are required to undergo energy audit from mid-2018. National Energy and Climate Plan (NECP) of Greece[9] sets target of Greenhouse Gas emission reduction by 15% as compared to 2005 emission levels. National Energy Efficiency Action Plan 2017 and National Energy and Climate Plan of Greece supports several initiatives to promote ESCO market growth. In Greece, article 18 of the EED is transposed into Article 19 of Law 4342/2015 (Government Gazette, Series I, No 143, 9.11.2015) entitled 'Energy Services'.[10]

National ESCO registry exist in the Greece, where all the ESCOs can register there voluntarily. Based on the budget of implemented projects, ESCOs are categorised. The ESCO registry is split into the four categories as A1, A2, A3 and B. Only category A1 ESCOs provide EPC based projects. As on June 2021 there are 61 ESCOs registered in the ESCO registry. Out of 61 registered ESCOs 23 are in category A and 38 are in category B.11 All of the ESCO companies are small (up to 50 employees) or medium companies (up to 250 employees).[12] Companies providing following services acts as ESCOs in Greece - Engineering and construction, energy consultation, energy audits, energy supply and providing building energy performance certificate. Shared saving model is most popular and demanded type of contract for EPC type of projects in Greece. Duration of most EPC projects in Greece is less than 5 years, none of the EPC project was more than 10 years.[13] ESCOs communicate with its client and finance providers.

The ESCO registry also provides information on EPC contracts, final consumer rights, available financial supports like incentives, grants, loans to promote the uptake of EPC projects. This website also provides information on best practices EPC suitable for building renovation and cost-benefit analysis with a lifecycle approach.

As per the requirement of Article 18 of Energy Efficiency Directive, to further support development of EPC market, a model EPC contract has been developed in Greece. The ESCO registry website also has two model Energy Performance Contracts (EPC) prepared by Directorate for Energy Policy and Energy Efficiency: - a) Model of guaranteed performance EPC. b) Model of shared benefit EPC.[14]

Although ESCO market is in embryonic stage and is not mature enough to cater the projects delivering Smart Energy Services, but market reforms are planned to introduce and incorporate renewable energy services (RES), demand response and energy storage services. Latest recovery and resilience plan 2021 of Greece supports installation of more than 8000 electric charging points for vehicles in the kay urban area and some strategic locations for example airports, parking areas,

[9] https://ec.europa.eu/energy/sites/default/files/el_final_necp_main_en.pdf
[10] https://ec.europa.eu/energy/sites/default/files/documents/el_neeap_2017_en.pdf
[11] http://www.escoregistry.gr/
[12] https://qualitee.eu/wp-content/uploads/QualitEE_2-04_CountryReport_EL_2018.pdf
[13] https://qualitee.eu/wp-content/uploads/QualitEE_2-04_CountryReport_EL_2018.pdf
[14] https://ec.europa.eu/energy/sites/default/files/documents/el_neeap_2017_en.pdf

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motorways across Greece. Hellenic Electricity Distribution Network Operator (HEDNO) have plans and started taking actions to replace around existing 7.7 million conventional electricity meters with smart meters across Greece.[15] Installation of smart meters will enable the integration of dynamic tariff structure for the consumers and network use.

Conventional energy efficiency interventions (upgrading building thermal insulation and energy inefficient appliances) are more popularly being implemented in residential and commercial buildings of Greece. Some other new energy efficiency measures implementation is in development stage for example renewable energy generation, installation of smart devices and smart energy management algorithm for controlling installed smart devices, peer-to-peer energy trading etc. Integration of smart meters and demand response/flexibility is the most prioritised development for Greek energy market. Ministry of energy and environment is also working to introduce energy storage system using hydro pumping station.

Office buildings, hotels, tourist facilities and public lighting are the most common business sector availing ESCO services in Greece. Small business struggle to fetch financing for ESCO projects due to very high interest rates offered by banks. However due to perceived risk of instable economy bigger ESCOs refrain obtaining bank finance for EPC projects. Similarly, Because of financial instability potential investors lack confidence to invest in EPC projects.[16] Internal funds of client or the provision of operating leases, are the most preferred financing option by ESCOs.

Higher energy prices, EEO targets and offering financial support/incentives for energy efficiency upgrades, guaranteed energy savings are the drivers for ESCOs to implement/adopt SES delivery in Greece. Lack of access to financing by clients/ESCOs, financial instability of the country and lack of suitable financing options is the most prevailing barrier for SES market in Greece.
More details can be found in section 7.3 Greece.

3.4 NETHERLAND

Energy service market in Netherland is moderately matured and at advance level, also is stimulated by political framework. ESCO market in Netherland has grown since 2015 due to supportive national legislations on energy efficiency measures and energy performance of offices. Also banks and financial institutions are supporting uptake of energy efficiency measures via Real Estate Finance loans. Government has issued a list of energy efficiency measures, upon implementing the listed ESCMs clients/ESCO will be eligible for the energy efficiency incentives. Energy Investment Allowance (EIA) supports the uptake of energy efficiency implementation by offering tax benefits when investing in energy efficiency technology and sustainability.[17] EPC and flexibility service offering by national companies is uniform across the Netherland.

Advancement of technology diffusion for the energy service market in Netherlands is relatively high compared to other European countries. Integration of artificial intelligence based digital layer, smart meters, smart grid, peer-to-peer energy trading, battery storage, energy management system and renewable energy system are most emerging technology in the energy service market of

[15] https://energypress.eu/tag/digital-power-meters/
[16] https://qualitee.eu/wp-content/uploads/QualitEE_2-04_CountryReport_EL_2018.pdf
[17] https://english.rvo.nl/subsidies-programmes/energy-investment-allowance-eia

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Netherlands. Prosumer market and advancement of peer-to-peer trading are the main focus for future development of smart energy service offerings in Netherland.

Typically, private national and international firms act as ESCOs in Netherland, who provide following services – Energy Supplies, utilities, engineering and construction, facility management, equipment supplies and installations. Public buildings (hospitals, education buildings and offices), commercial office buildings and hotels are major clients availing ESCO services in Netherland. The average duration of ESCO projects in Netherland is 5-10 years and average budget is €200,000-€5,000,000. Project financing and financing lease is the most common type of source of financing ESCOs projects in Netherland.[18] Netherland Energy Agency supports uptake of energy services by offering template for energy performance contract, financial structure and possible subsidies. Guaranteed saving, shared saving and Chaffee type of EPC are mostly used by ESCOs and their clients in Netherlands.

Small size compared to high cost of projects and ambiguities in the legislative framework are the most prevailing barriers that are limiting energy service implementation in Netherland. Energy cost reduction, decarbonisation of grid and one stop shop solution are the major driver for the energy service market of Netherland.

More details can be found in section 7.2 Netherland.

4 POTENTIAL OPPORTUNITIES FOR ENERGY EFFICIENCY, FLEXIBILITY AND RENEWABLE PENETRATION

The most important potential opportunities for energy efficiency, flexibility, and renewable penetration in various typologies of buildings are summarised in Table 1 below.

[18] https://vipo.iea.org/topics/energyefficiency/escos/TheNetherlands/

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Buildings	Energy Efficiency opportunities	Flexibility opportunities	Renewable penetration opportunities
Office	Set timers and thermostats Heating system maintenance Tune ventilation rate Energy management of office equipment	Thermal storage capacity of a building (thermal mass) Potential flexibility for demand response Thermal Comfort Control strategies based on set-point adaptation to different zones and time of the day Aggregation of building offices' flexibility to offer balancing services to the local electricity grid	PV opportunities. PV can be used for charging of workplace EVs.
Shopping centre	Improvements in HVACs efficiency Improvements in lighting efficiency Improvements to the building envelope	Controlling of HVAC and ventilation systems operation Partial sheddability of lighting (~25%) Reduction of peak-power consumption precooling (preheating) the building Micro grids	high potential for PV due to abundance of roof space Some opportunities for PPA with wind energy producers
Sports facility	Technologies to exploit renewable energy sources such as energy storage Improvement of the lighting system Modernisation of HVAC plant	Use of different types of energy sources Use of the large heat storage capacity Potential for micro grids installation and	solar heating for showers and PV for electricity production and biomass for co-generation.

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	and equipment Implementation of BMS control strategies Upgrades to the building envelope Upgrade of specific electrical equipment	cogeneration	
Industrial building	For the buildings without intense heat or pollution sources reduction of HVAC energy consumption For the buildings with intense heat or pollution sources, reduction of the ventilation system energy consumption	improvements in operational efficiency using Energy efficient devices and processes some sheddable loads industrial demand-side flexibility allows shifting demand over time and space to match fluctuations in renewable energy production	High potential for rooftop PV Some opportunities for PPA with wind energy producers

Table 1: The potential opportunities for energy efficiency, flexibility and renewable penetration in various typologies of buildings

4.1 IMPACT OF FUTURE MARKET DEVELOPMENTS AND POTENTIAL VALUE GENERATION THROUGH ENERGY INTERVENTION

Future market developments considered in T2.2 include dynamic tariff structures and potential for peer-to-peer trading. Dynamic tariff structure is defined as charging of different electricity rates at different time of day and year to reflect the time-varying cost of electricity supply.[19] Dynamic tariff structure can have further various categories as time-of-use (ToU), real-time pricing (RTP), critical-peak pricing (CPP), and peak-time rebates (PTR). Dynamic tariff structure is most useful for commercial and industrial use of electricity. Dynamic tariff structure will allow time-shift the electricity usage to the off-peak hours for example storage tasks, battery charging, electrical vehicle charging, other industrial process etc. Roll-out of smart meters plays very important role in implementing dynamic tariff structure in any country.

[19] https://fsr.eui.eu/implementing-dynamic-tariffs-for-electricity-retail-choices-and-barriers/

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Peer-to-Peer (P2P) energy trading is a system which allows distributed energy consumers and prosumers to exchange energy without need of any intermediate entity. P2P energy trading system creates an online marketplace where electricity prosumers and consumers can trade electricity at a mutual agreed price. P2P energy trading empowers prosumers and consumers and ultimately leads to increased integration of renewable energy and flexibility in the grid. This also leads to digitalisation of energy system and allows better use of their energy resources.

Potential of dynamic tariff structure and P2P are summarised in Table 2 and Table 3 for different typologies of buildings.

Typologies of buildings	**Relevance of Dynamic tariff structures**	**Benefits of dynamic tariff structures**
Office	Limited relevance for small businesses which have low interest in energy management.	Energy cost reductions for the end users that can perform demand side management. Lower carbon emissions because dynamic tariff structures support the deployment of renewables in the power system and replacement of conventional power plants with more renewables.
Shopping centre	Relevant with businesses which have installed smart meters and can perform energy management. Better opportunities in countries where the regulators made dynamic Time-Of-Use tariffs the default option (such as Spain). Adequate technology must be available to enable consumers to respond quickly to real-time energy price signals.	
Sports facility		
Industrial building		

Table 2: Relevance and benefits of dynamic tariff structures in various typologies of buildings

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Typologies of buildings	Potential for peer-to-peer trading
Office	Small businesses may not be interested in being prosumers, they could be power purchasers.
Shopping centre	They can be prosumers but generally their capability of selling energy is limited by the small amount of PV production compared to their energy demand. They can have purchase power agreements with other prosumers.
Sports facility	Large sport facilities with swimming pools may show a large thermal load compared to the electrical load. If CHP are installed heat generated can be used locally whereas electricity is sold to other prosumers. Moreover, batteries can be used to maximise self-consumption. PV power can be exported when production exceeds the consumption (and the amount which can be stored, in case batteries are installed). Power purchase agreement with other prosumers are also a possibility.
Industrial building	Potential may depend on the specific building. There may be some potential to sell excess of PV produced power and to control local generation such that power is sold to other prosumers. In case CHP are used, a certain amount of electricity can be produced only if there is sufficient thermal load to absorb the corresponding heat produced.

Table 3: Potential for peer-to-peer energy trading in various typologies of buildings

Potential value generation through energy efficiency can be categorised as economic benefits and social or non-energy benefits.

Economic Benefits –

1. Improved energy efficiency could play a key role for emerging economics and developing countries, as energy efficiency will enable them to fully utilise all the available resources and lead towards sustainable growth.

2. Energy efficiency is directly related to energy security of each country, as energy efficiency improvement and reduced energy demand results in industrial productivity and reduce fuel import bills.

3. Energy efficiency contributes to fight with energy poverty by reducing energy bills of individual buildings. Also energy efficiency will help fight with rise in energy price and improves the customer's energy affordability.

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4. In many countries energy efficiency investments qualify for some government supported financial aids like tax incentives, tax rebate, subsidies, and lower interest rates.

5. Energy efficiency improvement leads to enhanced competitiveness and reduced cost of production and O&M cost for industrial sector.

6. Reduced energy demand due to improved energy efficiency avoids cost of energy generation and transmission & distribution losses in the grid.

Social or non-energy benefits –

1. Energy efficiency retrofits in buildings improves thermal comfort of the building which leads to better health and wellbeing of occupants. Better health and wellbeing ultimately contributes to lower public health spending and improves social and economic impacts. This positive health impact is strongest among the vulnerable groups like elderly people, children and people with pre-existing illness.

2. Improved energy efficiency leads to reduced pollution and Greenhouse Gas emission and ultimately help fight with global climate change issue. Several governments are now deliberately aligning their energy efficiency policies with GHG reduction target.

3. Energy efficient buildings creates an improved green image of building and increases overall monetary value and rental value of the buildings.

5 INSIGHTS FROM INTERVIEWS

As part of the development of this task, some interviews have been carried out with key stakeholders of SmartSPIN (including EAB members) from different countries across Europe. The purpose was to know in more detail about the status and maturity of ESCO's market in each of the countries from these key stakeholder's point of view, as well as their current smart energy services in place.

CODEMA, the Dublin Energy Agency, acts as an EPC project facilitator for the public sector and thinks that since the meaning of terms such as ESCO or EPC guarantee are confusing in Ireland and can vary depending on the region, facilitators can act as trusted mediators between ESCOs and the clients or building owners, given that the latter are always the least informed.

Factor 4, an energy performance company based in Belgium, agrees with CODEMA in the relevance of trust, as ESCOs or outsourcing a project are usually seen as threats. For them, making sure that the energy consumption of the building is aligned with its use is one of the key discussion points of an EPC agreement between ESCOs and Building Owners.

On the other hand, ANESE, the National Association of ESCOs in Spain, states the efforts that the national legislation is putting to promote the ESCO model and make it clearer to the actors involved. They highlight the importance to engage not only landlords but also tenants with the ESCOs. In addition, they outline the role of aggregator that an ESCO may have, managing all relations with energy providers and clients.

Likewise, Carbon Minded, an energy consultancy based in UK, stands out the role of ESCOs as aggregators, assuming the responsibility of searching and engaging with landlords owning several buildings. Furthermore, it introduces the possibility of ESCOs acting as or developing a kind of

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one-stop-shop, bridging landlords and finance providers, concluding that: “the most successful ESCOs will be those who will undertake all the responsibility, taking all the hassle away from the clients and making everything easier for them”.

6 CONCLUSION

The ESCO market and hence SES market in the EU Member States have upgraded in recent years, specifically have matured in some countries. ESCO plays a notable and significant role for increasing energy efficiency and achieving long-term decarbonisation targets for any country. However, a number of challenges still persist, which refrain the growth and development of energy service market and restrict the ESCO market to achieve their full potential. These barriers are distinctly local among all the MS countries. Each country faces different challenge based on their geography, business culture, economy, government support & policies, definition, roles and activities of ESCO, ease of running business and level of awareness. Below Table 4 represents summary of the maturity of ESCO and SES market of Spain, Greece, Netherland and Ireland.

Particular	Spain	Greece	Ireland	Netherland
SES Market	Very starting stage	Embryonic Stage	Developing Stage – Energy services supported by ICT technology is developing. P2P trading is in academic research phase	Well developed – Smart grid, Smart meters, P2P energy trading, AI integration
ESCO Market	Developing – ESCO associations exist	Embryonic Stage – ESCO registry exist, ESCO categorisation based on project budget	Developing – No ESCO association exist. SEAI offers a long list of support for ESCOs and clients to promote energy service market.	Well developed – ESCO and flexibility markets are uniform throughout the country. ESCO are SMEs. Supporting govt. legislations.
Flexibility Market	Embryonic Stage	Embryonic Stage	Opportunities for earning revenues with demand response exist for manufacturing	

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			plants, food production facilities, cold warehouses, hospitals, hotels, quarries, cement factories.	
Drivers	High energy price. Guaranteed energy saving. Customer demand.	High energy price. EEO targets. Offering financial incentives. Guaranteed energy saving.	Government support Research & development in energy efficient technologies Demonstration of successful ESCO project case studies	Energy cost reduction. Decarbonisation of grid and heating sector. One stop solution.
Barriers	Lack of trust on ESCO model. Lack of financing. Contracts too complicated. Lack of govt. support. Lack of standardisation.	Economic uncertainty. Lack of financing. Contracts too complicated. Unclear legislative framework. Lack of standardisation.	Lack of appropriate form of financing Inexperience of actors Perceived business and technical risks	High cost of projects. Lack of trust in ESCO industry. Complex ESCO contract/lack of information.

Table 4: Maturity of the SES Market in the SmartSPIN pilot countries

The Energy Efficiency Directive 2021 under 'fit for 55' package proposed revise target of improvement of energy efficiency by 36% improvement by 2030. [20] Under the 2018/1999 Governance Regulation, all the EU MS are required to draw a 10-year National Energy and

[20] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en

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Climate Plan with detailed actions to achieve the 2030 energy efficiency targets.[21] Transposing and implementing of EED at national level is encouraging the ESCO market development.

Financing ESCO projects is one of the notable difficulty or challenge in all the EU MS countries. In Europe, majority of the ESCO projects have been executed in public sector buildings as public sector is considered as safer client that would not stop running their business. Introduction and integration of Combined Heat and Power (CHP) technology in the energy service market has encouraged large commercial centres, hospitals and industries to participate in ESCO projects.[22]

Providing model contract or contract template for various types of ESCO contract will enable standardisation of the market, common understanding among market stakeholders, increase trust among the customers and will encourage the development of ESCO market. Finland, Slovakia, Slovenia and Spain have successfully implemented the model contract scheme.

As mentioned earlier ESCO market is very much local driven for each country, hence drivers and recommendations for the development of ESCO market for all the countries will be different from each other depending on the current level of maturity of energy service market.

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[3] Smart energy management and smart buildings, https://realto.io/smart-energy-management-and-smart-buildings/, accessed on April 4th 2022.

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[8] JRC 2019 Report – Energy Service Market in the EU

[21] https://www.eceee.org/policy-areas/EE-directive/
[22] https://www.aceee.org/files/proceedings/2004/data/papers/SS04_Panel5_Paper04.pdf

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7 ANNEX-1

7.1 SPAIN

Country : Spain
How can the current state of the ESCO and flexibility national markets be summarized? Are there any specificities to be considered for the regional markets associated with the pilot site? Use published data to address these questions.
The Spanish Royal Decree-Law 6/2010 outlines a definition of Energy service companies and this definition conforms exactly with the definition outlined in Directive 2006/32/EC. The most widely used system of certification for ESCOs is the system established by Association for Standardization and Certification (AENOR) in 2016 and subsequently became standard UNE 216701 – "Classification of energy services providers" published in May 2018 by UNE (Spanish Association for Standardization).[23] The Spanish ESCO market has been categorised as developing market and thus poses a scope of being a well-developed market.[24] Article 18 of EED is well implemented in Spain. In Spain there are three main national energy service association AMI[25] (Asociación de Empresas de Mantenimiento Integral y Servicios Energéticos, ANESE [26] (Asociación Nacional de Empresas de Servicios Energéticos), A3E[27](Asociación de Empresas de Eficiencia Energética). There is no clear and official information available regarding current size of ESCO market in Spain. Above mentioned associations presents different numbers on size of Spanish ESCO market. As per AMI; for year 2018 ESCO market is estimated approx. €1.5 billion, whereas as per ANESE estimation current market is approx. €1 billion. As per data published by IDAE (Institute for Energy Diversification and Savings)[28], there are 1238 registered ESCOs in the Spain (QualitEE 2018j). Madrid and Andalusia have majority of ESCO registered. According to ESCO association, ANESE, there are 96 companies acting as ESCOs in Spain; 48% of these companies are small size companies (up to 50 employees), 29% of investigated ESCOs are medium size companies (up to 250 employees) and 23% large size companies (above 250 employees). Another ESCO association, AMI, indicates that 90% of all ESCO members of the association are large companies (above 250 employees).
What are the potential energy efficiency opportunities for each different commercial building type? What are the opportunities for flexibility? What are the opportunities to increase renewable penetration? What are the opportunities for energy efficiency, flexibility and

[23] https://qualitee.eu/wp-content/uploads/QualitEE_2-05_EuropeanReport-2018.pdf
[24] JRC. 2019. Energy Service Market in the EU. Joint Research Centre.
[25] http://www.amiasociacion.es/
[26] http://www.anese.es/
[27] http://www.asociacion3e.org/
[28] http://www.idae.es/empresas/servicios-energeticos

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renewables utilization in non-commercial buildings?
The National Energy Efficiency Action Plan 2017 (NEEAP 2017) categorised measures to promote energy efficiency in 3 categories: legislative, economic support and promotion measures. Spain is in embryonic stage of market for flexibility and Demand Response (DR) and has one of the deprived regulatory regimes regarding DR and asset aggregation. As per one of the report of SmartEn[29] Spain is least developed market activities, value stream availability & accessibility of Demand Side Flexibility (DSF), monetization of DSF in value stream, breadth of asset diversity used for DSF, breadth of customer segment engaged with DSF and competitive landscape for DSF. The same report has termed Spanish market as 'Emerging Market' among the EU MS. Aggregation is not legal in Spain and there is only one scheme called 'Interruptible Load Programme' which allows explicit demand response.[30] Aggregated DR neither have access to the balancing market nor to the ancillary services. Spain does have a program for interruptible contracts, but it is open only to consumers with contracted power above 5 MW.[31] In Spain asset aggregation is only allowed for generation activities. Since 2016, DG and renewable energy resources have been able to prequalify and participate in the tertiary reserve. Another issue in Spain is that its capacity market is only open to generation assets, while excludes energy storage (and with it solar and wind + storage) from this market.
What is the potential for different types of energy intervention in different building typologies within the market of the considered pilot region? What is their aggregated potential for energy savings and value generated?
According to ANESE's Observatory report, the average energy savings of a typical ESCO project in Spain is 35.86 % of baseline consumption. As per estimation of AMI 25% of energy savings can be achieved in buildings and up to 75% in the public lighting.[32]
What are the foreseen future market developments? What are the opportunities to implement dynamic tariff structures and peer-to-peer trading?
JRC 2018 survey classified Spain as growing market with slow increase for ESCOs operation. In Spain ESCO market has seen a slow increase since 2015. Lack of knowledge and awareness has been identified as the factor hindering ESCO market growth in Spain. One of the report 'Energy Service Market in the EU' published by European Commission's Joint Research Centre, listed some recommendations to help development of ESCO market in Spain. These recommendations are related to changes in the regulatory, legal, financial and informational framework of the ESCO market. Listed recommendations are: - • Create a white certificate scheme,

[29] https://smarten.eu/wp-content/uploads/2021/03/EU_Market_Monitor_2020_1-32.pdf
[30] https://ambience-project.eu/wp-content/uploads/2020/10/AmBIENCe-Factsheet-Spain.pdf
[31] https://guidehouseinsights.com/news-and-views/the-spanish-energy-transition-might-speed-up-but-where-should-it-go-now
[32] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC118815/jrc118815.pdf

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- Link energy savings to tax advantages,
- Implement a Guarantee Fund to ESCO projects,
- Creation of a National Guarantee Fund for Energy Performance Contracting (EPC) projects,
- Prepare and publish EPC models (buildings) for public procurements,
- Use the Spanish national energy saving fund to promote EPCs,
- Assistance program for SMEs for the execution of energy audits and the implementation of identified energy efficiency measures.

To successfully launch its distributed energy segment, Spain needs to restructure its markets to introduce the aggregator figure into its market and treat DR and storage as equals to generation. These changes have been implemented in several European markets; there is no technical reason why they can't be implemented in Spain.

How would you define a SES and which SES have you identified in your case? 2. What are the Smart Energy Services (SES) offered? Which building typologies can be associated to the SES and related smart energy contracts? 3. In the case that you have not identified one SES, what would be an optimal SES for your case?

Smart Energy Services implementation is at very starting phase. Under the current law aggregation of demand is permitted only with a sufficient volume of flexible generation, such as industries and tertiary buildings. However, it is expected it will open up further to independent aggregators in 2022[33].

Bamboo energy is an organization which is aiming to develop block chain flexibility services in northern Spain with consumer participation in flexibility[34] [35]- The ElectraFlex project, utilising Energy Web's blockchain, is being developed to deliver flexibility to the distribution grid in the Catalonia region via a platform. The platform will be developed, which will be aimed at demand aggregators. The platform will provide artificial intelligence-based energy optimisation to coordinate electricity distributors and consumers in a system with bidirectional energy flows. The platform enables functionalities including demand forecasting, customer flexibility forecasting, optimal bidding strategies, scheduling and intraday optimisation and alerts in case of excessive power rises. There is no specified building typology for in which this platform would be applicable.

What is the revenue/payment stream of the SES? What are the value creators? Please try to answer 1. Who pays to energy provider? 2. Who pays to energy efficiency service provider/ESCO? 3. Rewards/Benefits for landlords, tenants and ESCOs? 4. Who finances the energy efficiency investment? 5. Which energy related payments among the following ones: tax incentives, feed-in-tariffs, reduced energy bills, demand response revenues, are determining value generation? 6.Which non-energy benefits among the following ones: increased building value, increased rental value, increased occupant comfort, greater productivity, improved brand image, are determining value generation?

[33] https://www.smart-energy.com/industry-sectors/energy-grid-management/spanish-startup-eyes-consumer-participation-in-flexibility-markets/
[34] https://www.smart-energy.com/industry-sectors/new-technology/blockchain-flexibility-services-to-launch-in-northern-spain/
[35] https://www.smart-energy.com/industry-sectors/energy-grid-management/spanish-startup-eyes-consumer-participation-in-flexibility-markets/

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As mentioned in JRC's report, ANESE estimates that the average size of Spanish ESCO/EPC projects is €433,132. The average length of ESCO projects is 7-8 years. The most common type of contract used by ESCOs is EPC with shared savings (ESCO and client share the savings, ESCOs take financial risk). Whereas AMI and ADHAC (the Spanish Association of District Heating ESCOs) estimates, average size of ESCO/EPC projects might vary from €500,000 to €5000,000 and the average contract length of ESCO projects range from 10 to 15 years. The most popular types of ESCO contracts are: EPC with shared savings (ESCO and client share the savings, ESCOs take financial risk), Build-own-operate-transfer (BOOT) and Contract energy management (chauffage).
What is communication channel/path between all the actor (Landlord/Tenant/ESCO/Bank)? Who contacts whom and how they agree on the contract terms and permissions?
Landlord and tenants communicate with each other. In Spain landlord is mainly responsible for building renovation and installation of energy efficiency measures in the tenanted building, this indicates that landlord is responsible for communicating with ESCOs. Based on ESCO service model in Spain, we can assume that ESCO will communicate with bank/finance providers and own the economic risks based on agreed performance delivery.
Current levels of technology penetration for SES?
Engineering, installation and assembling are the broadly categorised activities for Spanish ESCOs. In Spain companies (national or international companies) providing following type of services, act as ESCOs – Energy supply companies, utilities, facility maintenance companies, and engineering and construction firms, and facility management and operation companies, and automation, control and equipment manufacturers, and equipment supplies and/or installers, and consulting firms, energy auditors, other energy specialists as well as Issuers of energy performance certificates, distributors and installers of renewable technologies (solar thermal and biomass mainly). [36] The typical technologies implemented by ESCOs are building level heating and heating systems, industrial processes, horizontal technologies, motor systems and street lighting. A research published by ENERAGEN on the EPC projects tendering processes within the public sector from 2009 to 2014, shows that among the total of projects, 45% are dedicated to public lighting and all of these have a municipal scope. The other technologies tendered are renovation of buildings, both lighting and renovation of buildings and installation of biomass (QualitEE 2018j).
Who are the SES Provider?
ESCOs are the major energy service provider in the Spain.
Who are the customers for SES? (Private Owner/Residential Landlords/Energy Service Provider/Multi-tenant Building Owner/Building Managing Organizations)

[36] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC118815/jrc118815.pdf

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The typical ESCO clients in Spain are public buildings including hospitals, education buildings and offices followed by commercial office buildings and hotels, and public lighting as well as industry sites and processes. According to QualitEE report, ESCOs have increased their activities on the public administration and private sector business niches in Spain in recent years. [37]

Spain's ESCO market has a high volume of projects in the private sector, specifically in office buildings.[38]

What are available financing options for ESA/SES? Are there any government incentives/support for SES? If yes, please provide details.

Spanish Law 8/2013 defines the criteria of financing the investments in energy efficiency measures with the energy saved. In terms of economic support of energy service market, there exist the following funds and programmes:

- The JESSICA fund[39]
- Programme PAREER dedicated to building renovation[40]
- The programs BIOMCASA II, GEOTCASA, SOLCASA and GIT are assumed to have also objective to promote Energy Service Companies and foment heating and cooling systems that use biomass, solar energy or geothermal energy through project financing[41]

To promote Energy Services, IDAE provides information on financial instruments, incentives and loans to support projects developed by ESCOs. National associations of energy service companies also provide information on energy service.

What are the barriers/obstacles/threat for SES market?

Different agencies and reports identified various berries to growth of ESCO market in Spain. Some of the identified barriers are listed below: -

1. Lack of trust on the ESCO model
2. Lack of financing
3. Contracts too complicated
4. Lack of knowledge of ESCO model
5. Lack of government support
6. Small size of project and high transaction cost
7. Lack of standardization
8. Perceived business and technical risks.

[37] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC118815/jrc118815.pdf
[38] https://www.bpie.eu/wp-content/uploads/2020/09/REPORT-ESCO_FINAL-1.pdf
[39] http://www.idae.es/ayudas-y-financiacion/fondo-jessica-fidae
[40] http://www.idae.es/ayudas-y-financiacion/programa-de-ayudas-para-la-rehabilitacion-energetica-de-edificios-existentes
[41] http://www.idae.es/index.php/idpag.33/relcategoria.1024/relmenu.377/mod.pags/mem.detalle

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9. Ambiguities in legislative framework
10. Lack of fiscal aid

The most highlighted barriers that hinder market growth include the lack of promotion and encouragement by Public Bodies, the lack of successful case examples, and financing conditions not good enough for ESCOs.

What are the drivers for SES market?
The drivers for ESCO market in Spain is listed below[42]: - 1. Increase in energy prices 2. Provision of external expertise/ Contracting turnkey service 3. Pressure to reduce energy cost 4. Offering energy saving guarantee 5. Customer demand

[42] https://qualitee.eu/wp-content/uploads/QualitEE_2-04_CountryReport_ES_2018.pdf

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7.2 NETHERLAND

Country : The Netherlands
How can the current state of the ESCO and flexibility national markets be summarized? Are there any specificities to be considered for the regional markets associated with the pilot site? Use published data to address these questions.
In the Netherlands, the ESCO market is stimulated by the political framework. EPC projects as well as other political measures effectively contribute to the achievement of the goals of the Energy Agreement. The ESCO and flexibility markets are rather uniform throughout the country because most of the SES are provided by national companies; the markets should be evaluated against those in other European countries. The offer of SES in the Netherlands includes various energy infrastructure solutions for heating, cooling, electricity, hydrogen, energy efficiency, storage, and mobility systems. These solutions may be managed by an artificial intelligence-based digital layer. Smart meters, smart grids, smart homes, integration of renewable energy, energy management systems, peer-to-peer energy trading are part of the national SES offer. Energy supply may be delivered as-a-service, i.e. built, owned and operated by an ESCO.
What are the potential energy efficiency opportunities for each different commercial building type? What are the opportunities for flexibility? What are the opportunities to increase renewable penetration? What are the opportunities for energy efficiency, flexibility and renewables utilization in non-commercial buildings?
There are significant opportunities for improving energy efficiency in both commercial and non-commercial buildings. The most advanced solutions that are available in the Netherlands are based on the integration of multiple technologies related to heating, cooling, solar panels, battery storage and electric vehicles. Artificial intelligence solutions are used to analyse and optimize energy consumption as well as to manage the available assets more efficiently[43].
What is the potential for different types of energy intervention in different building typologies within the market of the considered pilot region? What is their aggregated potential for energy savings and value generated?
The potential is overall high due to high level of technology involved and it depends on specific interventions applicable to the various building typologies. According to the largest provider in the Netherlands (Essent), the SES based on artificial intelligence and smart building controls can optimize the energy use with potential efficiency gains of up to 80% and reductions up to 20% in energy bills. Energy storage enables to fully exploit flexibility opportunities for reliable load supply, minimization of energy purchased from the grid and/or energy cost minimization.
What are the foreseen future market developments? What are the opportunities to implement dynamic tariff structures and peer-to-peer trading?
Future market developments are related to the offer of novel SES for Prosumers on the market and the extension of the peer-to-peer concept, including the management of

[43] https://www.smart-energy.com/industry-sectors/smart-grid/essent-launches-smart-energy-as-a-service/

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services related to prosumers to grid and organized groups of prosumers. Dynamic tariff structures will be determined by the produced energy mix, energy demand and amount of energy which can be stored. New hybrid plants based on the integration of PV-panels and batteries will enable to optimize both energy consumption and energy purchase or sell to the grid maximizing the benefits of the PV generation.

How would you define a SES and which SES have you identified in your case? 2. What are the Smart Energy Services (SES) offered? Which building typologies can be associated to the SES and related smart energy contracts? 3. In the case that you have not identified one SES, what would be an optimal SES for your case?

A SES is a service that uses either novel energy technologies to improve energy efficiency or a better utilization of traditional resources, achieved through energy auditing or data collection and analysis (energy consumption from the grid, energy consumption from local resources, daily demand patterns, information from individually metered loads etc). All the building typologies which will be part of smart cities and neighborhoods, industrial buildings and business parks, but also houses, offices, hotels, hospitals can be served by SES.

Most innovative SES identified in the Netherlands are:

- energy supply (based on the integration of multiple technologies) as a service [1]
- energy optimization using AI-algorithms[44]
- peer-to-peer energy trading[45]
- other services such as retrofitting, renewable waste energy, lighting, smart home appliances and total solutions (integrated offerings)[46].
- combined electricity/heat supply using a hybrid solar panel generating electricity and hot water at the same time[47]

What is the revenue/payment stream of the SES? What are the value creators? Please try to answer 1. Who pays to energy provider? 2. Who pays to energy efficiency service provider/ESCO? 3. Rewards/Benefits for landlords, tenants and ESCOs? 4. Who finances the energy efficiency investment? 5. Which energy related payments among the following ones: tax incentives, feed-in-tariffs, reduced energy bills, demand response revenues, are determining value generation? 6.Which non-energy benefits among the following ones: increased building value, increased rental value, increased occupant comfort, greater productivity, improved brand image, are determining value generation?

- The energy provider is paid either by the occupier or by the owner of the building depending on the specific contractual arrangement between the two
- The ESCO is paid by the actor subscribing the service. If energy and energy efficiency

[44] https://www.capgemini.com/our-company/our-corporate-social-responsibility-program/environmental-sustainability/client-services/

[45] https://vandebron.nl/

[46] Tolkamp, J. C. C. M., Huijben, J. C. C. M., Mourik, R. M., Verbong, G. P. J., & Bouwknegt, R. (2018). User-centred sustainable business model design: The case of energy efficiency services in the Netherlands. Journal of Cleaner Production, 182, 755-764

[47] Solarus Smart Energy Solutions, www.solarus.com (The Netherlands) , accessed on December 11th 2021

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are delivered as-a-service (equipment is owned and operated by the ESCO) the ESCO is paid by the building occupier.

- For the tenant main advantages are one-stop-shop solution, reduced carbon emissions, energy efficiency. For the landlord the main benefit is reduction of carbon emissions. For the ESCO the advantage are the energy savings.
- The value generation is mainly determined by reduced energy bills, followed by demand response revenues and tax incentives (if selected energy efficiency measure may benefit from available incentives).
- If the ESCO own the equipment according to the business model in [1], the subscription of the energy service will not likely determine a higher building value or increased rental value because the fee paid to the ESCO will cover the costs associated to provision and utilization of smart equipment. Increased occupant comfort and greater productivity are likely to be achieved due to service optimization performed by the ESCOs. Other business models are possible though[48].

What is communication channel/path between all the actor (Landlord/Tenant/ESCO/Bank)? Who contacts whom and how they agree on the contract terms and permissions?

Tenant is contacting the Landlord to obtain permission of engaging with ESCO, who will need to install new energy efficient equipment. ESCO will also liaise with the Landlord to obtain the permission to install new equipment in the building. They will eventually negotiate and agree the duration of contract and type of equipment included in the retrofit.

Current levels of technology penetration for SES?

The level of technology penetration for the current SES in the Netherlands is rather high if compared to other European countries. These technologies include systems like the artificial intelligence-based digital layer *ectocloud* proposed by Essent to optimize energy assets operation and energy use or other services for developing sustainable technology (based on artificial intelligence algorithms to analyze and optimize energy consumption) offered by large international companies like Capgemini. Moreover, novel technologies for renewable energy production are being utilized, such as the hybrid solar panels for electricity generation and hot water production and their integration with heat pumps by companies like Solarus Smart Energy Solutions.

Who are the SES Provider?

- The largest energy providers in the Netherlands offering SES are: Essent, Vattenfall, Green Choice, Budget Energie, Vandebron, Engie.
- Vandebron is providing a peer-to-peer trading service, which is currently limited to the matching of energy generation & consumption. This type of services could be extended to include energy storage and water heating.
- ENCO Group (NL) is a company which provides electricity to 2 million customers using dispatchable resource aggregation in a single virtual power plant.

[48] Shang, T., Zhang, K., Liu, P., & Chen, Z. (2017). A review of energy performance contracting business models: Status and recommendation. Sustainable cities and society,34, 203-210

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Who are the customers for SES? (Private Owner/Residential Landlords/Energy Service Provider/Multi-tenant Building Owner/Building Managing Organizations)
The customers are private owners or occupiers of residential buildings in smart cities and neighborhoods, as well as in industrial buildings and business parks. Multi-tenant buildings and building managing organizations may also engage and be served by the ESCOs for SES implementation.
What are available financing options for ESA/SES? Are there any government incentives/support for SES? If yes, please provide details.
There are three main business models applicable to the provision of ESA/SES [6]: • The *Shared Savings Business Model*, where the ESCO is responsible for designing, financing, and implementing the project, liaising with a Bank or other lender/investor. The ESCO is responsible to verify the savings during the contract period and gets a fixed portion of them over a fixed period. • The *Guaranteed Savings Business Model*, where the ESCO is solely responsible for designing and implementing the project, but it is not responsible for financing it. The client will be directly responsible for liaising with the lender to get the project financed, while the ESCO guarantees that the savings will be sufficient to pay the service fees. • The *Chaffee Business Model,* where the ESCO manages and transforms the energy system on behalf of the client to achieve the targets specified in the contract and self-finances the related projects liaising with the lender. Depending on the adopted business model either the ESCO or its client will liaise with a bank to get financed the retrofitting project enabling the provision of ESA/SES. Incentives are available in the Netherlands for implementing energy efficiency measures, which may be suitable for the implementation of some SES. The energy efficiency measures eligible for being incentivized must belong to a list of approved measures compiled by the Government. However, some technologies required by SES may not be eligible for an incentive. The available incentives are discussed in the policy-related section.
What are the barriers/obstacles/threat for SES market?
A complete taxonomy of the barriers associated to energy efficiency improvements includes Technology-related, Information-related, Economic, Behavioral, Organizational, Competence-related, and Awareness barriers[49]. The expansion of the ESCO market and SES is expected to contribute to lower or remove some of these barriers, for example those which are more technology and competence-related, if we assume that the technology is fully available to the ESCOs and that customers do not need any specific competencies to engage with ESCOs. Presumably several barriers remain not only for industrial customers, but also for the residential ones, related to lack of information on costs and benefits, information about the technology not clear, lack of trust in the information source, concerns about the intervention not to be sufficiently profitable, other priorities, lack of time, lack of awareness or lack of interest in SES. Small size of projects and high transaction costs; ambiguities in the legislative framework are the other berries identified in Netherland.

[49] Cagno, E., Worrell, E., Trianni, A., & Pugliese, G. (2013). A novel approach for barriers to industrial energy efficiency. Renewable and Sustainable Energy Reviews, 19, 290-308

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What are the drivers for SES market?
The main drivers are: • Energy cost reduction through more energy efficient assets • Decarbonisation of the grid and of the building heating sector • One stop shop solution To be fully trusted by the clients, an ESCO should behave in a fully transparent manner sharing the actual energy savings obtained with the client and giving the possibility to the clients to compare the amount of savings with the service fees. Decarbonisation of the electricity and heat sectors is strongly incentivised by the national policy in the Netherlands. The ESCOs that will offer SES based on zero-carbon assets will enjoy incentives and opportunities to lower implementation costs thereby further increasing their margins. Further information can be found in the section about the national policies in the Netherlands. A one-stop shop is a business offering multiple services (i.e., customers can get all they need in just "one stop"). In the Netherlands, the ESCOs are already offering the one-stop shop formula with the provision of energy supply based on the integration of multiple technologies (such as heat pumps, PV-panels, battery storage systems, thermal storage systems, building automation and controls, energy efficiency measures, electric mobility solutions etc.) as a service. That way, they will overcome some of the barriers hindering the acceptance of the SES, which are associated to lack of time/other priorities; furthermore, providing clear information to the customers about the technologies employed, their costs and benefits, they will also overcome the barriers related to lack of information.

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7.3 GREECE

Country: Greece
How can the current state of the ESCO and flexibility national markets be summarized? Are there any specificities to be considered for the regional markets associated with the pilot site? Use published data to address these questions.
ESCO market in Greece is at embryonic stage and has become stagnant. Market structure for ESCO market is not yet established in Greece As per JRC report (Energy Service Market in EU) published in 2019, Greece has scored 1 (out of 10) as the maturity of market. The maturity of market was assessed based on several indicators. Below are the indicators and score of Greece against each indicator: - 1. Associations (0) 2. Facilitators (1) 3. Demand-drive (0) 4. Quality labels (0) 5. Monitoring & Verification (0) Due to Economic instability of Greece, energy service market has not reported significant development since 2015. This market instability has caused difficulties for most of the businesses to invest in EPC projects either through their own capital or borrowing capital. Although renovation of public buildings is undergoing as the obligation of EU Directives. Also from mid-2018 Greek non-SME businesses are obliged to undergo mandatory energy audit. Some initiatives are in place to encourage ESCO market development as mentioned in NEEAP 2017 of Greece. Greece has an ESCO register, where all the ESCOs of Greece are registered. Based on the data provided by the ESCO registry, as of June 2021, a total of 61[50] ESCOs are registered in Greece. All of the ESCO companies are small (up to 50 employees) or medium companies (up to 250 employees). Based on total project budget of the individual ESCOs, the ESCO registry has been categorised in the four categories[51]. • **A1** – Companies that have implemented or are currently implementing energy efficiency projects with Energy Performance Contracts with a total budget of at least €300000 in the last five years. These companies provide EPC projects. • **A2** - Companies that have implemented or are currently implementing energy projects (energy efficiency and/or renewable energy) with a total budget of at least €1000000 in the last five years. These need not be accompanied by an EPC contract. • **A3** – All the companies belonging to neither category A1 or A2. • **B** – Natural persons that offer energy consultancy services.

[50] http://www.escoregistry.gr/#
[51] https://qualitee.eu/wp-content/uploads/QualitEE_2-04_CountryReport_EL_2018.pdf

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Engineering and construction firms, consulting firms, energy auditors, energy consultancy, energy supplies companies and building energy performance certificate issuer firms acts as ESCOs in Greece. These ESCOs usually offers services with guaranteed energy performance. These companies are listed under ESCO registry of Greece[52].

What are the potential energy efficiency opportunities for each different commercial building type? What are the opportunities for flexibility? What are the opportunities to increase renewable penetration? What are the opportunities for energy efficiency, flexibility and renewables utilization in non-commercial buildings?
In Greece, market reforms are planned to fully integrate demand response and energy storage in the energy market and will be fully eligible for Capacity remuneration mechanism in the Balancing Market.[53] Renewable Energy Systems (RES) is also in focus of National Energy and Climate Plan (NECP) of Greece for the energy market development. The process to introduce the demand side response and RES in the balancing market like market design, regulatory framework adaptation, IT systems and procedures is under progress. The integration of demand response in the Greek energy market will be all level including individual customers, load representatives and demand response aggregators. Under the National Resilience and Recovery Plan (NRRP), an explicit financial support will be announced as a friendly process to support the development of energy storage services and large-scale hydro pumping station with capacity around 700MW and batteries around 1400MW. These storage facilities will be utilised as load shifters along with the demand-response services. To integrate energy storage in the Greek energy market the Ministry of Energy and Environment has created a working group to make the legal framework. Roll out and installation of nationwide smart meters is also planned for Greece. This will enable the dynamic energy pricing for the consumers and network use and will trigger the energy efficient behavior of consumers.
What is the potential for different types of energy intervention in different building typologies within the market of the considered pilot region? What is their aggregated potential for energy savings and value generated?
Hardware interventions, software interventions and combination of hardware and software interventions are three broad classifications of most popular energy interventions in Greece. All these interventions are suitable for residential as well as commercial buildings. Hardware interventions can be further categorized as building thermal insulation upgrade, upgrading energy inefficient appliances, renewable energy generations, installing smart devices. But last two hardware interventions are not common in Greece. Software interventions are completely new to Greece. These interventions can be further categorised as smart energy management algorithm for controlling the smart devices/appliances and installed RES and performing energy trading optimisation, peer-to-

[52] http://www.escoregistry.gr/

[53] https://ec.europa.eu/energy/sites/default/files/greece_market_reform_plan.pdf

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peer energy trading.
What are the foreseen future market developments? What are the opportunities to implement dynamic tariff structures and peer-to-peer trading?
Installation of smart meters and integration of demand response/flexibility are highly prioritised for energy market in Greece. Government is taking actions to introduce these services and promote dynamic tariff structure in the Greece. As per government plans Demand response will start the market integration by Q1 of year 2022. Ministry of energy and environment is also working to introduce energy storage system using hydro pumping station.
How would you define a SES and which SES have you identified in your case? 2. What are the Smart Energy Services (SES) offered? Which building typologies can be associated to the SES and related smart energy contracts? 3. In the case that you have not identified one SES, what would be an optimal SES for your case?
Greece is in the embryonic stage of EPC market and hence for the SES market as well. Energy market is yet to develop and mature in Greece. Nationwide smart meters roll out and hence introduction of dynamic energy tariff structure is planned. Some of the smart hardware and software interventions can be categorized as SES for example installation of smart devices, smart energy management algorithm for the installed smart devices, peer-to-peer energy trading, demand response/flexibility. These smart services are yet not widely implemented in Greece.
What is the revenue/payment stream of the SES? What are the value creators? Please try to answer 1. Who pays to energy provider? 2. Who pays to energy efficiency service provider/ESCO? 3. Rewards/Benefits for landlords, tenants and ESCOs? 4. Who finances the energy efficiency investment? 5. Which energy related payments among the following ones: tax incentives, feed-in-tariffs, reduced energy bills, demand response revenues, are determining value generation? 6.Which non-energy benefits among the following ones: increased building value, increased rental value, increased occupant comfort, greater productivity, improved brand image, are determining value generation?
Most of the EPC projects in Greece lasts less than 5 years, and there are no projects with tenure more than 10 years. In Greece shared saving model of EPC contract is more prevalent than guaranteed saving EPC contract, where shared saving model of EPC contract is more associated to third party financing[54]. Building owner/tenants pay to the energy provider based on the terms and condition of their tenancy contract.
What is communication channel/path between all the actor (Landlord/Tenant/ESCO/Bank)? Who contacts whom and how they agree on the contract terms and permissions?
ESCOs acts as communication channel between its client and third party finance provider.
Current levels of technology penetration for SES?
Hardware interventions, software interventions and combination of hardware and software interventions are three broad classifications of most popular energy interventions in Greece. All these interventions are suitable for residential as well as commercial buildings.

[54] https://qualitee.eu/wp-content/uploads/QualitEE_2-04_CountryReport_EL_2018.pdf

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Hardware interventions can be further categorized as building thermal insulation upgrade, upgrading energy inefficient appliances, upgrading heating systems in buildings, cooling and air conditioning renewable energy generations, installing smart devices. But last two hardware interventions are not common in Greece. Software interventions are completely new to Greece. These interventions can be further categorised as smart energy management algorithm for controlling the smart devices/appliances and installed RES, automation and control systems and performing energy trading optimisation, peer-to-peer energy trading.
Who are the SES Provider?
ESCOs
Who are the customers for SES? (Private Owner/Residential Landlords/Energy Service Provider/Multi-tenant Building Owner/Building Managing Organizations)
Private commercial office buildings, hotels and tourist facilities as well as public lighting are the major customer of ESCOs to avail the energy efficiency services.
What are available financing options for ESA/SES? Are there any government incentives/support for SES? If yes, please provide details.
By far the most significant tool for financing EPC projects in Greece is debt borrowed by clients, operating leases, client's internal funds, project financing, debt borrowed by service providers. The small ESCOs in Greece struggle to fetch financing due to their small business size and exorbitant interest rates being offered by the banks. Whereas, the bigger ESCOs have easy access to financing but they are not keen on investing in bigger EPC projects due to perceived risk of instable economy of the country. Hence, internal funds of client or the provision of operating leases, are the most preferred financing option by ESCOs and lending banks due to its reduced risk for the implementation of EPC projects.[55] EPC providers and facilitators find procurement of financing for EPC project is difficult to very difficult in Greece due to aforementioned reasons. Through the Law 4342/2015, financial schemes supporting energy efficiency services projects and best practices for EPC for building renovations, are available. Ministry of Environment and Energy provides support like creating quality labels, providing contact points for customers to receive more information on energy services, developing risk evaluation methodology for assessing energy service projects, granting loans to energy service companies etc. for the development and growth of EPC market. Moreover, a training programme was organised for the ESCOs and financial institutions to help them with the technical and economical assessment of energy saving projects through EPCs.
What are the barriers/obstacles/threat for SES market?
Economic uncertainty of the country posed adverse effect on the Greek ESCO market development since 2015. Because of financial instability potential investors lack confidence to invest in EPC projects. Lack of access to financing by clients/ESCOs and lack of suitable financing options is the

[55] https://qualitee.eu/wp-content/uploads/QualitEE_2-04_CountryReport_EL_2018.pdf

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most prevailing barrier for SES market in Greece. Other barriers are complexity of EPC concept, unclear legislative framework to support ESCO/SES market development, lack of in-house technical expertise, lack of standardization, small size of project compared to high transection cost and lack of trust on ESCOs.
What are the drivers for SES market?
ESCO and Smart Energy Service market in Greece is in embryonic stage. Higher energy prices, EEO targets and offering financial support/incentives for energy efficiency upgrades, guaranteed energy savings are the drivers for ESCOs to implement/adopt SES delivery in Greece. The start of the Energy Efficiency Obligation (EEO) scheme in 2017 as well as the measures for the public sector could help to boost these markets.

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7.4 IRELAND

Country : Ireland
How can the current state of the ESCO and flexibility national markets be summarized? Are there any specificities to be considered for the regional markets associated with the pilot site? Use published data to address these questions.
The size of the ESCO market in Ireland has an estimated value of 20 million Euros but there are no official data about that. The market has been growing slowly since 2015 because the energy users are developing an awareness of the ESCO services and the ESCO are improving their market offer to better address the needs of the potential clients. There is a good support from the Government for the Energy Performance Contracts especially in the public sector even though some barriers hinder a better uptake such as a lack of understanding of EPCs, lack of accountability, institutional barriers, and reluctance to changes[56]. SEAI does not provide breakdown of data per regions (counties) thereby we assume that the market development is reasonably homogeneous throughout Ireland.
What are the potential energy efficiency opportunities for each different commercial building type? What are the opportunities for flexibility? What are the opportunities to increase renewable penetration? What are the opportunities for energy efficiency, flexibility and renewables utilization in non-commercial buildings?
The potential opportunities firstly around energy efficiency in typical commercial building will sit principally around controls optimisation, LED upgrades, re-engineering air handling and heating systems - VSD drives, occupancy/ use based controls introduced. The ability to promote on site generation and energy storage through PV arrays and battery storage are now becoming common strategies however batteries remain expensive and they are only beginning to be deployed on pilot or demonstration sites. SEAI has identified the main energy efficiency opportunities for all the sectors in its 2015 report. As for the commercial buildings they are (in brackets the potential for primary energy savings in 2020): Energy efficient lighting with controls (1.1 TWh/year), Heat pumps (0.8 TWh/year), Roof insulation (0.7 TWh/year), Energy efficient glazing (0.7 TWh/year). Heat pumps are the most important opportunity to increase renewable penetration. In addition, in public buildings and in residential buildings more efficient boilers with heating controls may be an effective measure to increase energy efficiency (respectively 0.4 TWh/year and 3.8 TWh/year), whereas in industry heat recovery (1.6 TWh/year), more efficient motor systems (1.1 TWh/year) and combined heat power units (0.8 TWh/year) are the most effective energy efficiency measures[57].
What is the potential for different types of energy intervention in different building typologies within the market of the considered pilot region? What is their aggregated potential for

[56] https://publications.jrc.ec.europa.eu/repository/handle/JRC118815

[57] Maximising Ireland's Energy Efficiency. The National Energy Efficiency Action Plan 2009 – 2020, https://assets.gov.ie/76575/d10c25dd-0b3f-48d3-bd6e-bb21fe4c5475.pdf

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energy savings and value generated?
There tends to be a similarity across many of the building typographies in terms of interventions. So LED upgrade if not already completed tends to be top of the list. Then the next in list would be controls upgrades and enhancements adding visibility and functionality to or replacing the existing systems. Efficiency upgrades on heating and air-conditioning plant is another area of opportunity consistent across building typographies. In terms of fabric upgrades roof insulation which often from part of a roof maintenance/leak repair programme is another intervention that is common to building typographies. The replacement of windows for improved thermal performance, reduced air permeability, solar gain and the introduction of hybrid natural ventilation is an intervention that again is common to all typographies. In terms of integration of renewables in Ireland this is principally PV and again subject to site constraints and electrical load profile it's an intervention that is common across typographies. Some interventions remain site specific such as demand based water circulation in swimming pools, heat recovery from refrigeration in hotel and retail sectors also. Three popular energy interventions are the installation of energy efficiency lighting with controls, the energy efficient glazing and the roof insulation. The aggregated potential for energy savings depends on the sector where these measures are applied to. The efficient lighting can save 1.1 TWh/year in the commercial sector and 0.5 TWh/year in the public buildings, transport sector and utilities. Energy efficient glazing can save 0.7 TWh/year in commercial buildings and 0.5 TWh/year public buildings, transport sector and utilities. Roof insulation can save 0.7 TWh/year in the commercial sector, 0.2 TWh/year in the public buildings, transport sector and utilities, and 1.2 TWh/year in the residential sector. Other measures which are more common in the residential sector are the solid wall insulation (1.5 TWh/year savings), utilisation of energy efficient appliances (0.7 TWh/year), reduction of 1 degree Celsius of room temperature (1.1 TWh/year).
What are the foreseen future market developments? What are the opportunities to implement dynamic tariff structures and peer-to-peer trading?
Ireland has a large potential for energy savings in the commercial sector by means of Demand Side Management (cost-effective opportunities for energy usage such as exploitation of dynamic tariff structures and demand reduction) which are measured in Primary-Energy-Equivalent (PEE). For the electricity, oil and gas consumption the potential savings achievable were estimated in 6000 GWh, 1560 GWh and 1000 GWh respectively in the National Energy Efficiency Action Plan 2009 – 2020. Opportunities for saving 8,560 GWh PEE in the commercial sector and 5,220 GWh PEE in the industry sector in 2020 were identified by the Government through various programmes[58]. Peer-to-peer trading is currently an academic research topic and will further increase the potential for demand side management through more cost-effective energy consumption.

[58] Maximising Ireland's Energy Efficiency. The National Energy Efficiency Action Plan 2009 – 2020, https://assets.gov.ie/76575/d10c25dd-0b3f-48d3-bd6e-bb21fe4c5475.pdf

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In terms of demand side management there is still a lack of clarity in the market with uncertainty around future tariffs is delaying development of the demand response market. Deployment of dynamic tariff from energy supply companies is still awaited although smart metering is substantially underway and only have day/night and a winter max demand in the market currently.
How would you define a SES and which SES have you identified in your case? 2. What are the Smart Energy Services (SES) offered? Which building typologies can be associated to the SES and related smart energy contracts? 3. In the case that you have not identified one SES, what would be an optimal SES for your case?
Smart Energy Services are all those which can deliver tangible improvements in energy efficiency verified using Measurement and Verification methodologies. These services may include installation of more energy efficient equipment or more efficient operation of existing equipment. SES are delivered through Energy Performance Contracts and Energy Performance Related Payment. Potentially all the typologies of buildings can benefit of SES even though some efficiency measures may generally apply only to some buildings (see also previous answers).
What is the revenue/payment stream of the SES? What are the value creators? Please try to answer 1. Who pays to energy provider? 2. Who pays to energy efficiency service provider/ESCO? 3. Rewards/Benefits for landlords, tenants and ESCOs? 4. Who finances the energy efficiency investment? 5. Which energy related payments among the following ones: tax incentives, feed-in-tariffs, reduced energy bills, demand response revenues, are determining value generation? 6.Which non-energy benefits among the following ones: increased building value, increased rental value, increased occupant comfort, greater productivity, improved brand image, are determining value generation?
The revenue of a SES is generated by a payment for energy efficiency performed by the client to the ESCO after verification that target contractual savings have been achieved. The value creators are the technologies which can deliver energy efficiency and energy savings, their manufactures and the experts who provide advice about the most effective measures to the clients for increasing the energy performances of a commercial building. 1. The building owner or occupier pays the energy provider, depending on the business model and contractual agreement between parties. 2. The energy efficiency provider/ESCO is ultimately paid using the energy savings achieved. The subject who receives the energy bill from the energy supplier will obtain the energy savings and will pay an energy performance related payment or a monthly fee to the ESCO. 3. The EPC contractual template provided by SEAI[59] is not specific for the split-incentive case. The landlord should be the client of the ESCO because he can give permission to install energy efficiency measures in the building, whereas the tenant cannot. The SEAI EPC contractual template includes both a guaranteed saving threshold and a shared saving threshold. The latter is higher than the former. The ESCO guarantees periodically a certain level of energy savings to its client upon a recurrent payment of a fee. If the savings are not achieved for the current

[59] https://www.seai.ie/business-and-public-sector/business-grants-and-supports/energy-contracting/

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reconciliation period (either 6 months or one year) the ESCO compensates the client by paying the difference between the guaranteed amount and the actual amount and refunding all the fees obtained within the current reconciliation period. If the savings are higher than the guaranteed level but lower than the shared level, the ESCO takes all the savings exceeding the guaranteed level. If the savings are higher than the shared threshold, then the savings exceeding the shared threshold are equally shared between ESCO and client. The economic benefits associated with the provision of an ESCO energy efficiency service might be in part shared between the landlord and the tenants but at least the tenant would obtain likely a renewed and more comfortable place.

4. The energy efficiency investment is financed by the ESCO through a lender, investor or bank.

5. Mainly tax incentives, reduced energy bills and demand response. The main tax incentive scheme is the Accelerated Capital Allowance[60] (ACA) which allows a company, sole trader, or farmer paying corporation tax in Ireland to deduct the full cost of energy efficient products & equipment from their profits in the year of purchase, resulting in a tax reduction paid by the organisation in that year of 12.5% of the value of capital expenditure. Opportunities for earning revenues with demand response also exist for manufacturing plants, food production facilities, cold warehouses, hospitals, hotels, quarries, cement factories throughout Ireland. These DR clients may get paid by DR aggregators per kilowatt of electricity that they can make available for demand reduction when required. Demand reduction can be achieved by switching some loads off, by switching on a local generator, or by delaying the start of a process[61].

6. The results of a survey undertaken in the Triple-A project[62] showed that buyers have a rare (52%) or very rare (27%) willingness to pay a higher price for a building retrofitted with energy efficiency upgrades, while 61% of the participants responded that more attention to such measures is paid in residential rather than commercial buildings. The high energy efficiency class of a building is influencing long-term capital investments, but a poor energy efficiency class is not considered as a decisive factor for rejecting a property. Building envelope retrofits, HVAC&R and lighting appliances' retrofits are expected to increase the value of the property when being applied. Energy efficiency upgrades have a direct impact on the value of the properties, affecting the market attractiveness, as well as driving the investors in the energy renovations process. A study of the JRC reported an increase of 3-8% in the price of residential assets due to energy efficiency improvements, and an increase of about 3-5% in residential rents with respect to non-retrofitted similar properties. For commercial buildings, it was found that the reward was even higher with an increase of the sales price between 10% and 20% compared to similar non-properties[63]. In Ireland each improvement of the energy efficiency of a house along

[60] https://www.seai.ie/business-and-public-sector/business-grants-and-supports/accelerated-capital-allowance/
[61] https://www.powerhousegeneration.com/dsu-grid-scheme/how-you-can-benefit
[62] https://www.aaa-h2020.eu/
[63] https://www.managenergy.net/node/683

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the BER scale was associated with an increase in the sales price between 1.5% and 2%[64].

7. These findings are likely to apply to Irish market as well. Other factors such as increased occupant comfort, greater productivity, improved brand image may also apply but are difficult to quantify and might be deemed less important than the increased value of the property.

What is communication channel/path between all the actor (Landlord/Tenant/ESCO/Bank)? Who contacts whom and how they agree on the contract terms and permissions?

Both tenant and landlord can initiate the process of engaging with an ESCO. A tenant may engage with an ESCO to receive advice regarding those simple energy efficiency measures which do not require upgrades to the building and construction works, such as energy monitoring, energy management, load shifting, advice on how to use appliances to save energy, advice on switching electricity tariffs and contracts. A landlord may engage with an ESCO to plan powerful measures that require replacement of existing equipment and interventions on the building envelope. Permission from the landlord must be always obtained prior to start works in the rented premise. The landlord may agree with the ESCO that first simple and low-cost measures will be installed to accumulate energy savings and that those savings will be used later to finance medium and high-cost measures. This will result in a staggered implementation plan of energy efficiency measures. The ESCO normally liaise with a bank to get the investment funded, but the landlord could also do it, depending on the specific contractual agreements. The landlord should inform the tenant about their intention to enter in a contractual agreement with the ESCO involving the installation of energy efficiency measures in the building units occupied by the tenant such that the tenant may decide to terminate the renting contract if not happy.

Current levels of technology penetration for SES?

Current level of technology available for SES is medium-high. There are SMEs in Ireland which can install advanced energy efficiency measures such as computer-based energy management systems, micro-grid generation and storage equipment and supply monitoring and diagnosis platforms. These companies often participate in large demonstration project with universities and other research institutions to further increase the level of innovation delivered by their products.

Who are the SES Provider?

SES providers in Ireland are Energy Service Companies (ESCO) also called energy efficiency providers. The electricity supplier ESB also provide SES such as (i) the Energy Management Hub which can monitor energy and water usage in buildings and enables their team of experts to devise solutions to control and reduce it; (ii) lighting as a service; (iii) battery storage; (iv) heating solutions[65].

Who are the customers for SES? (Private Owner/Residential Landlords/Energy Service Provider/Multi-tenant Building Owner/Building Managing Organizations)

[64] https://pinergy.ie/news/energy-rating-has-an-impact-on-value-of-irish-houses/
[65] https://esbecars.com/our-businesses/smart-energy-services/smart-energy-services-overview

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In principle private owners, residential landlords, energy service providers, multi-tenant building owners and building managing organisations may all be customers of SES. However major providers of SES (such as ESB) are targeting large commercial organisations such as Tesco Ireland, Medite, the Dublin Airport Authority, ABP Food Group, and Ardagh Glass offering thorough decarbonisation strategies based on the electrification of heat, energy storage, heat recovery and smart energy management systems[66].
What are the barriers/obstacles/threat for SES market?
Barriers and obstacles may be potentially located at all levels including technology, infrastructure, behaviour, legislation and Government policy. Potential buyers may not be fully aware of available technologies at the point that the rational decision-making is hindered. Moreover, there are market barriers to energy efficiency such as high energy prices, a disproportion between costs and benefits of efficiency actions, uncertainty about wide impacts on the society and presence of hidden costs (amongst them, that one associated to the climate change). Another barrier might be the lack of a timely and adequate Government policy to tackle the market barriers and allow the stakeholders to understand their best interests and to behave accordingly, making decisions that will keep creating benefits for themselves[67].
What are the drivers for SES market?
The drivers are research and development in energy efficient technologies, technological development of new products, development of Energy Performance Contracting practices and their institutional support (for example through contractual templates).

[66] https://www.irishtimes.com/sponsored/esb/where-sustainability-and-business-efficiency-align-1.4812065
[67] https://assets.gov.ie/76575/d10c25dd-0b3f-48d3-bd6e-bb21fe4c5475.pdf

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